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– PRODUCING LOCALIZED COMMODITY FRONTIERS AT THE END OF CHEAP NATURE: An Analysis of Eco-scalar Carbon Fixes and their Consequences

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Abstract

There is no single ‘great’ commodity frontier whose exploitation under current socio-technical conditions could fuel capital accumulation at the global scale. According to Jason Moore, this represents the ‘end of Cheap Nature’ and signals a terminal crisis for capitalism as we know it. In this article we complicate this assertion by showing how, in the context of global environmental governance frameworks of carbon control, a diverse range of actors situated at multiple scales are intensifying the use of cities and their hinterlands for the production/transgression of localized commodity frontiers. We draw on scholarship on uneven geographical development, state-led restructuring and eco-scalar fixes to present two case studies from different segments of the carbon cycle in the global South. The first case demonstrates how the introduction of waste-to-energy technology in Delhi facilitated the generation of ‘carbon credits’ while waste matter itself became a commodity. The second discusses attempts by the Brazilian state of Amazonas (Amazônia) aspiring to shift from rainforest exploitation to financialized conservation supported by the ‘green global city’ functions of metropolitan Manaus. These cases demonstrate that although the global carbon-control regime may enable accumulation, implementation remains speculative, and localized commodity frontiers provoke social resistances that jeopardize their durability.

Introduction

Prospects of unlimited economic growth, such as those promised by the ‘commodities boom’, the sustainable ‘green economy’, the ‘new economy’ and global technological revolution, have given way to a vista of unyielding crises that threaten to extend well into the twenty-first century. Most significantly these include global capitalism’s prolonged malaise, whose most recent avatar was the 2008 financial crisis, and the looming ecological collapse brought on by global warming and overexploitation of the biosphere. According to Jason Moore (2011: 2) these economic and ecological crises constitute a single crisis: ‘Capitalism does not *have* an ecological regime; it *is* an ecological regime’ (Moore, 2015: 2, original emphasis). Much more than a mode of production, capitalism is ‘*a way of organizing nature*’ (*ibid.*, original emphasis; see also Moore, 2011). The transgression of successive commodity frontiers underpins the expansion of capitalism by facilitating the appropriation of hitherto non-commodified resources. As resources are absorbed into circuits of capital, they become commodified, but, as Moore points out: ‘Every act of exploitation (of commodified labor-power) therefore depends on an even greater act of appropriation (of unpaid work/energy)’ (Moore, 2015: 54, bracketed text in original). He argues that if the ratio of appropriated resources declines in relation to those that are commodified, capital is subjected to a falling rate of profit. In response, new frontiers—either geographical or technological—must be identified and transgressed to re-establish access to unpaid work/energy and avert a crisis of overaccumulation. This explains why capitalism cannot ‘sustain itself as a closed system’ (Moore, 2000: 146) and must constantly expand.

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Moore maps his conceptualization of capitalism onto *longue durée* historical analyses (2000; 2015) and shows that the rise and fall of what Giovanni Arrighi (1996: 4) calls 'systemic cycles of accumulation' in the 'long' twentieth century were determined by their (in)ability to maintain the production and availability of cheap resources. Moore's analysis is scaled to the world-ecological system with a historical depth that allows him to convincingly make the following two proposals: first, capital accumulation has always required an ecological surplus, or what he calls 'Cheap Nature', and secondly, current modes of organizing nature cannot be counted on to generate such a surplus. Herein lie the roots of the current crisis: there are simply no reservoirs of untapped resources whose appropriation under contemporary socio-technical conditions could fuel an expansionary phase of capital accumulation at the global scale. According to Moore the 'end of Cheap Nature' is an insurmountable limit to capital accumulation, and this leads him to interpret the current crisis as terminal.

We do not take issue with the broad contours of Moore's analysis in this article. However, we are in agreement with Böhm *et al.*'s (2012) assertion that, first, even though Moore's analysis is informed by questions of geographically uneven development, he undertheorizes the contemporary geographical restructuring of regimes of accumulation (*ibid.*: 1627) and, secondly, the conceptualization of the end of Cheap Nature needs to engage the carbon economy more explicitly. Thus we seek to enrich Moore's analysis of capitalism as an ecological regime by offering an analysis of the state-led territorial restructuring that is taking place at the current conjuncture of world capitalism in crisis. Specifically, we argue that in the absence of a single 'great frontier', efforts to locate and appropriate Cheap Nature have not ceased. On the contrary, as a 'global ecological fix' appears increasingly unrealizable, multi-scalar growth coalitions are developing new repertoires to identify, produce and transgress localized commodity frontiers in and around cities. The goal of these coalitions is to produce and sustain strategic spaces of accumulation under more exacting economic and ecological constraints, and specialized territorial economies are the means. This explains why city-regions are becoming the key scale at which capital is territorialized, fixed and accumulated through novel (re-)configurations of relations among locally, nationally and globally situated actors (see Torrance, 2008; Bayirbağ, 2010; Kirkpatrick and Smith, 2011; Nugent, 2015; Loftus and March, 2016; Schindler, 2016). These regimes increasingly represent forms of ecologically oriented urban entrepreneurialism whose 'spatial reorganization [is] justified on environmental grounds to address economic crises' (Cohen and Bakker, 2014: 142). Thus our focus on the urban manifestations of the relationship between carbon control and localized commodity frontiers contributes to a growing body of scholarship on the proliferation, modalities and consequences of eco-scalar and socio-ecological fixes (Cohen and Bakker, 2014; McCarthy, 2015; Ekers and Prudham, 2017).

This article presents two case studies of global carbon-control frameworks that inform city-based eco-scalar fixes. Whereas city-centred carbon-control regimes in the US and Europe have come under intense scholarly scrutiny (Jonas *et al.*, 2011), scholars who focused on Southern urbanism have tended to research cities' efforts to adapt to climate change (Parnell *et al.*, 2007; Fuchs *et al.*, 2011; Carmin *et al.*, 2012). Further analysis of mitigation strategies and initiatives is particularly crucial in 'emerging economies' such as those of the BRICS countries (Brazil, Russia, India, China and South Africa), which have embraced and promoted the global expansion of carbon markets (Böhm *et al.*, 2012: 1628). We bring together two case studies that we have researched separately over extended periods (Schindler *et al.*, 2012; Kanai, 2014a; 2014b; Kanai and da Silva Oliveira, 2014; Schindler and Kishore, 2015; Demaria and Schindler, 2016; Kanai, 2016), which illustrate how efforts to produce and transgress localized commodity frontiers unfold in cities in the global South and their hinterlands. Both cases are informed by a logic of carbon control and concomitant global governance frameworks. Moreover, these cases are situated at different segments of the carbon cycle, yet in each

instance ‘fundamentally new ways of ordering the relations between humans and the rest of nature’ (Moore, 2015: 127) facilitate the appropriation of unpaid (nature’s) work.

In the first case we narrate the introduction of waste-to-energy incinerators in Delhi, India, as the cornerstone of Delhi’s municipal solid waste-management strategy. This was designed to foster the accumulation of capital by generating cheap electricity as well as Certified Emissions Reductions—called ‘carbon credits’ under the United Nations Framework Convention on Climate Change (UNFCCC) Clean Development Mechanism (CDM)—for the projects’ local proponents. In the second case we show how the Brazilian state of Amazonas sought to restructure the region’s model of territorial development, shifting from a logic of rainforest resource extraction to financialized conservation predicated on the commodification of carbon stored in standing forests. Various payments for ecosystem services and carbon-control schemes have been introduced with differing degrees of success. Instead of reducing Amazonas’ extreme territorial unevenness, these new development strategies have augmented the relative importance of metropolitan Manaus, which is increasingly promoted as a ‘green global city’ or advanced urban economy specialized in the production, consumption and trading of ecosystem-based commodities and services. Both cases demonstrate that eco-scalar fixes may be able to facilitate capital accumulation in strategic city-regions. However, they also raise questions surrounding the durability of such strategies, given the unpropitious prospect that global ‘capitalism might be able to decarbonize and “green” itself, effecting a dramatic transformation of its own business practices’ (Böhm *et al.*, 2012: 1633). Thus these initiatives may ultimately become examples of ‘green’ varieties of financialized neoliberalism which, according to Moore (2015: 304–305), seek to ‘colonize time’ by postponing crises in the short term rather than achieving a grand ‘fix’. Indeed, these regimes have encountered major difficulties to continuously expand the scale and scope of the appropriation of resources, such as various forms of social resistance to the violence and dispossessions that they require.

This article proceeds in three further sections. In the next section we review Moore’s framework in depth; then we advance the argument that eco-scalar fixes pursued by novel multi-scalar governance regimes are producing commodity frontiers and fuelling cycles of accumulation in and around cities. To substantiate this assertion, the following section develops case studies on global carbon-control initiatives in Delhi and Manaus, respectively. In our concluding remarks we make two related points. First, we argue that attempts to localize the appropriation of resources provoke environmental justice conflicts, which threaten the durability of multi-scalar growth coalitions. Secondly, we note that eco-scalar fixes are not the only way in which localized commodity frontiers are produced, and we propose a research agenda.

Spatializing the ‘end of Cheap Nature’

In this section we first introduce Jason Moore’s expansive understanding of capitalism as a world-ecological regime. Secondly, we seek to develop its geographical imagination by enriching it with scholarship on uneven development, and scalar, eco-scalar and socio-ecological fixes. In particular, we focus on how these fixes pertain to the implementation of emerging global carbon-control frameworks. We conclude the section by advancing the argument that the end of Cheap Nature indeed represents a major limit to capital accumulation and, in response, multi-scalar growth coalitions are intensifying efforts to restore conditions that are favourable to accumulation by producing and transgressing localized commodity frontiers in city-regions.

Jason Moore seeks to suture the chasm between society and nature inherent in Cartesian thinking—and social theory *tout court*—by proposing a socio-ecological theory of capitalism. Rather than a social system that has an adverse impact on an external and discrete environment, he conceptualizes capitalism as a set of *socio-ecological* relations underpinned by the appropriation of ‘unpaid work/energy of humans and the rest of nature

outside the commodity system' (Moore, 2015: 54). According to Moore the exploitation of commodified waged labour (Marx, [1867] 1990) and the appropriation of women's unpaid reproductive labour (Federici, 2014) is only part of the story. The expansion of capitalism also necessitates the appropriation of the unpaid work of nature. Accordingly, the 'law of value in capitalism is a law of Cheap Nature', which has historically been 'produced when the interlocking agencies of capital, science, and empire' have forced open commodity frontiers (Moore, 2015: 53). Historically, Cheap Nature was appropriated from its users and stewards, who were dispossessed, enslaved or even exterminated. However, capital accumulation fuelled by the appropriation of Cheap Nature atrophies over time as the ratio of commodified resources increases vis-à-vis those that are appropriated. Once resources are commodified, their owners must bear the cost of nature's reproduction, and the result is a long-term falling profit rate that inhibits capital accumulation.

Moore maps his formulation of 'capitalism-in-nature' onto Arrighi's historical analysis of the rise and fall of successive regimes of capitalist accumulation in the 'long' twentieth century. Arrighi ([1994] 2006) demonstrates that each regime was established by a hegemon, from Italian city states to Dutch mercantilists, the British Empire and finally America's petroleum-fuelled global supremacy. In each instance, the hegemon established the rules of the game with regard to relations among states and capital in a way that facilitated an expansion of global trade and capital accumulation. According to Arrighi, the limits that ultimately led to the collapse of each regime were built in from the outset, and rival centres of accumulation supplanted the existing hegemon by overcoming these contradictions through organizational and technological innovations (*ibid.*: 226). A careful reading of Arrighi indicates that he was not unaware of the importance of the 'material expansion' of the economy and access to resources for the stability and expansion of regimes of accumulation. For example, he notes that hegemons 'identify power with the extent of their command over scarce resources and consider territorial acquisitions as a means and a by-product of the accumulation of capital' (*ibid.*: 33). However, according to Moore, capital accumulation is dependent upon the *appropriation* of resources, not merely their control or ownership. His analysis culminates with the provocation that by the dawn of the twenty-first century we had arrived at the 'end of Cheap Nature'. He asserts that there are no remaining commodity frontiers, the transgression of which would allow for the appropriation of enough resources to power an expansionary phase of growth at the global scale. It follows that the current crisis is terminal.

– Explaining the proliferation of localized commodity frontiers

The end of Cheap Nature may indeed signal a profound crisis, but its consequences will unfold unevenly and shape situated urban political ecologies of crisis (Lawhon *et al.*, 2014). Neil Smith ([1984] 2010: 153) demonstrated that capitalism exhibits the 'tendency toward the equalization of the conditions of production and of the level of development of the productive forces', while individual capitalists seek out cost differentials in the factors of production. He explains how this contradictory tendency fosters uneven development:

[capital] move[s] from developed to underdeveloped space, then back to developed space which, because of its interim deprivation of capital, is now underdeveloped, and so on. If it can move with sufficient alacrity, capital can remain one step ahead of the falling rate of profit. To the extent that it can realize this geographical seesaw, capital can indeed realize some sort of spatial fix (Smith, [1984] 2010: 199).

The circulation of capital accelerates during a crisis as its owners instinctively attempt to protect it from devaluation. Their ability to locate price differentials in factors of production 'becomes a means not toward geographical equalization but

a differentiation upon which the survival of capital is predicated' (*ibid.*: 173). The circulation and territorialization of capital is enabled by reworked governance regimes comprised of differentially scaled actors. According to Brenner (1998: 461) 'capital necessarily depends upon relatively fixed and immobile territorial infrastructures, such as urban-regional agglomerations and territorial states, which are in turn always organized upon multiple, intertwined geographical scales'. These stable configurations can enter a state of flux in times of crisis, and their reworking—what Brenner (*ibid.*) calls a 'scalar fix'—can restore conditions favourable to accumulation. In these cases 'forms of territorialization for capital [are] restructured, reterritorialized, and, frequently, re-scaled' (*ibid.*: 461), thereby identifying or even producing new spaces within which capital can be territorialized and accumulated (see Bayirbağ, 2010).

The restructuring of governance regimes increasingly unfolds in the context of global governance frameworks. Jurisdictions are redrawn to mirror supposedly 'natural' territories, such as watersheds, with the objective of either internalizing or externalizing socio-economic conditions in a given territory (Cohen and Bakker, 2014; Cohen and McCarthy, 2015). The demarcation of new territories of environmental regulation constitutes an 'eco-scalar fix' to Cohen and Bakker (2014: 142) because 'spatial reorganization [is] justified on environmental grounds to address economic crises'. The rescaling of governance regimes is an integral component of attempts to territorialize 'socio-ecological fixes', which rework the 'ways in which landscapes are produced, how human and nonhuman organisms and socio-natural relationships are transformed, and how labour processes are restructured in order to address or offset (at least temporarily) entangled social and environmental crises of capitalism through conjoined productions of space *and* nature' (Ekers and Prudham, 2015: 2438, original emphasis).

Scholars of eco-scalar and socio-ecological fixes have critically examined the potential for a societal transition to a sustainable socio-technical regime within a capitalist mode of production (Castree and Christophers, 2015; McCarthy, 2015). While Moore's analysis precludes the success of a single fix given the absence of global commodity frontiers, there remains a possibility that rescaled governance regimes may be able to locate localized commodity frontiers and restore conditions favourable to capital accumulation. One pertinent example is that of global environmental governance schemes that impose market-based incentives designed to simultaneously reduce carbon dioxide (CO₂) emissions and facilitate capital accumulation. The governance of CO₂ emissions is 'fast becoming a common denominator for thinking about the organization of social life in relation to the environment' (Bridge, 2011: 821), and the emergent 'carbon control regime' (While *et al.*, 2010) is constituted by global governance frameworks that incentivize the reduction of CO₂ emissions by generating what are known as 'carbon credits', which are tradable in global financial markets (see Boyd *et al.*, 2011; Bond, 2012). These global frameworks incorporate expertise and capital situated at the global scale, as well as city-based stakeholders who implement and monitor particular projects. Indeed, cities are 'firmly on the climate change map' (Bulkeley and Broto, 2012: 1; see also Betsill and Bulkeley, 2006) of these schemes, and we argue that many examples of eco-scalar fixes, the objectives of which are to identify and produce localized commodity frontiers, are rolled out at the city or regional scale by growth coalitions comprised of actors situated at multiple scales.

In summary, the end of Cheap Nature heralds a period of intensified resource extraction, as capital combs over areas it has already incorporated in an attempt to locate and appropriate remaining resources. As Moore reminds us:

The conventional view is to think of ecological crisis in terms of diminishing flows of substances—not enough food, not enough oil—but it may well be more productive to think of crisis as a process through which fundamentally new ways of ordering the relations between humans and the rest of nature take shape (Moore, 2015: 127).

Global governance frameworks do this by linking expertise and finance situated at the global scale with local actors whose situated knowledge serves to identify potential commodity frontiers. In contrast to the expansion into a vast ‘great’ frontier, these coalitions are acting within territory that has already been incorporated into global circuits of capital. The novel multi-scalar growth coalitions that emerge can seek to expand a city’s territorial reach over a hinterland from which it secures material resources and energy, and/or they can be ‘intensive’ in the sense that they change the way humans engage nonhuman nature within cities (for example, through the introduction of new technology). This is not a straightforward process of which the outcome is assured. On the contrary, the appropriation and commodification of resources is achieved through rounds of dispossession, which are contested and have already led to a proliferation of localized environmental justice struggles (Martinez-Alier *et al.*, 2016).

In the section that follows, we examine two eco-scalar fixes that are focused on the supposed reduction of carbon emissions and carbon sequestration, in two very different cities in the global South. We emphasize the rescaling of governance regimes and the common mechanisms whereby localized commodity frontiers are produced and/or transgressed. Both instances sought to facilitate localized capital accumulation, but we argue that this may be short-lived: the ‘fixes’ also induced an urban political ecology of financial speculation and crisis. In the final section we conclude by suggesting that the proliferation of environmental justice conflicts may be attributed to the dispossession that is part and parcel of the transgression of localized commodity frontiers, and we draw attention to some of the other ways in which they are produced.

Producing and transgressing localized commodity frontiers: Delhi and Manaus

This section presents our two case studies. The eco-scalar fixes attempted in Delhi and in Manaus highlight the local implementation of global market-based carbon-control schemes—the CDM and REDD+ (Reducing Emissions from Deforestation and Forest Degradation, plus conservation, sustainable management of forests and enhancement of forest carbon stocks), respectively. They are brought together to illustrate the various mechanisms (technological, legal, financial, territorial) whereby multi-scalar growth coalitions attempt to produce and transgress localized commodity frontiers amid the global imperative to stabilize a carbon economy. Each case study is based on long-term research engagement with both cities, which included working closely with local civil-society organizations, interviews with a range of stakeholders and extended field visits.

– Putting waste to work in Delhi, India

Municipal solid waste management in Indian cities is reliant on extensive informal-sector networks that facilitate the collection, transportation and processing of solid waste. In their analysis of informal waste management in Bholakpur, a neighbourhood in Hyderabad, Gidwani and Maringanti (2016) situate municipal solid waste management at the ‘back end’ of a commodity frontier whose ‘front end’ extends to neighbouring states Odisha, Jharkand and Chattisgarh. The ‘brazenly violent’ (*ibid.*: 113) primitive accumulation in these states’ tribal areas ensures a steady stream of resources that sustain the city, and the work of informal-sector waste workers in Bholakpur manages the waste that accrues as a result. In this interpretation, informal-sector waste management enables the extension of a distant commodity frontier. Elsewhere in India, however, large-scale formal-sector waste-management enterprises have aggressively sought to gain control over flows of municipal solid waste. In Delhi the privatization of waste management, coupled with the switch from sanitary landfills to waste-to-energy incinerators, served to transform waste from an externality into a

valuable resource (Schindler *et al.*, 2012). According to Demaria and Schindler (2016: 309), one consequence has been that ‘the actual places where waste is collected and processed (such as doorsteps, transfer stations and landfills) have become a “commodity frontier” ... and the emergence of a commodity frontier within Delhi indicates that we can expect the conflicts surrounding waste to increasingly resemble resource conflicts’. This section demonstrates how the approval of two waste-to-energy plants by the UN’s CDM—and the subsequent award of ‘carbon credits’—transformed solid waste management from the ‘back end’ of a distant commodity frontier to a localized commodity frontier centred on the city. Importantly, the previous regime relied on the unpaid work of informal-sector waste workers, while the emergent system leverages capital-intensive incineration technology to transform solid waste into energy and harness the unpaid work of nature.

Waste management in Delhi has always been the responsibility of the municipal government—the Delhi Municipal Corporation Act (MCD, 1957: Chapter XVII) made it the duty of residents to deposit waste in neighbourhood collection depots (*ibid.*: Section 353), where it became the property and responsibility of the state (*ibid.*, Section 351). From its inception, the Delhi government embraced landfills as a long-term strategy to deal with waste that accumulated at these neighbourhood depots. Delhi’s original master plan (DDA, 1962: 37) noted that landfills were a solution to the city’s scarcity of land: ‘Cut up and low lying land may be reclaimed by hygienically conducted sanitary earth fills of garbage ... [which] will make available valuable lands (which are now waterlogged) for essential urban purposes like parks, etc.’. In the intervening years between the first and second master plans, ‘the environment’ was problematized as an object of conservation that requires ‘purposeful transformation’ so that Delhi’s inhabitants can ‘improve their economic capabilities and share the fruits of modernisation’ (DDA, 1990: 2). In this context, the second master plan identified solid waste as a hazard that ‘could become a cause of crisis in the Metropolitan life’ (*ibid.*: 29), and in subsequent years a twofold strategy evolved to deal with this threat. First, waste management was gradually privatized: by 2005 approximately 50% of waste management was controlled by private firms (Chaturvedi and Gidwani, 2011). Secondly, planners sought to expand the city’s capacity to absorb waste, and the most recent master plan called for the construction of four new sanitary landfills (DDA, 2010: 29, 31, 111).

As Delhi’s solid waste-management strategy evolved, one constant remained: the city’s reliance on the unpaid work of informal-sector labourers who scavenge recyclable materials (such as plastic, paper, metal), which they sell to formal and informal-sector recyclers (Talyan *et al.*, 2008; Gill, 2010; Gidwani and Maringanti, 2016). Scavenging from neighbourhood depots and landfills was outlawed in 1957, yet in practice, municipal authorities tacitly encouraged informal-sector waste workers who, by 2011, numbered between 150,000 and 200,000 (Chaturvedi and Gidwani, 2011). Delhi’s city development plan (MUD and IL&FS, 2006: 12–18) concurred, and estimated that 1,200 to 1,500 tonnes of waste is recycled daily, as ‘rag-picking of municipal solid waste is widely prevalent in Delhi through the involvement of an extensive network of informal (rag-pickers and scrap-dealers) and formal (recycling facilities) stakeholders’ (*ibid.*). The Ministry of Environment and Forests (MoEF) oversees waste management throughout India and amended the Solid Waste Management Rules in April 2016, calling for the ‘[i]ntegration of waste pickers/ragpickers and waste dealers/Kabadiwalas in the formal system’.¹ Delhi’s most recent master plan (2010: 110) noted that the informal sector has the potential to ‘reduce the quantum of waste drastically’, and it stated that ‘[the] involvement of rag pickers with RWAs, CBOs and NGOs is to be encouraged’.²

1 See <http://pib.nic.in/newsite/PrintRelease.aspx?relid=138591> (accessed 19 June 2018).

2 The abbreviations in the text stand for resident welfare association, community-based organization and non-governmental organization, respectively.

The plan to incorporate informal-sector waste workers into an improved system of solid waste management centred on four new sanitary landfills was abruptly revised in the mid-2000s in favour of a waste-management strategy geared toward the incineration of waste. This policy shift was facilitated by a subsidy provided by the CDM, the flagship programme that emerged from the Kyoto Protocol in accordance with the UNFCCC. It was ostensibly designed to subsidize the transfer of technology that could reduce CO₂ emissions from the Organisation for Economic Co-operation and Development (OECD) to the global South. Projects were issued carbon credits (that is, Certified Emissions Reductions) if they had the potential to reduce CO₂ emissions and would not take place in the absence of CDM approval. There is now consensus that the CDM's impact on CO₂ emissions in India has been negligible (Schiermeier, 2011). A leaked United States State Department cable related conversations between US and Indian officials, wherein the latter stated that first of all, many projects were approved without oversight, and secondly, that if projects were subjected to oversight, they would not have met the additionality requirements.³ This was indeed the case with Delhi's two waste-to-energy plants that were registered with the CDM.

For a project to receive CDM approval, its proponents must prove that it will result in a net reduction of CO₂ emissions in comparison with the status quo. This was a difficult requirement for the proponents of Delhi's incinerators to meet, given the fact that the informal sector recycles approximately 17.4% of Delhi's waste (Agarwal *et al.*, 2005), thereby diverting it from landfills where, if left untreated, it would emit greenhouse gasses. The proponents of incinerators needed to, in the words of James Scott (1998), render the informal sector 'illegible' in order to qualify for carbon credits under the CDM. The original project design documents submitted to the CDM credit the incinerators with reducing CO₂ emissions by 262,791 and 111,949 metric tonnes per year, respectively. These figures are supported by tables that quantify every aspect of the process (for example, coconut shells will apparently be 4.53% of the waste processed at one of the plants). The environmental impact of the waste-to-energy plants is then compared with counter-factual scenarios that are presented as business-as-usual, of how waste would be managed if the plants were not built. Although multiple scenarios are presented, the continued growth of the informal recycling sector is not explored as a possibility because 'these alternatives are required to be in compliance with all applicable legal and regulatory requirements' (UNFCCC, 2007: 21). In other words, the project proponents only provided alternative formal solutions to solid waste management, and since waste-pickers access waste that legally belongs to the state, the informal sector exists in legal limbo and its contribution to the management of Delhi's waste was not recognized. Once the contribution of the informal sector had been discounted, the state of waste management in Delhi appeared bleak. The proponents of one of the projects claimed that only 53 tonnes of Delhi's waste is treated (*ibid.*), and the other one stated that a whopping 99% of Delhi's waste is interred in landfills (UNFCCC, 2008: 15–16). It went on to conclude that the incinerator 'avoids land filling of 1300 tons of waste per day' (*ibid.*: 5), approximately the same amount that the informal sector recycles on a daily basis, according to the city development plan (as stated above; see also MUD & IL&FS, 2006). The important difference is that the waste-to-energy plant will incinerate this waste, while waste-pickers facilitate its transfer to recyclers.

Waste was hitherto an externality, the management of which was made possible by unpaid work of informal-sector recyclers at the 'back end' of a commodity frontier. The introduction of waste-to-energy plants contributed to the production of

3 See https://wikileaks.org/plusd/cables/08MUMBAI340_a.html (accessed 19 June 2018). The additionality principle mandates that a 'project must provide emission reductions that are additional to what would otherwise have occurred'.

a commodity frontier in Delhi, as waste became a resource, the incineration of which facilitated capital accumulation. The production of this commodity frontier required state-led restructuring in accordance with global environmental governance. The MoEF granted the quasi-public firm IL&FS clearance to construct a waste-to-energy plant on 15 May 2007,⁴ and in November 2007, IL&FS initiated a process to transfer this approval to a private firm. This tender was concluded in January 2008, and the project was awarded to Jindal Urban Infrastructure Limited (JUILL). The documents submitted for CDM approval fail to explain why the project was transferred to a third party, and this is no trivial matter, considering that JUILL's vice chairman boasted that the company expected an 18% to 20% return on its investment (Prasad, 2011).

Burning waste rather than burying it is a 'fundamentally new [way] of ordering the relations between humans and the rest of nature' (Moore, 2015: 127) that requires the implementation of new regulations and the adoption of new technology. These new regulations and incineration technology facilitate capital accumulation by putting high-calorific waste matter to work. Its incineration powers giant turbines, which generate electricity that is sold domestically and carbon credits that are tradable in global markets. This requires an uninterrupted supply of waste, the appropriation of which amounts to accumulation by 'brazenly violent' (Gidwani and Maringanti, 2016: 113) dispossession from informal-sector waste workers, whose unpaid labour has hitherto been a key component of Delhi's solid waste-management strategy. Thus the places from which high-calorific waste is sourced (for example, doorsteps, neighbourhood depots and retail outlets) have become a commodity frontier characterized by endemic conflict between informal-sector waste workers and formal public- and private-sector actors who facilitate the flow of waste to incinerators (Demaria and Schindler, 2016).

The transition to incineration has been met with resistance from multiple quarters. In addition to waste workers whose livelihoods are jeopardized, middle-class residents and government officials have taken aim at various aspects of the projects. Government officials at various levels have attempted to assert their authority in objection to the fix. The National Green Tribunal (NGT) adjudicates cases that involve environmental issues, and it heard a legal challenge against one of the incinerators launched by a middle-class resident welfare association. The NGT is a national-level court, and the case highlights the tension between municipal authorities and officials in the Indian government. The NGT ordered innumerable tests of ambient air quality, reviews of municipal plans for waste collection, and the technology used in one of the incinerators. Exasperated by the ad hoc nature of Delhi's waste-management system, its justices ordered the Delhi Chief Secretary 'to take a meeting of all the Commissioners of all the [municipal] Corporations and provide [a] complete and comprehensive solution to collect, transport and disposal of municipal solid waste'.⁵ Nevertheless, the final verdict led to the levying of a small fine on the project proponents for violating environmental standards, which amounted to little more than a slap on the wrist. There was also conflict between the proponents of the incinerators and the Delhi Electricity Regulatory Commission over the price at which the electricity generated would be purchased by public utilities. In this case, the NGT ruled in favour of the state, allowing the Delhi Electricity Regulatory Commission to simply fix the price in accordance with rules laid out by the Central Electricity Regulatory Commission. These conflicts demonstrate that while the application of new technology and the CDM have indeed produced a localized commodity frontier, it remains fragile and if flows of waste are interrupted, the capital immobilized in costly incineration technology will be devalorized.

4 The MoEF's approval letter is available on the project's page of the UNFCCC website at <http://cdm.unfccc.int/Projects/DB/SGS-UKL1185291186.52/view> (accessed 19 June 2018).

5 NGT order of 11 May 2016.

– Putting rainforests to work for Manaus, Brazil

Public policies in Brazil have sought to abate deforestation in the Amazon for decades. In the early twenty-first century, Amazonas, the largest-area state in the region and country, shaped up to become an exemplar of successful rainforest conservation combined with rapid economic growth. The state government began implementing pioneering schemes for Amazonas' vast primary forest areas. These sought to leverage international 'carbon credit' funds for welfare improvements in isolated communities, which policy elites began to construe as forest 'guardians'. Yet this conservationist turn did not hamper the continued growth of Manaus, the powerful state capital, which exhibits an astonishing level of urban primacy—territorial concentration of economic resources and population—within Amazonas. The city of Manaus, which had become a competitive industrial location among Brazil's major metropolitan areas, began harbouring ambitions to develop 'green' global-city functions based on its unique location amid the world's largest tropical rainforest. This section shows how rainforests were 'put to work' in unprecedented ways. If rubber-tree exploitation provided capital for the city's initial growth and *belle époque* splendour in the late nineteenth century, the free-zone scheme established in 1967 helped Amazonas to modernize using the enclave economy of the city as industrial platform: the leveraging of carbon-sink functions, ecosystem services and other natural products from biodiverse rainforests promised to support a new era of ecologically oriented prosperity centred on Manaus. This green economy offered the potential to harness nature's unpaid labour more profitably and sustainably than cheap yet environmentally destructive activities such as logging, cattle ranching and soy cropping. Yet this ambitious eco-scalar fix soon exhibited limits, as shown in the analysis that follows. Our analysis, which lists the structural contradictions and external factors that have destabilized the arrangement in recent years, points to the intensification of uneven development and increased inequalities produced by the attempt to commodify and financialize the carbon stored in standing rainforests.

Since the 2000s, Amazonas has become an early subnational adopter of REDD, and subsequently of REDD+. Toni (2011) argues that this international funding scheme can help promote the decentralization of conservation policy in Brazil, providing incentives for subnational units (states and municipalities) to augment their efforts against deforestation, and create new locally managed conservation areas. Moreover, the state, with the non-governmental Sustainable Amazonas Foundation (Fundação Amazonas Sustentável, or FAS) as its flagship institution, has been praised for its approach to conservation policy through pioneering pursuit of multi-sectoral collaborations with international donors, national institutions, NGOs, science, and local communities (Gebara *et al.*, 2014). Among these, Marriott International, a multinational corporation in the field of hospitality with headquarters in the US, provided FAS its most high-profile international partnership, which reached a milestone at the 2016 Climate Summit of the Americas held in Guadalajara, Mexico. Representatives from FAS and the state government presented Marriott an emissions-reduction certificate, allegedly the first of its kind ever to be issued in Brazil. The partnership supposedly resulted in a reduction of 400,000 tonnes of carbon dioxide (t CO₂) between 2006 and 2013 through Marriott's financial support of the Juma Sustainable Development Reserve (SDR), a joint initiative of FAS and the state government (GCFTF, 2016).

Located in an area of close to 590,000 hectares in the south-eastern quadrant of Amazonas state, which is threatened by deforestation owing to its proximity to Rondônia state's agricultural corridor, the Juma SDR plays a paramount role in the state's economic strategy. It constitutes a proof of concept for international carbon-credit generation, provides a testing site for additional social schemes involving forest peoples, and is an iconic signifier of Amazonas' innovative, cosmopolitan and compassionate approach to local conservation and global climate-change mitigation—including

the production of globally accessible imagery from inside the SDR (this through a partnership between FAS and Google Street View). Beyond FAS-sponsored conservation studies, researchers have reached varying conclusions regarding the Juma initiative and wider plans for state-level conservation units—Amazonas has created an extensive network with 19 million hectares protected across 41 units, several of which, however, exhibit much more precarious governance arrangements with the highest levels of protected-area deforestation in the entire region (TCE-AM, 2013; Souza, 2017). On the positive side, Locatelli *et al.* (2011) have noted that Juma inserted adaptation concerns into what was originally a mitigation project, and emulated policy innovations from the federal government by combining payments for ecosystem services with commitment from beneficiary families to keep children enrolled in school. The programme's comprehensive development orientation also includes allowances for community activities, sustainable micro-enterprise activities and a focus on public health (Viana *et al.*, 2008).

Nevertheless, critiques abound regarding flaws in the Bolsa Floresta (Forest Protection Allowance), the programme that has grown out of the Juma experience to include 15 conservation units across the state (Bakkegaard and Wunder, 2014). Rival (2012: 13) chronicles that for engaged NGOs, the approach has introduced meagre 'welfarism' into forest communities and a dominant market ideology that commodifies carbon and water, thus inhibiting people from pursuing alternative development paths. Instead, community leaders demand better access to services and markets for their products as well as the 'bundling' back together of ecosystem services and human labour (see also Gebara, 2013, for participatory shortcomings of the programme's various components). Agustsson *et al.* (2014) argue that, despite modest current reductions in deforestation (within an area where little was occurring in the first place), the programme's main environmental effects may only materialize in the long term: through its indirect impact on improving residents' knowledge and awareness, and by maintaining communities in place to deter deforestation by external actors. Furthermore, Juma's carbon benefits may have been overcalculated owing to leakage (displacement of deforestation to other areas) and faulty baseline models that overestimate pressures on the sites to be protected (Yanai *et al.*, 2012). Overall, while protected areas, including state-level conservation units, may have a role to play in anti-deforestation policy, Fearnside (2008) points to the need to coordinate these with the territorial design of infrastructure networks (such as roadways), overarching land-use regulations and fiscal incentives and deterrents.

In sum, Amazonas' high-profile/low-investment conservation policies have been critiqued for their relative overreliance on international funding to support 'flagship' projects, the relative unimportance of conservation areas vis-à-vis larger territorial interventions with incompatible consequences, and even greenwashing governmental neglect of remote forest communities. However, we also need to consider the overall political economic context of the state of Amazonas in the early twenty-first century. The overarching concern at this historical conjuncture was to redefine the Manaus Free Zone (Zona Franca de Manaus or ZFM). The ZFM federal programme had underpinned economic development in the city and state for decades, having been started in Brazil in an era of highly regulated import substitution industrialization, and as a counterbalance to its territorial focus on the most developed metropolitan regions—which are clustered in the country's southeast. Thus, the protection of rainforest environments can be understood as ancillary rather than secondary to the aim of rescuing, restructuring and upgrading the city's economic base (Kanai, 2014a). Following the neoliberalization of the Brazilian economy in the 1990s, tax abatements and tariff exemptions had become less effective, and new opportunities had to be found in an integrated global economy. Thus a new model of accumulation was built upon a possible locational (dis-)advantage of Manaus, and its uniqueness amid vast undeveloped rainforests.

The city might perhaps have leveraged the major role attributed to the Amazon region in sustaining the threatened planetary environment (Fearnside, 2008). Yet, owing to the high level of dependency that the state economy still exhibited vis-à-vis industrial production and employment in the ZFM, the eco-scalar fix necessarily had to include this industrial agglomeration as the fulcrum of future growth. In fact, the eco-economic policies that the state began to pursue were overlaid on, and shaped by, earlier efforts by multiple actors to shore up Manaus' industrial district after the abrupt decline it had experienced in the early 1990s. Further corporate benefits and exemptions to incentivize industrial relocation; support of science and technology to stimulate industrial restructuring and investments in research and development; and public investments in urban and regional infrastructure to improve the city's built environment and enhance its external connectivity were all part of the initial package of transformative state actions (Pereira, 2006). Green initiatives were meant to diversify the local economy and increase the value added to the restructured economic base, and such initiatives would also contribute to Brazil's quest for global recognition as an international environmental leader. Thus, in 2003, the federal government built the massive Centro de Biotecnologia da Amazônia (or CBA, the Amazon Biotechnology Centre) in Manaus, as part of its multi-year investment plan, called PROBEM (Programa Brasileiro de Ecologia Molecular para o Uso Sustentável da Biodiversidade, or the Brazilian Programme for Molecular Ecology for the Sustainable use of Biodiversity). In the same year, the first high-profile Amazonas state programme for sustainable development was unveiled, tellingly named the Green Free Zone (Zona Franca Verde, or ZFV), to promote development in the state's remote communities while strengthening conservation initiatives and the protection of biodiversity. Prominently supporting the ZFV was governor Eduardo Braga (2002–2010), a reformist politician under whose leadership FAS was created as an independent NGO (outside state government structures to avoid political interference), and the first state law to regulate climate-change policies was passed, allowing the Amazonas government to engage in international carbon trading (Becker and Stenner, 2008).

The stated policy goal was to broaden the economic base away from industrial manufacturing, and to support the growth of green industries within a sustainable development framework. Yet the brunt of state initiatives and new investments remained territorially concentrated in and around Manaus. The various plans and programmes put in place either focused on upgrading the urban core to support more advanced and profitable activities, or on expanding the metropolitan area by extending the provision of services and basic infrastructure. In terms of the former, PROSAMIM (Programa Social e Ambiental dos Igarapés de Manaus, or the Manaus Waterways and Environmental Programme) was the first high-profile intervention that was rolled out. This creek restoration programme, in fact, refers to the piping and paving over of many of the city's central waterways. More controversially, PROSAMIM displaced resident populations to peripheral locations, where they were offered access to formal housing. Additionally, the successful bid to host matches during the FIFA World Cup 2014 resulted in several large-scale initiatives and investments to distinguish Manaus as the 'green' host city (Kanai, 2014a). While several of these are still to materialize, such as the sustainable mobility scheme, Amazonas state built one of the most expensive and technologically sophisticated stadia in Brazil, which was awarded a LEED certification.⁶ In terms of the latter, the state established a top-down framework to govern investments in the metropolitan region, and built the first (mega-)bridge over a main tributary to the Amazon River, thereby linking Manaus to the south bank region. This opened up erstwhile rural municipalities to accommodate growth overflow from Manaus (Kanai, 2014b). The more recent, currently stalled, initiative to build a 'university city' in a

6 The acronym LEED stands for Leadership in Energy and Environmental Design.

greenfield area of Iranduba exemplifies the territorial expansion aims: in addition to educational facilities, the area was slated to accommodate spaces for life-sciences and biotechnological research, and clean industrial production, as well as high-end housing, retail and recreational sectors, all overlaid on protected forest areas that were to be turned into premium green amenities.

In recent years, Amazonas' eco-economic schemes have been reduced to a more conventional form of ecologically themed city-regional entrepreneurialism intent on attracting foreign investment and linking local activities to transnational circuits of capital (Kanai, 2014a). Technological bottlenecks have impeded the growth of local bio-industries, and foreign investments in rainforest conservation have been lower than initially expected in the context of ongoing international problems to set global markets for carbon and ecosystem services. Instead, speculation has abounded, particularly in the Manaus real-estate sector, triggering rapid land appreciation (*ibid.*). Furthermore, whereas industrial production continued growing rapidly under the ZFM scheme, and certain quarters developed advanced urban functions in the 2000s, particularly related to specialized consumption and high-value residential land use, economic benefits did not spread widely in Amazonas. The increasingly unbalanced economic dynamics have led to the continuation of in-migration from the hinterlands. Socio-ecological conflicts have increased in periurban areas, where informal urbanization is met with strengthened conservation enforcement, but also in the urban core, where the working and middle classes increasingly protest the contradictions of 'environmental' building projects that result in high levels of pollution, vulnerabilities and deficient support infrastructures in their everyday lives. Furthermore, the infrastructure networks developed to sustain Manaus' metropolitan growth have had the unintended consequence of enabling deforestation activity. The paving of the BR-174 roadway that links the city to the extensive roadway network and coastal ports of Venezuela was meant to enhance surface connectivity for industrial products and passenger traffic, but is also used by illegal loggers. Similar dynamics plague energy projects such as the Coari-Manaus gas pipeline, which puts in evidence the limitations of protected-area conservation schemes within an overall development approach that disregards the deforestation implications of infrastructure and industrial policy (Kanai, 2014b; 2016).

In the 2010s, deforestation increased amid a national recession and a rollback of forest protection in Brazil (Souza, 2016). The territorially extensive eco-scalar fix set up in Amazonas, with metropolitan Manaus at its core, is further threatened by the recent notable decline of industrial production. The ZFM has proven highly sensitive to reductions in domestic consumption, given the model's failure to develop substantial export markets outside Brazil (Paiva, 2015). With less funds to support conservation agencies, slashed-and-burned rainforests increasingly have an adverse effect on air quality in the city. Politically discontented populations increasingly feel the burden of economic slowdown, and an ongoing legitimacy crisis was triggered by high-profile corruption cases, leading to elected officials being forcefully deposed. Local institutions and stakeholders are exploring new alternatives for the failing development model. Yet there is uncertainty about the right 'fix' to appropriate higher values from rainforests. Concerns abound regarding the possibility of protecting standing forests to a degree that will not imperil regional and global climate dynamics further, as Amazonas shows signs of being unable to green its development model and reduce deforestation-related carbon emissions beyond speculative financing.

Conclusion: localized commodity frontiers, uneven development and inter-city connectivity

Jason Moore's world-ecological analysis of capitalism highlights its dependence on the availability of Cheap Nature, which has historically been generated by appropriating resources on recently opened commodity frontiers. As these resources

are accounted for and commodified, their reproduction constitutes a cost which, over time, will inhibit capital accumulation. The history of capitalism is one of constant expansion beyond successive commodity frontiers, in a relentless quest to maintain a favourable ratio of accumulated/commodified nature. Moore argues that the crisis of contemporary capitalism is terminal, because there are no 'great' commodity frontiers whose transgression would restore the production of Cheap Nature and fuel an expansionary phase of *global* capitalism. In this article, we have shown that in the absence of a 'great' frontier, multi-scalar growth coalitions have sought to identify, produce and transgress localized commodity frontiers. These eco-scalar fixes are achieved by combining expertise and capital situated at the global scale with powerful locally embedded actors, whose intimate knowledge of places allows them to identify resources that have hitherto remained non-commodified and can be leveraged in a global carbon economy. While some of these commodity frontiers are geared toward the extraction of material resources, such as the transformation of municipal solid waste into refuse-derived fuel, others rely on global governance frameworks to produce fictitious commodities such as 'carbon credits', awarded for rainforest conservation. We presented two case studies of city-oriented eco-scalar fixes from different segments of the carbon cycle, and in both instances conditions favourable to capital accumulation for some stakeholders were restored at least temporarily. In the case of Delhi, authorities engineered an 'intensive' eco-scalar fix by introducing waste-to-energy technology that allowed capital to appropriate the unpaid labour of nature through the incineration of waste and subsequent generation of tradable carbon credits. The 'extensive' eco-scalar fix in Manaus, by contrast, was predicated on exerting control over rainforest hinterlands, the conservation of which generated financial/symbolic resources. Taken together, these case studies demonstrate that global environmental governance frameworks—and particularly those associated with carbon control—serve to produce Cheap Nature in various ways, such as through the adoption of new technology and laws, the territorial expansion of extractive activity, or a combination thereof. This explains why eco-scalar fixes are occurring in a broad range of geographical contexts and with variegated empirical manifestations in terms of modalities and tactics.

The ability of these regimes to sustain capital accumulation relies on maintaining a steady stream of appropriated—rather than commodified—resources, which is the basis for producing Cheap Nature (Moore, 2015). This requires unceasing efforts to dispossess those who have historically used non-commodified resources. Marginalized populations bear the brunt of this unrelenting primitive accumulation, and this explains the 'increasing numbers of ecological distribution conflicts that sometimes overlap with other social conflicts related to class, ethnicity or indigenous identity, gender or caste and which may be further related to institutional configurations such as property regimes or territorial rights' (Martinez-Alier *et al.*, 2016: 732). These conflicts have the potential to disrupt the appropriation of resources and call into question the durability of the regimes of accumulation achieved by eco-scalar fixes. For example, one of Delhi's waste-to-energy plants was challenged in court by nearby residents and, although this bid was ultimately unsuccessful, it posed a major risk to the project's investors, as it threatened to devalorize capital already immobilized in costly waste-to-energy technology. Indeed, as the search for remaining non-commodified resources intensifies, investors will be forced to territorialize capital in increasingly risky locales and ventures. In instances where capital is devalued, the question will be whether the loss is borne by private-sector firms, municipal authorities or global investors. This adds a scalar dimension to the classic version of entrepreneurial urbanism in which the public sector assumes the risk while the private sector reaps the financial rewards (see Harvey, 1989).

In closing, we have attempted to show how multi-scalar coalitions mobilized global governance frameworks to produce localized commodity frontiers in different segments of the carbon cycle. However, we need to clarify that this article's engagement

with eco-scalar fixes does not exhaust all the dimensions of the geographies of the end of Cheap Nature that should be investigated. In particular, there is an apparent intensification of attempts to expand city-based infrastructure networks into heretofore peripheral resource-rich areas (Enns, 2018), as policymakers at multiple scales seek to integrate vast tracts of non-urban land into planned networks of human settlements (Zoomers *et al.*, 2017). UN-Habitat's (2016) New Urban Agenda, which was ratified by UN member states, affirmed the intention of national governments to plan national urban systems and infrastructure development. To assist national urban planners UN-Habitat (2015) released the International Guidelines on Urban and Territorial Planning, which advocates territorial planning at multiple scales and establishes 'general rules and mechanisms for coordinated inter-municipal urban and territorial planning and management' (UN-Habitat, 2015: 9). These plans represent a state-orchestrated commitment to the production and transgression of localized commodity frontiers under conditions of recentralized political power. This has the potential to intensify uneven development as some peripheral areas are 'plugged in' to global circuits of capital and others are bypassed (Murray, 2017; Kanai and Schindler, 2018). Therefore, future research should not only focus on the prospects of global capitalism's decarbonization, and the impact of producing localized commodity frontiers: we should also attend to the actors engaged, the modalities of activities and the (increasingly urban) geographies that are subject to transformation. Alongside speculative fixes, socio-ecological impacts and politicized resistances loom large in the uneven and contested landscapes at the end of Cheap Nature.

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