The friction of the mundane: on the problematic marketization of the carbon stored by trees in the tropics

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Abstract

Carbon dioxide released from the burning of fossil fuels is a major concern of our times. There is now a political agreement that these emissions must decrease. So far one way forward has been to design and maintain carbon markets. As part of this process, trees in the tropics have been enrolled in peculiar transactions: actions such as reforesting a land of degraded savannah or preserving a piece of forest can produce tradable emission credits to offset against CO2 emissions in distant locations. Based on a multi-sited investigation of carbon offsetting, including fieldwork in the Congo, the paper presents a journey across different marketization sites where the enrolment of forest carbon into market exchanges can be seen to be at stake. Several operations are foregrounded, from United Nations negotiations and the measurement of carbon stocks, to business venture and legal work. The paper proposes a focus on the mundane that attends to details and frictions. This provides a deflationary story of the marketization of forest carbon, a story of contingencies and unexpected ramifications.

Introduction

Carbon dioxide released from the burning of fossil fuels is a major concern of our times. Under the impetus of United Nations negotiations on climate change, there is a now a widely shared political agreement that these emissions ought to decrease. So far, one way forward has been to establish targets limiting the amount of CO2 collectively emitted and create tradable emission rights. The latter's scarcity is expected to make the release of carbon into the atmosphere costly, at the same time as making the reduction of emissions a profitable action. As part of this process, trees in the tropics have been enrolled in peculiar transactions: quantities of emissions supposedly reduced by interventions such as afforesting a piece of land can be exchanged against money to compensate for CO2 emitted elsewhere. The mundane market matters of this new type of exchange, commonly referred to as carbon offsetting, will be the focus of this paper.

It has now become frequent to think of global warming in terms of the Anthropocene, a word used by geologists to debate whether our planet has entered a new age because of mankind's activity (for a review see Lorimer 2017). Within the social sciences, the notion of the Anthropocene triggers discussions pointing out that carbon emissions originate from productive activities and globalized market exchanges in a highly unequal world. From such a perspective, the development of offsetting is the continuance of what Moore (2015) would call the cheapening of nature. Cost-effectiveness (achieving a climate target at the lowest cost possible) is the main justification for trading CO2 units (Lane 2012), in particular, those derived from forestry projects. As we will see in this paper, the latter have consistently tended to be considered the cheapest means to reduce emissions, not the least by Stern (2007)

in his high-profile report ‘The economics of climate change’. The reliance on trees planted in the tropics to absorb CO2 while polluting processes are left untouched sounds almost ironic when one has in mind the proposal made by Haraway et al. (2016). They suggest that the plantation system (from cotton fields to timber plantations) epitomizes the kind of long-distance exploitation that has long been at work in Europe’s colonizing enterprises, the slave economy of the United States and contemporary capitalistic exchanges of natural resources. Carbon offsetting via plantations and other forestry activities seems then to perpetuate this controversial history that has caused, among many other problems, global warming.

Concrete attempts to swap the carbon sequestered through photosynthesis in the trunks and roots of trees for the carbon emitted by coal-based power generation, for example, have not been left unquestioned. For the environmental activist organization Greenpeace (2013), ‘fossil carbon’ and ‘forest carbon’ are simply incommensurable. While the latter will eventually circulate into the atmosphere and oceans because trees die, the former has formed deeply underground over millions of years; releasing this fossil carbon increases the total amount of CO2 exchanged aboveground, and only a very limited fraction of this additional quantity can be slowly absorbed by the terrestrial bio- sphere. CO2 offsetting through forestry activities is therefore not a suitable response to the warming of the Earth. Case studies further this critique by documenting specific instances of contentious initiatives in places like China, Mexico, or Uganda (e.g. Corbera and Brown 2010, Osborne 2015, Nel 2017). Turning forest carbon into tradable emission offsets, it is said, unsettles common property rights and encourages privatization and land eviction. It also tends to equate trees to biomass and privilege simplistic land use models whose capacity to sequester CO2 might be lower than more complex and bio-diverse human-shaped ecosystems. Moreover, offsetting projects unequally distribute revenues, either by benefiting consultants (who are required to calculate and verify carbon stocks) or by leaving behind unfulfilled promises. In a nutshell, selling and buying forest carbon is a highly contested activity.

The empirical and theoretical accounts discussed above consider that offsetting is problematic because of what it does to inhabited forested landscapes as well as because of what it does not do, like ‘initiating a new historical pathway that leads away from the dependence on fossil fuels’ (Lohmann 2010, p. 80). Taking note of these critiques, I propose here to ask: when, where, and how exactly is the capacity of trees in the tropics to store carbon enrolled in market transactions in the form of CO2 offsets? Guided by this question and some of the work done within Science and Technology Studies (STS) on markets, the story told in the following pages ought to deflate the reach of market exchanges involving forest carbon. These exchanges, I suggest, have remained quite marginal, partly due to the disputes they tend to provoke, but also because of more discreet resistances such as the unruliness of living things and taken-for-granted practicalities failing to materialize. Carbon offsetting is a minimal and limited intervention unable to confront the problem of global warming caused by industrial processes and land use changes. Yet I would like to suggest that this unthreatening appearance may, in fact, have allowed it to contribute to establishing carbon emission as a problem. As imperfect, useless, or damaging as one may say they are, carbon markets emerged at a time when releasing greenhouse gases into the atmosphere was not a political issue, while it may be partly due to these markets’ (problematic) existence that carbon emissions have now become a durable concern.

The approach proposed here to explore carbon offsetting (in particular when it involves tropical forests) can be described as a focus on the mundane. The paper will examine how these market relations become of the world in specific places and under specific circumstances. It will pay attention to the logistics of offsetting, that is, the detailed organization and implementation of diverse operations (political negotiations, metrological requirements, business practices, and legal infra- structures) through which it happens. This focus on the mundane allows us to nuance the effect of, for example, a United Nations text creating a market mechanism. This kind of announcement participates in making market exchanges of CO2 units a reality, but only as an idea, at best a plan, whose concrete realization must be investigated. The logistical sensibility employed here thus aims to look at how, where, when, and in what form the market relations of carbon offsetting take shape. This provides, I suggest, a deflationary story that foregrounds contingency and traces unexpected ramifications.

In the next section, I will discuss a selection of STS work on markets and present the empirical research I have conducted. This will allow me to introduce the notion of marketization site and further develop what I mean by a focus on the mundane. The paper will then move on to the empirical description, organized into four sections, each dedicated to a different marketization site, followed by a conclusion where I will say a last few words about the friction of the mundane.

A focus on the mundane and its frictions

The theoretical starting point for this enquiry into carbon offsetting is Callon's work on markets, especially when, together with Çalışkan, he suggests considering 'markets as arrangements configured during a marketization process' (Çalışkan and Callon 2010, p. 2). Marketization is minimally characterized by the exchange of goods and the transfer of ownership against monetary compensations. It involves heterogeneous elements (rules, technical objects, calculative tools, texts, knowledge, various skills, etc.) and asymmetrical capacities to act, leading sometimes to disputes (see also Callon 2007). To approach markets as marketization processes, Çalışkan and Callon (2010) provide a series of analytical tools that refer to interrelated operations, from 'pacifying goods' and 'marketizing agencies' to 'price-setting' (p. 5). Of particular interest for us is the operation they call 'market design and maintenance' (Çalışkan and Callon 2010, p. 19). Talking about market design reveals that carbon offsetting has been invented as an international climate policy and that the question of how the exchange of CO2 units can work for this purpose is key. Talking about maintenance (or in other words logistics) allows us then to wonder how these transactions are effectively accomplished. In offsetting, the design and maintenance of market relations are meant to solve a problem: the process of marketization responds to a certain way of defining what is problematic with global warming and, as suggested in the introduction, this conception of the problem has been extensively questioned (cf. Callon 2009).

To organize my analysis of the enrolment of trees in offsetting exchanges, I propose to delimit several marketization sites in which the problematization activity described above can be witnessed. The paper will take us to specific places and times where and when the marketization of forest carbon has been at stake, namely United Nations negotiation sessions, a plantation in the Congolese savannah, and the ministry of environment in Kinshasa, Democratic Republic of the Congo. These marketization sites are narrative artefacts that help me render a multi-located fieldwork investigation

whose geographical and thematic displacements were driven by the multivalence of the issue under scrutiny. From 2010 to 2013, I constituted a substantial documentation on carbon markets (UN texts, various reports, press releases, academic articles, etc.) and carried out interviews (around 60) with a large range of stakeholders. I also conducted observations in the Democratic Republic of the Congo (in Kinshasa, within the ministry of environment for six weeks, and during a field trip to the savannah), and at United Nations climate negotiations in Durban, South Africa. Organizing the empirical narration of this paper into marketization sites allows me to put forward multiple operations (political negotiations, metrological requirements, business practices, and legal infrastructures) that are mobilized for offsetting to happen and whose details matter to the (problematic) accomplishment of marketization.

Paying attention to details through a kind of logistical sensibility is precisely how MacKenzie (2009a, 2009b) documents the emergence of markets trading CO2 units, such as the Clean Development Mechanism (CDM) of the Kyoto Protocol. The Kyoto Protocol is an international treaty, through which wealthy nations committed to comply with emission targets. The text created two kinds of carbon market that would help them to do so. The first type is a cap-and-trade system, whereby the total emission cap is translated into emission allowances that can be sold by governments expecting to emit less than their target to those expecting to exceed it (on the European adaptation of this system, see MacKenzie 2009a). The second type of market, to which the CDM belongs, is project-based offsetting. Emission credits are generated by projects whose implementation leads to a reduction in emission levels compared to business-as-usual. The Kyoto Protocol allows wealthy countries to meet their cap by importing emission credits obtained from such activities located in developing countries (including, under specific conditions, planting trees). With regard to the CDM, MacKenzie (2009b) wonders how equivalence, a priori justified by the global nature of CO2, is practically established between a power generator in Scotland buying emission credits and a modernized chemical plant in China selling these credits. He shows that a series of devices and calculations are involved in translating both activities into the same unit, tonnes of CO2, either emitted by fuel combustion or reduced by the treatment of exhaust gas. In particular, MacKenzie examines a scientific equation used to convert trifluoromethane, a greenhouse gas released during the production of refrigerants, into CO2 equivalents based on the comparative climatic impacts of the two gases. By computing that one tonne of trifluoromethane equates to 11,7000 tonnes of CO2, the formula has made the sale of emission credits from the treatment of trifluoromethane exhaust (and subsequent emission reductions) in the Chinese and Indian refrigerant industry a very lucrative business (see Bryant et al. 2015). The calculative technicality, which produces taken-for-granted numerical values, happens to be an important market matter, a detail that creates profit-making opportunities and triggers investment decisions.

MacKenzie's (2009b) engagement with carbon offsetting is mainly restricted to measurement devices that are derived from the climate sciences and form the basis for quantifying emissions and give an existence to the new object of exchange. We too will encounter such black-boxed metro- logical resources. But instead of focusing on one formula, which then appears as the cornerstone of the whole market, carbon offsetting will be approached in this paper by attending to a plurality of details, such as disputed words in a United Nations decision, cash flow estimates, trees growing slower than expected, and moral judgments about corruption. A parallel can be drawn with Barry's (2013) work on the construction of a pipeline in Georgia. His account of this infrastructural project involves, among other things, compensation rules, art-

activist campaigning, experiments assessing the impact of construction traffic, and debates over the properties of the coating material. To describe his approach, Barry talks about 'the study of material politics', understood as 'a commitment to a certain form of empiricism, one that requires us to attend at once to the specificity of materials, to the contingencies of physical geography, the tendencies of history and the force of political action' (Barry 2013, p. 183). Talking of the mundane to examine the enrolment of forest carbon in offsetting, as proposed here, amounts to a similar move.

This focus on the mundane will point to details that help shape and maintain the possibility of exchanging carbon offsets but tend to be overlooked, because at first sight they look negligible. More- over, given its other meaning – the mundane as that which is of this earthly world – the term sounds particularly relevant to interventions set up in response to the warming of the Earth and which should, therefore, seek to transform how human societies engage with other earthly things. In particular, the paper will examine an offsetting project taking the form of a plantation of acacias, a group of species to which, funnily enough, Haraway (2016) dedicates one of her stories meant to make us think of how to better live and die on a damaged planet (or in the Anthropocene). Haraway's story explains in great detail how acacia trees and ants help each other reproduce, showing 'species in all their complexities and ongoingness [that] do great harm and sustain whole worlds, sometimes in association with human people, sometimes not' (p. 125). The story told by this paper will mostly be about people and artefacts, and we will see acacia trees being planted in neat rows to serve the purpose of absorbing CO2 released by human productive activities. The enrolment of trees in offset- ting seems to sustain a mode of engagement with earthly things that treats the latter as resources. This form of exploitation is quite ordinary in many places of our contemporary world (cf. the plantation system, Haraway et al. 2016). A focus on the mundane means, then, attending to such habits and developing a logistical sensibility to get closer to the details of their enactment.

The process of marketization described here is not a success story, but a series of frictions. The term friction has been coined by Tsing (2005), for whom it is the modality of globalization; it is through misunderstandings and local adaptations that connections 'across distance and difference' are established. In this paper, the term friction will also highlight the vulnerability of a series of action meant to address global warming, constrained by a certain reluctance to change (the habit to burn fossil fuels) and various sorts of disruptions, including the unruliness of acacias trees. This focus on the mundane and its frictions, as well as the possibility to take stock of more than 20 years of carbon offsetting, will nuance the enthusiasm of Callon (2009) when he refers to the marketization of CO2 as 'ongoing collective experiment'. A trial and error dynamic can be identified in the evolution of United Nations negotiations about whether or not to rely on trees in the tropics to store carbon. But the process seems to lack the reflexivity required to acknowledge that offsetting might just not be how to seriously act on carbon emissions. In what follows, the marketization of forest carbon will be told as a story of contingencies and unexpected ramifications. This story aims to give a glimpse of the resistance of our world towards the changes that the warming of the Earth, the warnings of climatologists, and the Anthropocene debate are calling for. This resistance is what I call the friction of the mundane.

Marketization site 1: disputes at UN negotiations

In the late 1980s, the consolidation of scientific facts about the warming of the Earth triggered a process of collective decision-making under the aegis of the United Nations (UN) (see Edwards 2010). Early on, devising market arrangements emerged as a way forward to reduce emissions. CO2 units would be quantified, desired, and exchanged because of a political will formulated through the diplomatic construct of sovereign nations, ranked according to their income and brought together as an assembly of delegates. Here I suggest that UN negotiations provide a good opening for a story that seeks to situate how, and through which geopolitical circumstances, carbon markets started being of this world, emerging from a recent past, when emitting CO2 without restriction was unproblematic.

In the early 1990s, as the foundational text of climate diplomacy (the United Nations Framework Convention on Climate Change) was being negotiated, it was clear that the responsibility for addressing global warming would fall on wealthy, post-industrial economies. Yet implementing interventions in developing countries to offset against CO2 emitted by developed countries became a topic of discussion (Bodansky 1993, Grubb et al. 1993). Some delegations, from the United States and Nor- way notably, fervently advocated for this new kind of transaction. The motive was grounded in a cost minimizing logic building on international asymmetries. The cost of reducing one tonne of CO2 through plantations in Costa Rica, for example, was assumed to be lower than transforming the Norwegian oil extraction industry. The rationale was that, from the vantage point of the global climate, no matter where on the Earth CO2 is emitted or absorbed, it should be possible for highly emitting activities to partially relocate their effort by financing distant reductions. Moreover, scientific statements for policy makers, including by the Intergovernmental Panel on Climate Change, expected biological carbon sinks to provide low-cost credits (Brown et al. 1996). Trees in the tropics could be treated as 'cheap nature' in this new way (cf. Moore 2015). But many delegations from countries supposed to host this new productive activity rejected the idea. Offsetting, they argued, would prioritize CO2 reductions instead of local needs, take advantage of the cheapest domains of climate action, and allow rich nations to escape their obligations and not tackle the problem they have caused. Negotiators from both sides eventually settled on a pilot phase to test the controversial principle already implemented in a few voluntary initiatives (Moura-Costa and Stuart 1998). Most offsetting initiatives launched during the 1990s were forestry projects in Latin America, which involved North American conservation organizations and energy companies but often lacked the metrological and calculative tools to enact market exchanges.

In the early days of UN negotiations, the marketization of forest carbon existed in an aspirational form. Although the idea was contentious, the possibility of producing and exchanging CO2 credits acquired a more solid existence in a negotiation twist during the writing of the Kyoto Protocol (Grubb et al. 1999, Werksman 1998). Discussions on the treaty's text had begun several months in advance of the decision-making session scheduled for the end of 1997, with delegations circulating public proposals and participating in ad hoc encounters. One proposal, from the Brazilian government, contained a provision for levying fines on developed countries not complying with their emission targets (see the introduction); the fines would be pooled into a Clean Development Fund to finance climate-friendly actions in developing countries, up to an amount indexed on the emission reductions they would achieve. While the latter's negotiators supported the suggestion, delegations of the former rejected it, as it could be expected. The matter seemed helpless; the positions were too polarized. Yet to a few delegates it gradually

appeared that the emission reductions achieved by projects benefitting from the fund's support could match the quantity of CO2 liberated beyond the tar- gets. This new understanding made the Brazilian idea resemble the offsetting option actively supported by United States negotiators. As the negotiation deadline came closer, the possibility for wealthy economies to invest in development projects saving emissions abroad was presented as helping domestic compliance and the penalty aspect was dropped. On paper, the word Fund was eventually replaced by Mechanism, giving birth to what would progressively develop into an operational offsetting market.

UN negotiations in the 1990s contributed to make global warming a matter of concern and established a past when it was not so. The timelessness of the dependency on fossil fuels of con- temporary Western democracies was over, though this past time seemed reluctant to pass. By authorizing excess emissions and lowering their cost through carbon trading, the Kyoto Protocol almost ensured that in the short term not much would change (cf. Lohmann 2010). The capacity of markets to act on gains and losses aimed to soften the new constraint. In particular, the CDM, which at the time was being referred to as the 'Kyoto surprise' (Werksman 1998), permitted a geo- graphical distribution of the emission reduction effort (and its cost) via exchangeable credits translating how much a given action reduces CO2 compared to a baseline that would have supposedly occurred without the intervention. With such a convoluted counterfactual reasoning, the market would have a limited (if debatable, see Lohmann 2005) effect on the atmospheric concentration of CO2, but it would make the issue circulate, including to places like the Congo where emission levels had always been low.

If planting and conserving trees in the tropics were widely considered cost-effective actions to reduce CO2, forestry activities ended up with a marginal role in the CDM. When delegates started discussing operational rules to flesh out the new market, national representatives (e.g. from Brazil, the European Union, China), together with environmental activists, resisted the marketization of forest carbon (Fry 2002). Beside a persisting wariness towards offsetting, forest carbon was described as unsuitable, because the storage of CO2 is non-permanent. Another concern was the fear that given its low cost, forest carbon would flood the market with credits, depriving more expensive projects from investors and buyers. Moreover, crediting actions such as the conservation of an area threatened by deforestation was said to be flawed, because the logging or agricultural activity threatening the place could easily relocate elsewhere (a phenomenon called leakage). Finally, the interventions' potential scale was perceived as impeaching national sovereignty over a territory and its development prospects (via the unlimited exploitation of timber and land). In 2003, after years of textual battles in international conference centres, the conditions under which forests could participate in the CDM were agreed on, and only plantation was allowed (Fry 2007). Negotiators also decided that due to the short-lived existence of trees, emissions credits from forestry projects would be temporary. A government buying these credits would need to later replace them. In this market that 'makes things the same' (MacKenzie 2009b), forest carbon had a special status that made its rather unattractive. When in 2005 European decision-makers launched a cap-and-trade scheme to translate national commitments (of the Kyoto Protocol) into a law regulating power generation and industrial production (see MacKenzie 2009a), they authorized the regulated installations to buy units from the CDM to meet their emission levels, except for temporary credits. The ban was consequential; Europe constituted the main demand for offsets after 2001, when the newly elected President

of the United States withdrew from the Kyoto treaty to continue emitting CO2 unrestrictedly.

So the story begins with UN negotiations focused on devising a market to respond to a new political injunction (reducing CO2 emissions). The possibility to compensate for what a nation or an industrial installation emits through distant emission reduction actions shows a certain inertia exerted by a recent past when global warming was not an issue. While we saw that trees in the tropics were meant to have a bright future in the emerging UN offset market, several political twists took place within and beyond UN negotiations and put forest carbon at the margins. As a result, in the CDM online database managed by UN secretariat, only 71 forestry projects have been registered as of June 2017, representing 0.8% of all interventions and 0.6% of issued credits.1 To further explore this marginal market segment, we will now turn to one of such projects and attend to its own frictions.

Marketization site 2: acacia trees in the savannah

Our second marketization site is a forestry project added to the CDM database in 2011 and located in the Congolese savannah 150 kilometres north-east of the country's capital. There, acacias trees have been interwoven with crops to produce and sell charcoal and cassava flour in Kinshasa, and emission credits compensating for CO2 emitted far away, in Europe. As we move from a historical perspective on UN negotiations to the practical set up of an offsetting activity, the metrological and economic conditions of the marketization of forest carbon in a specific place can be unpacked. New frictions become witness-able, from the stubbornness of procedural details to the unruliness of living trees.

To be a CDM project, the plantation owned and managed by a family business has had to navigate a series of exigencies. Within UN negotiations, once agreement had been reached on the restrictive legibility of forestry activity in the new market (cf. above), more precise rules gradually emerged as projects were proposed, assessed by independent auditors, accepted, and registered by the CDM board (the market authority composed of delegates of various nationalities). The Congolese enterprise had to hire the help of a French consultancy firm to shape its project accordingly, gather evidential material, and fill the required paperwork. This is when a baseline is established, which represents the emission level that would have occurred in the absence of the project. Here, the pro- posed baseline was the perpetuation of the state of the land in the late 2000s, a grassy savannah barely inhabited and regularly degraded by bushfires (see Ehrenstein and Muniesa 2013). But the requirements of the CDM concern other aspects of the activity as well. The zone to be reforested had to be geolocalized, property rights demonstrated, the place described (climate, soil, vegetation, etc.), the tree species specified, the plantation calendar projected over the lifetime of the activity (30 years), and the carbon stock accumulated annually estimated. Such operations prepare for a spatial and temporal containment, based on which emission credits might be produced electronically and assigned to the plantation owner (see Lansing 2012). This would occur during the project's implementation, when auditors come to verify the calculation of carbon stocks in accordance with techniques (sampling procedures, etc.) already anticipated at the registration stage.

In the market design of the CDM, a fundamental exigency is geographical. The land to be af/reforested should not be a forest, with 'forest' defined according to three criteria: a minimum surface, minimum canopy coverage, and minimum tree

height. We are miles away here from how forests might be experienced by people who live in and with them (see Tsing 2005) or described and under- stood by ecologists. Within UN negotiations, articulating a single common definition had been hard. Eventually all delegates agreed to adapt the one already used by the Food and Agriculture Organisation in its survey of productive forests (Fry 2002). Based on a simplistic but institutionalized and easily actionable concept of forest, negotiators then defined afforestation as land switching from being in a state of non-forest since 1960 to a state of forest. The activity in the Congo was initially presented as such, and visual evidence from the past was needed to prove that the region had been a grassy land for a while. But as no relevant evidence from colonial times seemed to exist, the issue delayed registration for months. A solution was eventually found by renaming the activity reforestation. This lowered the evidential requirement regarding the state of the land that should be non-forest since 1990 only, a date for which NASA satellite images could easily be retrieved. Many details, negligible at first sight, must be attended to in order to enable the marketization of forest carbon.

Each CDM project is a priori unique, situated in a particular landscape, shaped by specific factors. The savannah along the Congo River is certainly very different from the Colombian mountains hosting another forestry project registered the same year. But the procedures governing this peculiar market tend to encourage reproduction rather than silvicultural innovation. As only plantations are authorized and project developers must make sure they have the metrological tools to anticipate and measure carbon stocks, well-known species in simple designs (monocultures) might be preferred over more complicated ecosystems. The project examined here is actually a copy of a nearby charcoal-producing plantation financed since the late 1980s by European overseas aid, and the equations used to quantify its carbon stock are borrowed from the work on acacias' productivity conducted by French agronomists in the region during the 1990s. Offsetting does not occur in a vacuum; the new market arrangement is shaped by localized legacies from anterior actions and other market activities (cf. Lovell and MacKenzie 2015). The CDM rules organize what Barry (2013) would call an 'informational enrichment' of the planted trees oriented towards their control and the quantification of their carbon. The acacias plantation is thus conceived, at least on paper, to generate 'passive goods' (Çalışkan and Callon, 2010, p. 5).

To describe the circumstances in which forest carbon can be marketized, attending to metrological demands is not enough and the vagaries of business must also be considered. For the owner of the acacias plantation, selling offsets was not an end, only a means. In the mid-1990s, he left Brussels and his teaching position in agronomy to revive the family enterprise in Kinshasa. But the economic and political crisis affecting the Congo that led to the 1998–2002 war put the ambition on hold. When the country eventually underwent pacification under the UN umbrella, it was still difficult to raise capital at a reasonable interest rate. Despite its requirements and associated costs (e.g. consultants, audits), the CDM appeared as a resource to make the activity more attractive by modifying its business plan and adding an income stream. To fit what Muniesa et al. (2017) call the 'the logic of capitalization', the enterprise would commercialize cassava flour in the short term and charcoal in the long term. Meanwhile 1 million tonnes of CO2 would be sold to reimburse loans provided by Belgian investors. For them, the project became valuable when it secured two forward sales of emission credits. The sales contracts were passed in 2009 with a World Bank fund and a French private bank, and they referred to calculations based on generic growth rates for acacias in a tropical climate (500,000 tonnes of CO2 each

delivered by 2017). In both cases the price was 4 dollars per tonne. Given the European ban on temporary credits, willingness to pay for temporary credits was rare and varied. The World Bank had pooled financial contributions and issued purchase contracts with two-dozen projects in a diplomatic move, probably to show that developed economies finance forestry activities in poor countries. As for the private bank, it aimed to resell the credits to companies interested in offsets for marketing purposes. In parallel to the CDM but outside the scope of UN negotiations, voluntary certification was emerging wherein forestry projects were appreciated for the nice stories they sold alongside CO2 units (Diaz et al. 2011). As Çalışkan and Callon (2010) remind us, markets are sites of power asymmetries and the bargaining capacity of the plantation's owner was rather weak here.

The offsetting project became of the world at the junction of many transactions with different temporalities and spatial extensions. The articulation and fulfilment of these various promises relied on the capacity of trees to absorb CO2 as monitored by the metrological tools of the offsetting market. In the Congolese savannah in the early 2010s, the carbon stored in the planted trees started to be quantified, while bags of flour were routinely transported to Kinshasa and the project developer was prospecting for kiln equipment. When the measurement's preliminary results came out, they were much lower than expected. They were even negative due to a metrological convention of the CDM that required counting the removal of the savannah vegetation during land preparation as CO2 emissions. The bad performance of the plantation compared to projections was explained by uneven working rhythms and the unexpected behaviour of acacia trees, which had grown slower and died more often than what the generic rates involved in the ex ante estimate had anticipated. But the details of their local existence in relation to the soil, its insects, and the climate were not investigated. Rather, the financial montage of the project was modified. The discrepancy threatened the future of the plantation and for the venture to hold up, at least a little longer, its market ambition had to be drastically reduced. Adjustments like prepayment, volume renegotiation, and forms of non-market support (aid grants) were needed to cope with the uncertainty resulting from the encounter of market promises, rigid calculative tools, and unruly trees.

The marketization of forest carbon in a specific place (the Congolese savannah) involves metrological and business operations potentially impaired by the ability of earthly things not to behave as needed to fulfil promised exchanges. In the bureaucratic turmoil of the CDM, the material existence of acacias on savannah soil had been neglected. The unpredictability of life had already been alluded to in UN negotiations with the debate about the non-permanence of carbon storage in forests. Here, this friction could unravel the long-distance transaction of CO2 offsets carefully prepared in paperwork and contracts and make a local business bankrupt. Browsing the CDM database, one finds that many forestry projects seem to have remained unable to claim emission credits, and for others, the certified amount is often much lower than what had been projected. For the global climate, the CO2 absorbed by the few additional trees planted in the tropics via the emerging carbon market is mere noise. Yet as we continue moving in time and across space to map out the marginal marketization of forest carbon, the events told so far will acquire new ramifications.

Marketization site 3: back to UN negotiations

Within UN negotiations, the dispute on offsetting and trees in the tropics did not end with the creation of the CDM and its restrictive conditions for forestry activities. UN

decision-making on climate change is an iterative process and new topics can emerge. This was the case of REDD+, a set of rules in discussion from 2005 to 2013 whose purpose was to incite the reduction of CO2 emissions from deforestation and forest degradation in the tropics2. Our story thus comes back to the first marketization site, UN negotiations, but now a decade after the Kyoto Protocol. This return allows us to examine how the marketization of forest carbon resurfaced, shaped again by past, unquestioned choices and assumptions, as well as by the intrusion of novel concerns provoked by further extending the UN-driven emission reduction effort to developing nations.

REDD+ started with a proposal put forward in 2005 by a small group of delegations, led by Costa Rica and Papua New Guinea (UNFCCC 2005). The text emphasized the amount of emissions caused by tropical deforestation according to state-of-the-art-expertise (15 – 20% of worldwide CO2 emissions in the 1990s) and suggested the establishment of a new mechanism or the amendment of the CDM. The reason for forest loss, it was argued, was a lack of financial revenue derived from keeping trees in the tropics standing. CO2 offsets used by developed nations for compliance with their Kyoto targets could provide the missing incentive. The proposal acknowledged the CDM controversy by introducing an important change: the action would be in the hand of nations, with deforestation and emission levels calculated across national territories and offsets sold by national governments (cf. the sovereignty and leakage arguments described above). The gist of the proposal, the creation of a new negotiation topic, was accepted in 2007, including by Brazilian negotiators whose new disposition to discuss how emissions from forest loss could be limited was attributed to a recent decline of the country's deforestation rate (Fearnside 2013).

From one negotiation session to the other, REDD+ was charged up with various objectives (La Viña and de Leon 2014, UNFCCC 2014). Delegates agreed that beside deforestation, other actions could be targeted, such as forest degradation. Trees in the tropics were seen as more than carbon sticks now, and the protection of biodiversity was mentioned in a list of safeguards. Moreover, African delegations became active negotiators. Most of these countries represented the poorest nations of the world, highly dependent on overseas aid. REDD+ had to accommodate their problems and aspirations. For example, while it was initially thought that to calculate reduced emission levels, past deforestation rates would be used as baselines, African delegates argued for adjustments. These would anticipate a future development of their economies and allow for the legitimate increase of the exploitation of wood and land. Another of their requests concerned REDD+ metrological exigencies, which had to be loosened when it appeared that an operation as simple as measuring forest cover would be a challenge in places lacking reliable electricity supply and an efficient Internet. The Congolese forestry administration was such a place, physically unable to receive satellite images sent by foreign partners given the digital weight of the data. Two different mundane constraints are witnessed here: first, a developmentalist attitude bequeathed by past habits when preserving the environment was not an issue, and second, the absence in some parts of the world of infrastructures whose omnipresence is taken for granted from the vantage point of wealthy countries.

In place of offsetting rules attuned to deforestation, what REDD+ was meant to be became more vague but also more encompassing. A kind of learning by doing was made possible by the rhythm of UN negotiations, wherein decision-making amounted to a 'series of rendezvous', to quote Callon et al. (2009). With REDD+ activities simultaneously initiated on the ground (see below), it could almost be said

that negotiators were participating in an ‘ongoing collective experiment’ (cf. Callon 2009). But the experiment lacked reflexivity, and certain ideas were continuously left unquestioned. For example, as mentioned in the introduction above, the low cost of CO2 reductions from forestry activities was reasserted in the influential 2006 Stern review, bringing REDD+ to the attention of an international audience. Yet the claim remained unproven; it built on the assumption that land is cheap in nations with low incomes and ignored the difficulties (e.g. transactions costs, financial risks) encountered by forestry activities in the CDM. Another unquestioned idea was that governments would react to incentives as rational market agents, and new revenues could easily induce large-scale land use change (a point made in Karsenty and Ongolo 2012). Unlike the economists involved in the European cap-and-trade studied by MacKenzie (2009a), here the behavioural precept was not part of a broader, evolving theoretical apparatus; it was only a self-evident assumption.

What was, however, hotly debated was whether incentives to decrease deforestation and CO2 emissions could come from a demand for offsets. Within UN negotiations, the marketization dispute thus continued. In 2010, negotiators agreed that at the following iteration (the 2011 session in Durban), they would explore financing options (UNFCCC 2014). No choice had to be made, yet simply listing options already proved controversial. A balanced wording was eventually found that appeased the main opponents (Brazil versus Papua New Guinea) and their allies by equally acknowledging both market and non-market options without further specifications. As unspectacular as it might seem, this result almost did not happen. At the last minute, a delegation (Australia) asked for introducing one additional word in the two-page text. The modification would come to matter if several future developments took place: if some jurisdictions (local, national, regional) unilaterally created their own markets involving REDD+-like actions, and if UN negotiations established a REDD+ market, then CO2 units traded in the former arrangement could be de facto recognized in the latter. The demand triggered an outcry and was eventually dropped. Many negotiators strongly disagreed with the de facto linkage that would weaken the role of UN negotiations in providing the main space where the marketization of forest carbon can be problematized. More importantly, the request felt inappropriate, because there was not enough negotiation time to consider its implications. Making carbon markets a reality depends on contingent events (e.g. a new US President) and the management of a negotiation. UN sessions are organized into small groups of well-acquainted delegates specialized in a topic. Beside routinized writing practices (see Riles 2001), their interactions are governed by a certain deontology. One word added in a carefully composed compromise, even if its consequences are hypothetical, is a disruption that contravenes delegates’ disposition to negotiate. This kind of decisional modality matters to understand the (un)making of carbon markets, and the surprise of the CDM related earlier in the paper had happened partly by tinkering with words.

In 2013, negotiators finalized the Framework for REDD+, a verification procedure to which the measurement and calculation of forest-related emission reductions could be submitted on a voluntary basis (UNFCCC 2014). It amounted to guidance rather than a mechanism able to generate a demand for CO2 units and regulate transactions. Within UN negotiations, the Framework was a stand-alone set of decisions, disconnected from topics like the renewal of Kyoto commitments. REDD+ seems actually to have pioneered a new kind of action, organized in an ad hoc manner, able to enrol countries whose emissions had never been frontally addressed until then. This approach can be found in the 2015 Paris Agreement

wherein all nations agreed to a collective effort through unilaterally decided and only partially quantified commitments. The revival of forest carbon via REDD+ participated in moving beyond CO2 quantification and a rigid international categorization legated from past times when minimal market arrangements seemed enough.

Forest carbon resurfaced in UN negotiations in the mid-2000s, an episode that demonstrated how details (one word in a two-page text) and the legacy of the negotiations intervene in consensus-based decision-making whose iterative mode preserves traces of previous debates. The idea of tackling global warming via the trading of CO2 units remained controversial. I even suggest that it started to appear out of date, though as we shall see next, the loose scope of REDD+ allowed actors to pursue accommodating market exchanges at its margins. As our story unfolds, marketization becomes drawn into new relations: when in the Kyoto Protocol, offsets from trees in the tropics aimed to serve wealthy nations, REDD+ put developing nations and their needs centre stage. This extension of the emission reduction effort to parts of the world different from Western settings, points to frictions of a new kind (cf. lack of infrastructure) that will be further examined below.

Marketization site 4: in the Congolese ministry of environment

After tracing the emergence of carbon markets, examining the set up of a plantation supposed to generate CO2 offsets, and returning to UN negotiations when marketization (more precisely offsetting) seemed out of fashion, I now propose to attend to a last marketization site, the ministry of environment of the Congo. In the late 2000s, its ministerial staff had barely heard of carbon markets, and it was the owner of the acacia plantation previously examined who introduced them to the topic. A few years later, foreign consultants paid by overseas aid were working for the ministry to make REDD+ happen in the country. One focus of their activity was the possibility of offsets exchanges. By looking into the ordinary (dis)functioning of the Congolese state, the exploration of how, when, and where carbon markets are designed and maintained continues in a new direction, around a legal intervention that will reveal the local absence of a market morality assumed to be universally desired.

Since 2010, the Congolese ministry of environment had benefitted from so-called readiness grants provided by aid programmes managed through multilateral organizations like the World Bank and the United Nations Development Fund (MECNT 2010). The funding supported the activity of a temporary entity advising the ministry, a focal point for REDD+, whose staff included a few international consultants. These young expatriates had good relational skills but no scientific expertise per se; their task was that of project managers. They were, for example, in contact with foreign research centres, which had the knowledge and equipment to measure and study the dynamic of the Congo's forest cover. The consultants spent a lot of time organizing meetings in Kinshasa to promote the idea that forest carbon mattered and attending meetings abroad to present the country's REDD+ accomplishments to donor representatives. This advocacy was supplemented by more tangible preparatory interventions such as legal work on the possibility for the country to welcome and supervise voluntary offsetting projects.

Indeed, with REDD+, the possibility of protecting a small piece of forest from deforestation had unexpectedly received a new impulse. If the decisions gradually emerging from UN negotiations did not establish a project-based market, in 2009, delegates agreed, after fierce debate, that in the short-term countries might host

subnational REDD+ actions (UNFCCC 2014). The marketization of forest carbon was sticking around, but now beyond the oversight of UN authority. It was becoming the realm of private certification schemes proposing metrological tools to calculate emission reductions from forest conservation and rehabilitation projects, rules applied by nature conservancy organizations to supply buyers like airline companies with CO2 offsets (Diaz et al. 2011). Voluntary REDD+ emission credits were issued across the world, including by interventions that two decades before had been part of the UN-driven pilot phase for offsetting and then considered ineligible under the CDM. In the Congo too, a market version of REDD+ was making its way. In 2011, a Canadian organization obtained a ministerial approval to carry out a project in a former logging concession and other initiatives were talked about.

The Congo is a country whose territory contains large quantities of various minerals generating a rentiership economy. Forest carbon was treated as yet another resource (cf. 'cheap nature', Moore 2015). Given the forest's immensity, tracking the use of this resource through offsetting would be a struggle for the central administration. To address the situation, the consultants of the ministry of environment envisioned a legal process that would screen and authorize projects carried out in the Congolese forests. As shown by Mitchell (2011) for oil fields, legal (and physical) access can make a natural resource an object of investment and consumption, or of speculation and private (rather than collective) enrichment. Here, the consultants aimed to ensure a collectively beneficiary marketization process by avoiding dubious deals between individuals acquiring rights for land speculation and ministry officials handing them for bribes. Due diligence would be conducted upfront and externally to keep at bay fraudulent business. Project developers would then obtain from the ministry an agreement to exploit the carbon of a given area conditional to submitting the activity to one of the certification schemes evoked above within a fixed delay. This decision would be made by a Kinshasa-based committee, including civil servants and representatives of environmental and human rights organizations. To incite this committee not to delay the processing of applications (a technique usually used to obtain bribes), fees paid by project developers would be redistributed to committee members only if they complied with fixed deadlines. Finally, the projects' documentation and committee meetings' minutes would be available online.

Looking into the practicalities (e.g. fees, deadlines) of legal access casts light on the moral expectations around an essential step of the marketization process. In an audit-type report for the Norwegian aid agency (a major donor to REDD+ actions worldwide), corruption defined as the use of entrusted power for private gain was said to be pervasive in the Congo – a way of life, a rampant disease (PWC 2011). The report, whose naturalized conception of corruption is contestable, nevertheless reveals the assumptions apparently shared by donors and investors that REDD+ ought to involve some sort of idealized accountable state and ethical business. The universal adoption of these moral references seems to be unquestionably desirable for the marketization of forest carbon (as in oil exploitation, cf. Weszkalnys 2011, Barry 2013, and local development projects, cf. Li 2007). This is not the kind of 'response-able naturecultures inhabited by accountable companion species' advocated by Haraway (2016), where attention is paid to the way earthly things 'sustain whole worlds' (p. 125). The consultants devised a response to the climate of suspicion and condemnation surrounding Congolese economic and political life, not the extractive use of the new natural resource. In the procedure to allocate rights over forest carbon, decision-makers were supposed not to seek opaque inducements by the provision of

legitimate payment under public scrutiny. But this scrutiny was missing. The consultants had expected local civil society organizations – motivated by concern about the issue of governance – to drive enforcement. It turned out they were not. The legal intervention did not face opposition, just the indifference of a public too busy advocating for other long-standing causes, like the translation into state law of the customary ownership of forest land. In Kinshasa, activists' concerns were not aligned with the supposedly universal morality assumed by overseas donors.

The Congo is a place where elections are contested, civil servants barely paid, law enforcement weak, and international indicators on the facility for doing business continuously low. This situation bears the traces of a tumultuous past, the legacy of colonization, dictatorship, and war. In this light, the preparatory legal intervention was derisory. Its achievement was less to transform the administration than to demonstrate a commitment to REDD+ and maintain the ministry of environment in donors' field of vision. Over time in Kinshasa, it became clear that REDD+ would be mostly funded through their support. For example, the forest carbon concession obtained in 2011 by the Canadian conservation organization was incorporated into a broader programme that the World Bank was supposed to finance according to result-based rules (FCPF 2016). The ministry also secured multilateral aid funding to invest in productive activities targeting deforestation drivers like charcoal production (CIF 2011), while the timber sector was also expecting to receive foreign support to adopt sustainable practices and be relieved from a moratorium on new logging rights. These actions, their financial transactions and commercial prospects would seldom translate into the exchange of CO2 offsets. More heterogeneous REDD+-related activities were emerging, again amid friction. For example, if the land near Kinshasa was relatively suitable for reforestation (despite the poor offsetting performance of the acacias plantation mentioned earlier), farther away the flora and fauna of the savannah were more diverse and local organizations were wary of the envisioned charcoal-producing plantations. The future of the logging economy was another contentious topic. Exploiting new forest areas, even sustainably, could liberate large amounts of carbon stored underground in peat lands whose existence has only been recently discovered (Lewis et al. 2017). These debates differed from the market/non-market antagonism of UN negotiations in the early 2010s. They indicate that if the CO2 problem ought to be taken seriously, other markets (charcoal, timber, etc.) and habits (a certain developmentalist attitude towards forests or their carbon) would need to be acted upon.

In this last marketization site (the Congolese ministry of environment), we see that the carbon stored by forests amounted to a new natural resource situated within national borders. It was drawn into the (dis)functioning of what appears to be a fragile state, at least when compared to an idealized version of proper administration. Beside metrological equivalence (cf. MacKenzie 2009a), the marketization of forest carbon also involves legal interventions and expected moral standards about the practices of public and private sectors, expectations that the Congo failed to meet. This story, which now comes to an end, nevertheless suggests that the global visibility of Congolese forests acquired through REDD+, together with the limited reach of carbon markets on these landscapes, has had some potentially valuable effects. It notably seems to call out for transforming the economic flows in which the earthly life of trees in the tropics is entangled.

Conclusion

The paper opened with the statement that carbon dioxide released from the burning of fossil fuels is a major concern of our times. It can be argued that the events related here have contributed to this state of affairs. Carbon markets and their minimal intervention seemed to have gradually normalized the injunction that CO2 ought not to be emitted without restriction, even from forest loss in the poorest parts of the world, such as the Congo. After having traced how the marketization of forest carbon evolved within and beyond UN negotiations, we can now suggest that this market arrangement is better understood as transitory action rather than some ultimate solution to global warming. The marketization process in focus has probably had a derisory direct effect on the global level of CO2. It may even seem to have animated a process of cheapening nature, which some have argued is contributing to the problem of global warming (cf. Moore 2015). But, as my story implies, the ongoing marginal existence of carbon offsetting can claim other ramifications (e.g. drawing worldwide attention to the carbon stored in the Congo Basin) that could have future positive impacts on the Earth's climate.

To examine how forest carbon became enrolled in market exchanges, the paper adopted a logistical sensibility to move across four marketization sites, different places and times in which the marketization of CO2 absorbed by trees in the tropics could be seen to be at stake. We first looked at the early years of UN negotiations on climate change, when the problem of CO2 emissions only started becoming an issue, notably through the devising of forms of market exchange that led to a long dispute about the suitability of forest carbon for these transactions. We then focused on one of the few forestry activities authorized to produce offsets, a plantation in the Congolese savannah set up in the late 2000s and framed by UN metrological requirements, before being threatened by the recalcitrant behaviour of trees. Our third marketization site was the UN negotiation process again, when in the mid 2000s a new topic emerged around tropical deforestation and its emissions that revived the dispute about marketization. CO2 meanwhile started to be considered a more encompassing problem, rather than simply a matter of quantification and offsets. Finally, we went back to the Congo, this time in the ministry of environment, where overseas aid consultants were busy giving forest carbon a legal existence to enable moralized offsetting transactions. Though the latter did not really materialize, the preparatory intervention contributed to make the carbon stored in Congolese forests more visible in Kinshasa and beyond. The story thus suggests that the marketization of forest carbon has been shaped and often impaired and impeded through frictions taking different forms, from the unruliness of earthly life and disruptions caused by mundane details to legacies from the past and failed universality.

Presented together these four episodes of the problematic marketization of forest carbon indicate a series of operations to compose a market designed and maintained to address a public problem. We saw the importance of political negotiation in establishing demand for the new good, whose exchange is meant to respond to the problem at issue. We witnessed the tension between rigid metrological conventions regulating the production of the good and flexible financial commitments required to attract and maintain investors in the productive activity. We encountered moral expectations regarding who and how the new resource could be appropriated to be made productive and become an object of marketization. For each of these operations, we attended to what has been carried out, always through friction, never from scratch or in a vacuum. I called this approach a focus on the mundane. This focus helped me highlight some features of the globalized world, where carbon emissions are now a major concern; these features include the consensus-based

diplomacy of the United Nations, the ideal of accountable states and moralized economies, unequal access to scientific infrastructures, and a developmentalist conception of nature. To address the problem of global warming, this world needs to change. Here, I would like to suggest that a way forward might be to better acknowledge the friction of the mundane, that is, the myriad resistances, reluctances, disruptions, and dilemmas brought about by this need to change.

Notes

1. The numbers are retrieved from: http://www.cdmpipeline.org/cdm-projects-type.htm. The CDM online database can be accessed here: https://cdm.unfccc.int/Projects/projsearch.html.
2. In UN negotiations, REDD+ refers to policy approaches and positive incentives on issues relating to reducing emissions from deforestation and forest degradation; and the role of conservation, sustainable management of forests and enhancement of forest carbon stocks in developing countries.

References

Barry, A., 2013. *Material politics: disputes along the pipeline*. Oxford: Wiley Blackwell.

Bodansky, D., 1993. The United Nations framework convention on climate change: a commentary. *Yale Journal of International Law*, 48, 451–558.

Brown, B., et al. (1996). Chapter 24: management of forests for mitigation of greenhouse gas emissions. In: R.T. Watson, M.C. Zinyoera, R.H. Moss, eds. Climate change 1995. *Impacts, adaptations and mitigation of climate change: scientific-technical analyses*. Intergovernmental Panel on Climate Change. Cambridge: Cambridge University Press, 773–798.

Bryant, G., Dabhi, S., and Böhm, S, 2015. 'Fixing' the climate crisis: capital, states, and carbon offsetting in India. *Environment and Planning A*, 47 (10), 2047–2063.

Çalışkan, K. and Callon, M., 2010. Economization, part 2: a research programme for the study of markets. *Economy and Society*, 39 (1), 1–32.

Callon, M., 2007. An essay on the growing contribution of economic markets to the proliferation of the social. *Theory, Culture & Society*, 24 (7–8), 139–163.

Callon, M., 2009. Civilizing markets: carbon trading between in vitro and in vivo experiments. *Accounting, Organizations and Society*, 34 (3–4), 535–548.

Callon, M., Lascoumes, P., and Barthe, Y., 2009. *Acting in an uncertain world. An essay on technological democracy*. Cambridge, MA: The MIT Press.

Climate Investment Fund (CIF), 2011, June. Investment Plan Democratic Republic of Congo. Agenda item 5, FIP/ SC.6/4, Cape Town. Available from: https://www-cif.climateinvestmentfunds.org/sites/default/files/FIP%204% 20DCR%20IP_0.pdf

Corbera, E. and Brown, K., 2010. Offsetting benefits? Analyzing access to forest carbon. *Environment and Planning A*, 42 (7), 1739–1761.

Diaz, D., Hamilton, K., and Johnson, E., 2011, September. State of the Forest Carbon Markets 2011: From Canopy to Currency, Ecosystem Marketplace. Available from: http://www.forest-trends.org/documents/files/doc_2963.pdf

Edwards, P.N., 2010. *A vast machine: computer models, climate data, and the politics of global warming*. Cambridge, MA: The MIT Press.

Ehrenstein, V. and Muniesa, F., 2013. The conditional sink: counterfactual display in the valuation of a carbon offsetting reforestation project. *Valuation Studies*, 1 (2), 161–188.

Fearnside, P.M., 2013. What is at stake for Brazilian Amazonia in the climate negotiations. *Climatic Change*, 118 (3–4), 509–519.

Forest Carbon Partnership Facility Carbon Fund (FCPF Carbon Fund), 2016, November. Mai-Ndombe Emission Reductions Program, Democratic Republic of Congo. Available from: https://www.forestcarbonpartnership.org/sites/fcp/files/2016/Dec/20161108%20Revised%20ERPD_DRC.pdf

Fry, I., 2002. Twists and turns on the jungle: exploring the evolution of land use, land-use change and forestry decisions within the Kyoto protocol. *Review of European Community and International Environmental Law*, 11 (2), 159–168.

Fry, I., 2007. More twists, turns and stumbles in the jungle: a further exploration of land use, land-use change and forestry decisions within the Kyoto protocol. *Review of European, Comparative & International Environmental Law*, 16 (3), 341–355.

Greenpeace, 2013, November. Flawed logic: why forests cannot offset fossil fuel emissions, Greenpeace International, Amsterdam. Available from: http://www.greenpeace.org/international/Global/international/briefings/forests/2013/Offsets-briefing-Flawed-Logic.pdf

Grubb, M., et al., 1993. *The earth summit agreements: a guide and assessment. An analysis of the Rio 92 UN conference on environment and development*. London: Royal Institute of International Affairs and Earthscan Publications.

Grubb, M., Vrolijk, C., and Brack, D., 1999. *The Kyoto protocol: a guide and assessment*. London: Royal Institute of International Affairs and Earthscan Publications.

Haraway, D.J., 2016. *Staying with the trouble: making kin in the Chthulucene*. Durham: Duke University Press.

Haraway, D., et al., 2016. Anthropologists are talking–about the anthropocene. *Ethnos*, 81 (3), 535–564.

Karsenty, A. and Ongolo, S., 2012. Can 'fragile states' decide to reduce their deforestation? The inappropriate use of the theory of incentives with respect to the REDD mechanism. *Forest Policy and Economics*, 18, 38–45.

Lane, R., 2012. The promiscuous history of market efficiency: the development of early emissions trading systems. *Environmental Politics*, 21 (4), 583–603.

Lansing, D.M., 2012. Performing carbon's materiality: the production of carbon offsets and the framing of exchange. *Environment and Planning A*, 44 (1), 204–220.

La Viña, A.G.M. and de Leon, A., 2014. Two global challenges, one solution: international cooperation to combat climate change and tropical deforestation. CGD

Working Paper 388, Center for Global Development. Available from: https://www.cgdev.org/publication/two-global-challenges-one-solution-international-cooperation-combat- climate-change-and [Accessed 4 April 2017].

Lewis, S.L., et al., 2017, July. International scientists ask Norwegian government not to fund the logging of Congo's peatland, Open letter to minister Helgesen from concerned scientists. Available from: http://www.afritron.net/ en/news/news-list/jul-17-international-scientists-ask-norwegian-government-not-to-fund-the-logging-of-congo- s-peatlands

Li, T.M., 2007. *The will to improve: governmentality, development, and the practice of politics*. Durham, NC: Duke University Press.

Lohmann, L., 2005. Marketing and making carbon dumps: commodification, calculation and counterfactuals in climate change mitigation. *Science as Culture*, 14 (3), 203–235.

Lohmann, L., 2010. Neoliberalism and the calculable world: the rise of carbon trading. In: K. Birch and V. Mykhnenko, eds. *The rise and fall of neoliberalism: the collapse of an economic order?*. London: ZED books, 77–93.

Lorimer, J., 2017. The anthroposcene: a guide for the perplexed. *Social Studies of Science*, 47 (1), 117–142.

Lovell, H. and MacKenzie, D., 2015. Allometric equations and timber markets: an important forerunner of REDD+?. In: B. Stephen and R. Lane, eds. *The politics of carbon markets*. London: Routledge, 69–90.

MacKenzie, D., 2009a. Making things the same: gases, emission rights and the politics of carbon markets. *Accounting, Organizations and Society*, 34 (3–4), 440–455.

MacKenzie, D., 2009b. *Material markets: how economic agents are constructed*. Oxford: Oxford University Press.

Ministère de l'Environnement, de la Conservation de la Nature and du Tourisme de la République démocratique du Congo (MECNT), 2010, July. Readiness plan for REDD 2010–2012, R-PP Final Version. Available from: https://www.forestcarbonpartnership.org/democratic-republic-congo [Accessed 4 January 2016].

Mitchell, T., 2011. Carbon democracy: political power in the age of oil. London: Verso.

Moore, J.W., 2015. *Capitalism in the web of life: ecology and the accumulation of capital*. London: Verso Books.

Moura-Costa, P. and Stuart, M.D., 1998. Forestry-based greenhouse gas mitigation: a story of market evolution. *The Commonwealth Forestry Review*, 77 (3), 191–202.

Muniesa, F., et al., 2017. *Capitalization: a cultural guide*. Paris: Presses des Mines.

Nel, A., 2017. Contested carbon: carbon forestry as a speculatively virtual, falteringly material and disputed territorial assemblage. *Geoforum*, 81, 144–152.

Osborne, T., 2015. Tradeoffs in carbon commodification: a political ecology of common property forest governance. *Geoforum*, 67, 64–77.

Price Waterhouse Cooper (PWC), 2011, October. Implementing REDD+ in the Democratic Republic of Congo How to manage the risk of corruption. Norwegian Agency for Development Cooperation, Price Waterhouse Cooper, Libreville. Available from: http://www.redd-monitor.org/wp-content/uploads/2012/01/NORAD-PwC- Implementing-REDD-in-DRC-Corruption-risks-NORAD-Final-Version-E.pdf

Riles, A., 2001. *The network inside out*. Ann Arbor: University of Michigan.

Stern, N., 2007. *The economics of climate change: the stern review*. Cambridge: Cambridge University Press.

Tsing, A.L., 2005. *Friction: an ethnography of global connection*. Princeton: Princeton University Press.

United Nations Framework Convention on Climate Change (UNFCCC), 2005, November. Reducing emissions from deforestation in developing countries: approaches to stimulate action: Submissions from Parties. FCCC/CP/2005/MISC.1.

United Nations Framework Convention on Climate Change (UNFCCC), 2014, June. Key decisions relevant for reducing emissions from deforestation and forest degradation in developing countries (REDD+). Bonn: UNFCCC Secretariat.

Werksman, J., 1998. The clean development mechanism: unwrapping the 'Kyoto surprise'. *Review of European, Comparative & International Environmental Law*, 7 (2), 147–158.

Weszkalnys, G., 2011. Cursed resources, or articulations of economic theory in the Gulf of Guinea. *Economy and Society*, 40 (3), 345–372.