Progress in Human Geography
35(6) 820–834

10.1177/0309132510385524
phg.sagepub.com
SAGE

Resource geographies 1: Making carbon economies, old and new

Gavin Bridge
The University of Manchester, UK

Abstract
This progress report is the first in a series of three on resource geographies, and reflects a renewed interest within human geography and cognate disciplines in classic resource questions of scarcity, access and governance. It focuses on carbon, an element which is fast becoming a common denominator for thinking about the organization of social life in relation to the environment. The report examines how researchers are applying one of resource geography's principle tenets – that so-called 'natural resources' are an outcome of political, economic and cultural work – to understand the resource-making processes associated with the 'carbon economy'. Significantly, it expands this term from its limited association with carbon markets and offsetting to encompass the 'actually existing' carbon economy associated with the extraction and consumption of fossil fuels. By reading these 'old' and 'new' carbon economies together, the report considers the making of carbon resources as they extend from the upstream, extractive end of the hydrocarbon commodity chain to the emission, capture and sequestration of carbon downstream. It harnesses the reductionism inherent to 'carbon' – its capacity to put apparently different entities on the same page – in order to identify commonalities and connections between the old and new carbon economies that are ordinarily overlooked. The report is organized around three core 'logics' of resource making that can be identified in recent work: economy, territory and subject formation.

Keywords
carbon economy, enclosure, oil, resources, territory

I Introduction

It has been some time since 'natural resources' formed the subject of a report for *Progress in Human Geography*. Natural resource management and conservation were staple features of reviews from the establishment of this journal in the 1970s until the early 1990s (Mitchell, 1980; Munton, 1983; Owens and Owens, 1987, 1989; Simmons, 1977, 1979, 1980, 1982; Wescoat, 1991, 1992, 1993). Since then research on the appraisal, appropriation, regulation and co-production of the non-human world has continued to feature within *Progress* but largely under the alternative flag of 'environmental issues' (Braun, 2005, 2006, 2008; Castree, 2002, 2003, 2004; Reed and Christie, 2009) or political ecology (Neumann, 2009, 2010).

This series of three progress reports on resource geographies reflects a renewed interest within the discipline in classic resource questions of scarcity, access and governance. A feature of

Corresponding author:
School of Environment and Development, The University of Manchester, Oxford Road, Manchester M13 9PL, UK
Email: gavin.bridge@manchester.ac.uk

recent work is its critical engagement with the making of resources: a concern to understand the political, economic and cultural processes through which particular configurations of socionature become imagined, appropriated and commodified. In part, this is due to a confluence of external events that confirm the social contingency of natural resources. These include spectacular rises in prices for many raw materials; economic policies that encourage states and firms to reappraise biophysical systems as 'natural assets' with which to leverage growth and development; extra-territorial adventuring by states to secure access to critical resources such as agricultural land, oil and industrial minerals; and political and legal recognitions that give new shape to claims about identity, responsibility and sovereignty around natural resources (such as ILO Convention 169 on Indigenous and Tribal Peoples and the Kimberley Process for diamond certification). Phenomena like these affirm the resource geographers' creed that 'natural resources are not naturally resources' but the products of cultural, economic and political work (Hudson, 2001). But the renewed interest in resource questions is not solely a reaction to external events. It is also home-grown and, as we shall see, the result of a sustained effort to bring a range of critical social theory – eco-Marxism, economic sociology, science and technology studies, and postcolonial theory – to bear on the 'management of nature' (Castree, 2007).

In this first report I focus on carbon. Nervous travellers, however, should be assured that it is not the first stop on an extended tour of the geographies of the periodic table (although Mendeleev's 150-year framework has proven to be a creative narrative device in other contexts, e.g. Levi, 1985; Sacks, 2001). The rationale for opening this series with a single element is that carbon is fast becoming a common denominator for thinking about the organization of social life in relation to the environment.[1] From fossil-fuel addiction and peak oil to blood barrels and climate change, carbon's emergence as a dominant optic for thinking and writing about the world and human relations within it is tied to the various emergencies with which it is associated. The problematic space-time geographies of fossil fuels and greenhouse gases define the Anthropocene: the essential 'element of life' now threatens species survival (Crutzen, 2002; Dalby, 2007; Knox-Hayes, 2010; Roston, 2008). Not only is 'thinking about carbon … becoming further engrained in cultural and social behaviour' (Boykoff et al., 2009: 2301), but 'carbon control' has become a primary objective of political and economic governance at urban, regional and international scales (While et al., 2010: 77). A form of elemental reductionism, carbon provides an ordering logic and mode of accounting through which space and social practice are being rewritten. The ink in the pen of a new geo-graphy (earth writing),[2] carbon achieves these effects through three techniques: first, *a cartography* of resources, reserves, fluxes, sinks and dumps that territorializes and fixes carbon in space while at the same time throwing places into new forms of relation, creating an imaginative gazetteer of enclosure and connection[3] (Gabrys, 2009; Lansing, 2010; Yusoff, 2009); second, *ethnographies* of 'carbon management' that appraise basic social practices (such as food provision and housing) and individual behaviours (like shopping and travelling) in terms of their contribution to carbon metabolism and their potential for decarbonizaton (Lovell et al., 2009a); and, third, *a biopolitics* in which carbon has become the condition of possibility for the living of life and so holds the balance of life and death, whether imagined through a collapse of civilization at the hands of peak oil or an apocalypse of climate change (Baldwin and Metzler, 2010; Bridge, 2010; Swyngedouw, 2010).

In a biological sense, of course, carbon is an essential constituent of life on earth: it is the role of carbon as a cultural object and its increasing centrality to the organization of *social* life,

however, that provides the justification for focusing on carbon in this report. Placing carbon at the centre also has another benefit: its capacity to link together work on the powerful incumbency of fossil fuels with research on climate change.[4] Energy and climate traditionally have been 'relatively discrete' academic and policy domains and in many jurisdictions they remain so (Lovell et al., 2009b). Until recently, work in the social sciences on carbon has focused primarily on the downstream, post-utility end of economic activity, a terrain of emissions, sinks and wastelands lying beyond economy's conceptual walls. Here the elemental moniker 'carbon' has stood in for carbon-dioxide equivalent, a fictitious molecular category through which several different greenhouse gases are made commensurable. These materialities of carbon have traditionally defined economy's 'outside' but lately have become one of its leading edges: the brave new world of the 'new carbon economy' (Boykoff et al., 2009; Brown and Corbera, 2003). However, limiting the label 'carbon' to this downstream portion is unnecessarily restrictive. There is an 'actually existing' carbon economy that extends backwards from the point of greenhouse gas emissions all the way upstream to the site of fossil fuel extraction. As Smil (2005) points out, a very large proportion of the world's population is either already a 'high energy society' or aspires to be so and, for the most part, the sources of this energy are carbon-intensive fossil fuels. It is desirable, therefore, to extend the idiom 'carbon' beyond its conventional association with greenhouse gases to examine the installation and maintenance of contemporary fossil-fuel intensive forms of social life, and the cultural and political forms to which they give rise (e.g. Huber, 2009a; Lohmann, 2005; Mitchell, 2009).

Holding these old and new carbon economies together effectively redraws the boundary of the 'carbon problem': climate change becomes no longer an emission problem or a sequestration problem, but one of carbon throughput; while fossil fuel supply questions (from peak oil to energy security) become issues of reducing the carbon dependency of energy services (Bradshaw, 2010). This is more than an analytical nicety: it helps to distinguish between an approach that manages climate change by creating 'carbon dumps' and one aimed at phasing out fossil fuels by removing incentives for their extraction and consumption (Lohmann, 2005). My objective in this report, then, is to consider recent work on the making of carbon resources as they extend from the extractive end of the 'hydrocarbon commodity chain' to the emission, capture and sequestration of carbon at the other (Bridge, 2008). I harness the reductionism inherent to 'carbon' – its capacity to put apparently different entities on the same page – in order to identify commonalities and connections between the old and new carbon economies that are ordinarily overlooked. The rest of the report is structured around three 'logics' associated with the making of carbon resources: economy, territory and subject formation.

II Logics of economy: Commodification, primitive accumulation and carbon enclosures

A core theme in recent work is the process of enclosure and commodification that characterizes the making of carbon resources. There is a strong sense that carbon resources constitute a contested frontier of incorporation, a zone where the relentless 'economization of nature' collides with behaviours, systems and polities that are often radically different. In the main, the intellectual resources deployed to understand the creative-destructive processes at work here – and the geographically uneven forms of development to which they give rise – have been Marx and Polanyi. Indeed, the hydrocarbon commodity chain is the exemplar par excellence of the contemporary 'Polanyian moment' (Watts, 2010): in both the global atmosphere and in the great

fossil commons of subterranean hydrocarbon reserves, forms of carbon are being liberated from their geo-ecological and sociohistorical contexts and thrown into the circuits of the *social* carbon cycle.

The centrality of property to the making of carbon resources has been a focal point, reflecting resource geography's long-standing interest in property rights institutions and resource access regimes. Writing in the context of Appalachian coal, Haas (2008) describes the mountaintop removal techniques through which once uneconomic coal reserves have been brought into production at the expense of massive landscape change. She shows how this intensification of production rests on an evolution in the spatial form of property rights and the consequences for Appalachian communities and ecologies as property rights have expanded vertically and horizontally. Labban (2008: 123) takes up the question of property in an analysis of access regimes in the international oil sector. He shows how geographies of oil and gas extraction are 'structured by a contradiction between the integration of resource-rich territories into the circuits of global capital and their fragmentation through protectionist measures that regulate the extension of foreign capital into the oil industry'. This tension between fragmentation and integration is expressed in the material form of the concession, because of the critical role that these institutions of property play in enabling resource owners to withhold resources from the market (see also Bridge, 2009). Through work on oil, Labban makes a more general point: how carbon economies old and new hinge on the creation of scarcity, the critical role of property/enclosure in enabling scarcity in the face of prodigious natural abundance, and how property regimes are enacted by states and constituted spatially – not just in the obvious sense of having a geographical expression, but in the way they produce particular geographies and scales of integration.

Through a focus on property, work on carbon resources makes the connection between enclosure and environmental and social transformation. Bebbington (2009), for example, examines the ongoing expansion of the hydrocarbon frontier in Latin America and the impact of legislation to encourage investment in extractive industries by breaking the connections between indigenous and campesino communities and land. He emphasizes not only the scale and pace of enclosure, but also the overlap between extractive concessions and the geographies of community and territorial claims and critical watersheds. Kaup (2008) looks at the way in which gas in Bolivia has become 'an object of profit and protest' as corporate, state and indigenous interests have sought to pursue their agendas via the country's large hydrocarbon reserves. He considers the strategies employed by the Bolivian government and transnational firms to physically and socially disembed natural gas while also negotiating the various demands of local communities. Bebbington and Bebbington (2010a) place the enclosure and commodification of subterranean resources in Bolivia, Peru and Ecuador as part of a broader reordering of Latin America's position in global political economy that, at the same time, is reproducing a classic core-periphery relationship. Their analysis suggests a deeply rooted economic logic at work in the expansion of the hydrocarbon frontier in Latin America: despite their self-conscious post-neoliberal positioning, governments in Bolivia and Ecuador are pursuing enclosure and extraction no less forcefully than Peru.

The historical resonances, pronounced asymmetries of power and reliance on 'extra-economic' mechanisms (e.g. military conquest) for securing access to resources has encouraged authors to interpret these strategies via reference to Marx's concept of primitive accumulation. Through this analytical device, researchers examine how the acts of enclosure and commodification through which carbon economies are constituted are at the same time processes of dispossession: resource making, then, is a form of

taking or theft in which the material and cultural attachments of existing resource users are alienated. Spronk and Webber (2007; see also Perreault, 2006) characterize resistance to gas and water privatization as a struggle against accumulation by dispossession, while Bond (2006) applies this framework to the 'looting' of Africa's subsoil wealth. Zalik (2009) compares two moments of dispossession in Mexico and Nigeria associated with securing oil production and ensuring an interrupted flow of hydrocarbons. She shows how the implementation of an exclusion zone around oil platforms in the Gulf of Mexico in the wake of 9/11 displaced small-scale fishers, and how an ostensibly humanitarian evacuation of thousands of people from riverine communities in the Niger Delta served to tighten foreign, corporate control over subsoil resources. The result, she argues, is that 'industrial costs ... are partially and violently absorbed by residents of the extractive site even as welfare interventions moderate this absorption' (p. 559). Oil also seeps through the accounts by Harvey (2003) and Retort (2005) of the causes of the second Gulf War. However, rather than focus on the privations and dispossessions of Iraqis during the war and understand them as the result of a simple oil grab by an hegemonic power ('blood for oil'), these accounts situate oil as the carrier of a far wider process of restructuring through which the material conditions for expanding the reproduction of capital are reconstituted. Here primitive accumulation refers not to the acquisition of oil resources per se, but to the periodic expansion of capitalism into fresh terrains of plunder.

Similar processes of enclosure, commodification and dispossession are unfolding in the context of a 'new' carbon economy, as a host of new socionatural assemblages and spaces are offered up as outlets for surplus (Boykoff et al., 2009). Although much of the geographical work on the new carbon economy focuses on the construction of climate policy and the governance of carbon markets, research has begun to focus on the enclosures and transformations necessary to produce sequestration landscapes as objects of speculation and instruments of profit – what Lohmann (2005: 204) terms the framing of 'a carbon dump commodity'. As Bumpus and Liverman (2008) point out, there is a distinctive geography to this 'spatial fix' because:

> carbon reductions are like many other resources in that they can be expensive to obtain locally and are often easier and cheaper in the developing world, where industrial processes are generally less efficient, forest offsets are more effective, opportunities for implementing 'cleaner' energy systems may be less costly, and labor and land are generally less expensive. (Bumpus and Liverman, 2008: 131)

Because of this interdependence with landscapes in the global South, they liken the commodification of the atmosphere to 'earlier models of the conversion of collective property, such as common land to private ownership and colonial takeover of natural resources facilitated by the state through law and military authority'. Cognizant of how the socio-ecological conditions and the technologies of offsetting are critical to their effects on landscapes and livelihoods (Boyd, 2009; Bumpus, 2009), Lovell and Liverman (2010) have recently called for greater attention to the materialities of offset projects as a way to get beyond what they see as often quite crude debates for and against offsetting. Other researchers have extended analysis of the economic logics at work in the new carbon economy to consider the way making carbon offsets also produces a form of 'carbon debt' as emitters who purchase offsets are spared the cost of actively reducing their own emissions (Kallis et al., 2009; Martinez-Alier, 2002). In this way offsetting mirrors the same form of 'unequal ecological exchange' through which oil (and other resources) are extracted from the periphery and embedded in the infrastructures of industrial economies where they underpin superior levels of productivity (Hornborg, 2006). Similar processes of enclosure, land conversion, social transformation and ecological exchange are at work around

the development of biofuel resources (Prudham, 2009), although to date there has been relatively little work by geographers on the complex geographies and political ecologies of biofuels (however, see Mol, 2010; Tomei and Upham, 2009).

III Logics of territory: Enclaves, colonies and democracies of carbon

Resource-making activities are fundamentally matters of territorialization – the expression of social power in a geographical form. The spatial and scalar dimensions of the resources that make up the old and new carbon economies are 'unsettled political space(s)' that are not fixed by nature but by the play of power (Lovbrand and Stripple, 2006: 234). The emergent geographies of the new carbon economy illustrate the process of territorialization particularly well. Lovbrand and Stripple (2006), for example, describe the accounting, measurement and regulatory practices of international climate negotiations through which in a very short time the global carbon cycle has become territorialized as national sources and sinks. While et al. (2010: 89) examine the downscaling of this process to localities in the UK, a process they describes as the 'coming to ground of carbon control'. The authors explore the disciplining effects of carbon control at urban and regional scales and suggest how the rationalities and practices involved in 'managing the city as a space of carbon flows' are likely to be different to those of sustainable development.

Although more socially sedimented and familiar, the territorial formations associated with 'carboniferous capitalism' are no less an outcome of contending interests seeking to embed fossil carbon within a particular (e.g. national) scalar frame while also disembedding it as a commodity. For some, this question of territorialization turns on the landed character of carbon resources: the way subsoil resources constitute the material body of the nation so that territorial form and cultural identities often become fused. Perreault and Valdivia (2010; see also Perreault, 2006; Valdivia, 2008), for example, examine popular mobilization around underground carbon stores of oil and natural gas in Ecuador and Bolivia. Reminding us that 'resources struggles are never only about resources' but also about 'the meanings of development, citizenship and the nation itself', they show how social movements have sought to reclaim the sites and infrastructures of hydrocarbon production by turning them into 'spaces of nation-making' (see also Bebbington and Bebbington, 2010b, on resource grievances in Bolivia). Baldwin (2009) also examines the intersection of carbon with national subjectivities but in the context of carbon management plans for the boreal forests of Canada. While thinking of the forest as a 'space of carbon' may challenge the rip-and-run logics of logging, mining and oil and gas extraction, Baldwin shows how carbon forestry management is also a form of discipline that 'enacts a political geography of racial difference'. He draws on critical race theory to highlight the epistemic violence of carbon management which, in the context of Canada's boreal forests, 'consolidates a vague notion of "white" national subjectivity, while simultaneously either erasing aboriginality or enfolding flattened variations of aboriginality into its ordering logic' (p. 233).

This linkage between the scalar projects of territorialization and the forms of social power to which particular configurations of space and nature can give rise is a persistent theme in recent work. The strikingly uneven geographies of fossil fuels and carbon offsetting and their tendencies to reproduce a North/South geography of core-periphery has meant that for some the reference point is the extractive relations of colonialism and imperialism. Bachram (2004), for example, mobilizes language used by activists in India to challenge monoculture plantations for carbon sequestration as 'carbon colonies' that

impose the interests of the North on the global South. Robbins (2007) also takes up this theme in the context of climate forestry in India and, drawing attention to the close relationships that have existed between forestry, economic hegemony and imperial power long before the reimagining of forests as carbon stores, he explicates the extractive logic of colonial relations. The issue, he argues, is that climate forestry projects overlook the way trees are *already* incorporated into the livelihood strategies of local peoples and therefore they 'run the risk of catalysing the production of global exchange values from local use values and facilitating uncompensated extraction and accumulation from the world's poorest people' (p. 280).

Both Bachram and Robbins highlight the spatial divisions of labour and nature of which carbon colonies are one part: the emergence in the global South of land cover regimes managed for their carbon storage or sequestration capacities is paralleled by the proliferation and consolidation of fossil fuel consumption in the global North. Their assessment of the coercive and extractive character of global carbon management strategies is echoed by Baldwin (2009: 239), who argues that 'the global carbon market ... bears the unmistakable marks of colonial power ... carbon offsets rely on a form of sovereign colonial power ... that disproportionately favours states and multinational corporations over local actors'. For others, however, the implications of carbon management are more ambiguous and need not necessarily rearticulate colonial resource regimes. For Boyd et al. (2007) the 'high reliance (of the rural poor) on natural assets for security to cope with unexpected events' and the contested nature of rights to forests and other resources of the new carbon economy create risk and uncertainties that are constraining the development of forest carbon projects. Meanwhile Adams (2008) emphasizes the capacity of a decarbonization agenda to move conservation beyond its traditional 'protected areas' approach, which has sought to defend specific parcels while allowing extensive land use change outside.

The 'colonies' metaphor, then, may be effective at drawing attention to the spatial divisions of labour constructed through carbon at the global scale, but it has its limits for understanding how carbon economies are materialized and sustained 'on the ground'. The unruly, sometimes nightmarish conditions of oil extraction – and the complex relationship between oil's abundance/scarcity, conflict and development (see Le Billon and Cervantes, 2009) – have provided plenty of scope for exploring this question. Writing on Africa's experience with extractive industries, Ferguson (2005; see also 2007) highlights the enclave character of oil development and how extractive carbon economies are 'tightly integrated with head offices of multinational corporations and metropolitan centres, but sharply walled off from their own national societies'. This distinctive spatiality, he argues, diverges sharply from the standardization of space via its homogenization within the territorially continuous national grids of (colonial) state modernization projects, so clearly described by Scott (1998). The result is a form of 'selective territorialization' in which dispersed zones of intensive carbon exploitation are networked together 'in a selective point-to-point fashion' and administered separately from the vast spaces of the 'unusable' rest (p. 380). For Ferguson, the model is the Angolan offshore – an extreme form of insulation from the political entanglements of national territory that exemplifies the 'socially thin' character of oil. This archetypal space is the focus of Reed's (2009) political ecology of Angolan oil, which examines the violence and degradation from the perspective of fishing and farming communities located in the extractive zone. Her work illustrates how the enclave enables a highly exclusionary form of development while also highlighting 'the distortions and externalities that bleed out' from these spaces.

Watts' work on Nigerian oil and the failed project of petro-modernization has its foundations in an analysis of primitive accumulation and enclosure, but builds upon this to consider the forms of (un)rule to which this has given rise in the Niger Delta. He situates the toxic mixture of ethnonationalism and insurgency in the Delta as a reaction to strategies of enclosure and dispossession undertaken by and through oil, and shows how this has 'produced … a fragmented polity in which we have forms of parcellized and turbulent sovereignty … rather than a robust modern nation'. For Watts, these 'ungovernable' spaces of the carbon economy reveal the particular and contradictory forms of community that are created and sustained through oil. From bands of youth militia in the Delta (Watts, 2008a) to the way an 'unruly' Gulf of Guinea licenses American military action (Watts, 2008b), carbon economies are examined not as exemplars of the 'resource curse' and a deficit of 'good governance' but as generative of – and functional to – certain forms of political organization. Mitchell (2009) takes up this theme but applies it to a more expansive canvas: the growing embeddedness of fossil fuels in society since the mid-19th century. He argues that the physical, financial and intellectual infrastructure associated with carbon-based energy systems has underpinned several distinctive forms of politics during the 19th and 20th centuries. His provocation, then, is that coal – and now oil – set the 'limits of carbon democracy' (p. 400). This is no simple energy determinism based on some imaginary 'power of carbon' but an effort to 'trace the connections that were made between pipelines and pumping stations, refineries and shipping routes, road systems and automobile cultures, dollar flows and economic knowledge, weapons experts and militarism' in order to see 'how a peculiar set of relations was engineered among oil, violence, finance, expertise and democracy' in the 20th century (p. 422). Taken together, recent work on the political geographies of carbon understands territorialization as a dialectical process in which spatial and scalar outcomes are 'always in the making' (Lovbrand and Stripple, 2006). By doing so, it is able to highlight what Ferguson (2007: 203) calls the contending 'political and scalar models' associated with the governance of carbon economies.

IV Logics of subject formation: Forging connections, identities and responsibilities through carbon

Through work on the politics of oil and climate change, researchers have shown how political communities form in and through the management of carbon flows. Extending this interest in the political identities licensed in and through carbon, research has begun to probe the processes of subjectification occurring around carbon: that is, how the status of hydrocarbons or standing biomass as resources for the carbon economy hinges on people orienting themselves towards them in particular ways. Much might be said about the fraught subject positions of those who purvey fossil carbon in an era of 'dangerous climate change' or of other 'carbon workers' on whose labour sources and sinks depend (Lovbrand and Stripple, 2006; see also Gillon, 2009, on 'energy patriots'), but the focus of recent work has been on the subjectivities of end users: those who consume fossil energy, produce emissions and – perhaps – purchase offsets. A core question here is how thinking about – and, more specifically, calculating – social practice in terms of carbon mobilization constructs particular understandings of agency and responsibility. Since these notions of self in relation to others lie at the heart of identity, researchers have begun to explore the identities of the 'carbon (consuming) subject' and what they mean for the relationship between an individual and society (see also Dowling, 2010). Rutland and Aylett (2008) examine the 'creation of a responsible, carbon-calculating individual' at the heart of Portland, Oregon's Carbon Dioxide Reduction Strategy. Their analysis focuses on the

epistemological work required to produce a prevailing 'common sense' that the best way to address climate change is to focus on individual behaviour and household energy efficiency (as opposed, say, to direct regulation of CO_2 emissions or overall reductions in energy consumption).

Paterson and Stripple (2010) are similarly interested in the 'calculative spaces' of the new carbon economy but point out how the individualization of responsibilities for carbon emissions – materialized in carbon footprints, personal carbon accounts, and carbon diets – nonetheless relies on a form of 'communicative rationality' common to social networking: it is through 'peer pressure, comparison, communication ... validation, (and) innovation' that the 'conduct of carbon conduct' is achieved. Their point is that carbon economies may be 'a vanity-oriented, virtue politics of self-denial, sacrifice, and neo-colonial offsetting' but they are also 'something that calls into question the freedom-oriented discourse of neoliberal politics' (p. 347). Like Rutland and Aylett (2008), Paterson and Stripple draw on the intellectual resources of 'governmentality' to consider how scaling responsibility for carbon management to the level of the household and individual constitutes a liberal form of governance that is premised on a 'facilitative' type of power. It does not operate through the authority of states but, by 'empower(ing) citizens to do certain things and not others' – what Paterson and Stripple term 'responsible agency' – it reproduces the state's institutions and structures (Rutland and Aylett, 2008: 641). Observing that acting as a responsible citizen is now 'one of the most important features ... of responses to climate change' (Wolf et al., 2009: 518), several authors have begun to explore how, by shifting the boundary between the private and public spheres, carbon reworks the meaning of citizenship (Dobson, 2003; Melo-Escrihuela, 2008).

The broader picture here is the question of what moral economies are being constructed through and around carbon. While questions of personal and collective responsibility around the 'old' carbon economies are a feature of the contemporary condition and manifested in a variety of form – including boycotts of oil companies, direct action against coal-consuming utilities, and urban-scale proposals for urban energy descent (e.g. Bailey et al., 2010; North, 2010; Sawyer, 2010; see also Sadler, 2004) – there have been very few efforts by geographers to think about the logics of care and responsibility associated with fossil fuels. These connections are frequently made in the popular literature (Manning, 2004; Margonelli, 2007), but the cultural and moral economies of fossil fuels have yet to feature alongside the more familiar studies of fashion and food.[5] However, researchers have begun to consider the emerging moral economies shaping the new carbon economy. Putting carbon into conversation with research on the cultural economies of fair trade, Lovell et al. (2009a) examine the 'consumer subjectivities and 'ethical dispositions' developing towards carbon dioxide in relation to the voluntary offset market. Through a content analysis of adverts for offsetting, they show how the market relies on 'making ordinary practices – driving, flying, heating, homes and offices – the subject of ethical consideration through the deployment of new narratives, or rationalities, about what such practices should involve' (p. 2361). Their analysis – and that of others on the prospects for certification in the new carbon economy (e.g. Ciscell, 2010) – complements work on the rationalities of carbon governance by highlighting how 'offset narratives and their critiques are shaping the production process through the development of new codes and regulations' (Lovell et al., 2009a: 2375). The comparison with conventional fair trade commodities is instructive as it reveals the significance of large institutions (rather than individuals) as offset consumers and, based on the experience of the UK, the role of government in developing regulatory structures.

V Conclusion: Carbon's social metabolism

Carbon is a strikingly generative cultural object. 'Carbon control' – understood here as the social strategies that govern the release of carbon from underground reservoirs, its circulation through economies and its return to biophysical systems – strongly inflects social life. Through the logics of economy, territory and subjectification, carbon transforms the relations and conditions of production, putting people, places and ecological systems into particular configurations that give shape to carbon resources. While some contemporary 'spaces of carbon' are novel and potentially transformative, others intensify established social and spatial relations. A bewildering diversity of landscapes may be considered as connected in one way or another to the management of carbon, but I have focused in this progress report on the resource-making practices most closely associated with the 'old' and 'new' carbon economies.

By surveying recent work on oil, coal and gas alongside new research on offsetting and 'carbon conduct', I have sought to read these two, conventionally separated carbon economies together. My aim has been to use this report on recent progress to develop an agenda for research on the resource geographies of the 'carbon age' by highlighting four things. First, to demonstrate how similar processes of resource making and claiming – enclosure, sociospatial ordering and the shaping of subjectivities – lie behind the conversion of lived ecologies into carbon 'resources', whether these be the classic spaces of fossil fuel extraction, or the more varied landscapes of carbon sequestration, offsetting and carbon-capture-and-storage. Second, to use the novelty and becomingness of the new carbon economy to 'render strange' the more familiar extractive economies of oil, coal and gas: the territorialization of carbon offsets, for example, epitomizes what Polanyi (2001 [1944]: 171) described as the 'weirdness' of commodifying land and disembedding it from its sociohistorical context, a process whose violence has long been disguised as the 'discovery' of natural resources.

Third, I have identified some of the interdependencies between the old and new carbon economies so that they appear as extensions of each other rather than separate (or even alternative) entities. From the perspective of fossil carbon throughput, for example, offsets and sequestration projects license the continued development and extraction of fossil fuels.[6] Furthermore, the scarcity of carbon offsets is ultimately tied to the continued extraction and throughput of fossil carbon: as Spash (2010: 191) points out, the new carbon economy 'has many vested interests whose opportunities for making money rely on maintaining GHG emissions, not reducing them'. When the peripheralization of carbon extraction and carbon dumping mean the old and new carbon economies collide in the *same* geographical space, these tensions and mutual dependencies are exposed with a particular clarity. In western Canada, for example, the coincident geographies of tar sands and boreal forests bring these tensions into sharp relief, while also highlighting a shared colonial epistemology haunting resource management (Baldwin, 2009; see also Howitt, 2001). The Arctic is a similarly liminal space onto which contending carbon futures are projected and through which they are increasingly being worked out, but also where a 'vicious circuit of (carbon) accounting … (of) sea ice loss and its future disappearance feed into the development of energy production opportunities and further circulation of carbon credits' (Yusoff, 2009: 1026). In such places carbon's social valency can perform abrupt switches as biomass becomes revalued as carbon storage rather than food or fuel, or when a change in resource management policy turns 'carbon forests' into 'carbon bombs' (Baldwin, 2010; Staddon, 2009).

My fourth objective has been to position anthropogenic climate change as fundamentally

a problem of carbon mobilization. The significance of this apparently rather modest move is that climate management strategies tend to concentrate on spaces of fossil fuel consumption and adaptation, rather than on upstream interventions to choke off fossil fuels at the point of extraction and decarbonize economies at source. So far these downstream strategies have produced only modest reductions in carbon dioxide emissions (Liverman, 2009). However, the idea of 'keeping the coal in the hole and the oil in the soil' has been broached by several social and environmental justice organizations as a more effective means of avoiding climate change and addressing a host of other development issues (Bond, 2008; Davis, 2008). Rather than leaving the rate of extraction to market forces and targeting policy towards changing consumption habits downstream, their goal is direct regulation of the social carbon cycle via climate policies that ensure coal, oil and gas remain shut in. By examining the upstream reaches of the hydrocarbon commodity chain along with its outfalls downstream, an analytical perspective centred on carbon's 'social metabolism' (Clark and York, 2005; Prudham, 2009) suggests alternative policy approaches for dealing with the anthropogenic mobilization of carbon via fossil fuel combustion. It also serves to highlight how accumulation and social power are sustained through the making of carbon economies both old and new.

Notes

1. The reductions and equivalences of life made possible through the chemical category 'carbon' suggest its capacity for driving the 'fungibility of all being', which Glassman (2007: 96) describes as one of the potential logics of neoliberal primitive accumulation.
2. We can extend the Retort (2005: 39) collective's commentary on the cultural investment of oil with 'magic' creative powers to carbon more generally: 'capitalism would be nothing without its continual ability to make materials ... the Creators of New Worlds'. Geographical research on carbon has generally refused such mystification, preferring instead to specify the social relations through which carbon achieves these apparent effects.
3. These imagined geographies include fossil fuel's 'deepwater horizons', the jigsaw puzzle of 'missing sinks' played out on a landscape scale, fugitive fluids (like oil and gas) that can be 'stranded' or 'shut in', and the surreal prospect of a planetary emergency constituted (in part) through the interior geographies of methane-producing ruminants.
4. The majority of carbon dioxide emissions are associated with the combustion of fossil fuels (75%) and deforestation. In addition to carbon dioxide, anthropogenic climate change is associated with the accumulation of five other gases with radiative forcing potential: methane, nitrous oxide, perfluorocarbons, hydrofluorocarbons and sulphur hexafluoride (Liverman, 2009).
5. Huber (2009b) considers the moral economy of entitlement (to low-price oil) that is expressed in discourses of livelihood (the 'American way of life') associated with popular protest at high gasoline prices in the United States.
6. Liverman (2009) discusses the negotiating positions that culminated in sinks (carbon absorption by land cover) being included in the Kyoto Protocol in 1997, and how nations vulnerable to climate change sought to exclude sinks in an effort to get large and quick reductions in atmospheric concentrations of carbon dioxide.

References

Adams WM (2008) Conservation, carbon and transition to sustainability. *Oryx* 42: 469–470.

Bachram H (2004) Climate fraud and carbon colonialism: The new trade in greenhouse gases. *Capitalism Nature Socialism* 15(4): 5–20.

Bailey I, Hopkins R, and Wilson G (2010) Some things old, some things new: The spatial representations and politics of change of the peak oil relocalisation movement. *Geoforum* 41(4): 595–605.

Baldwin A (2009) Carbon nullius and racial rule: Race, nature and the cultural politics of forest carbon in Canada. *Antipode* 41(2): 231–255.

Baldwin A (2010) Environmental citizenship and turbulent materialism: The problem of carbon in an era of climate security. Paper presented at the Association of American Geographers Annual Conference, 17 April, Washington, DC.

Baldwin A and Meltzer J (2010) Environmental citizenship and climate security: Contextualizing violence and citizenship in Amazonian Peru. Conference Paper. Environmental Citizenship in Latin America, Simon Fraser University, 23 April, Vancouver.

Bebbington A (2009) The new extraction: Re-writing the political ecology of the Andes? *NACLA Report on the Americas* 42(5): 12–20.

Bebbington A and Bebbington D (2010a) An Andean avatar: Post-neoliberal and neoliberal strategies for promoting extractive industries. *New Political Economy*, forthcoming.

Bebbington D and Bebbington A (2010b) Anatomy of a regional conflict: Tarija and resource grievances in Morales' Bolivia. *Latin American Perspectives* 37(4): 140–160.

Bond P (2006) *Looting Africa: The Economics of Exploitation.* London: Zed Books.

Bond P (2008) The state of the global carbon trade debate. *Capitalism Nature Socialism* 19(4): 89–106.

Boyd E (2009) Governing the clean development mechanism: Global rhetoric versus local realities in carbon sequestration projects. *Environment and Planning A* 41(10): 2380–2395.

Boyd E, Gutierrez M, and Chang M (2007) Small-scale forest carbon projects: adapting CDM to low-income communities. *Global Environmental Change* 17(2): 250–259.

Boykoff M, Bumpus A, and Liverman D (2009) Guest editorial: Theorizing the carbon economy. *Environment and Planning A* 41(10): 2299–2304.

Bradshaw M (2010) Global energy dilemmas: A geographical perspective. *Geographical Journal*. doi:10.1111/j.1475-4959.2010.00375.x.

Braun B (2005) Environmental issues: Writing a more-than-human urban geography. *Progress in Human Geography* 29(5): 635–650.

Braun B (2006) Environmental issues: Global natures in the space of assemblage. *Progress in Human Geography* 30(5): 644–654.

Braun B (2008) Environmental issues: Inventive life. *Progress in Human Geography* 32(5): 667–679.

Bridge G (2008) Global production networks and the extractive sector: Governing resource-based development. *Journal of Economic Geography* 8(3): 389–419.

Bridge G (2009) The hole world: Scales and spaces of extraction. *New Geographies* (Harvard Graduate School of Design) 2: 43–48.

Bridge G (2010) Geographies of peak oil: The other carbon problem. *Geoforum* 41(4): 523–530.

Brown K and Corbera E (2003) Exploring equity and sustainable development in the new carbon economy. *Climate Policy* 3: S41–S56.

Bumpus A (2009) Carbon development: A political ecology analysis of carbon offset projects for local development and global climate benefits. DPhil thesis, University of Oxford.

Bumpus A and Liverman D (2008) Accumulation by decarbonisation and the governance of carbon offsets. *Economic Geography* 84: 127–155.

Castree N (2002) Environmental issues: From policy to political economy. *Progress in Human Geography* 26(3): 357–365.

Castree N (2003) Environmental issues: Relational ontologies and hybrid politics. *Progress in Human Geography* 27(2): 203–211.

Castree N (2004) Environmental issues: Signals in the noise? *Progress in Human Geography* 28(1): 79–90.

Castree N (2007) Neo-liberalising nature: The logics of deregulation and reregulation. *Environment and Planning A* 40: 131–152.

Ciscell GM (2010) Beyond CO_2lonialism: the potential for fair trade certification to embrace voluntary carbon offsets. *International Journal of Sustainable Society* 2(2): 121–132.

Clark B and York R (2005) Carbon metabolism: Global capitalism, climate change, and the biospheric rift. *Theory and Society* 34(4): 391–428.

Crutzen PJ (2002) Geology of mankind. *Nature* 415: 23.

Dalby S (2007) Anthropocene geopolitics: Globalisation, empire, environment and critique. *Geography Compass* 1(1): 103–118.

Davis T (2008) Breaking ground without lifting a shovel: Ecuador's plan to leave its oil on the ground. *Houston Journal of International Law* 30: 243.

Dobson A (2003) *Citizenship and the Environment*. Oxford: Oxford University Press.

Dowling R (2010) Geographies of identity: Climate change, governmentality and activism. *Progress in Human Geography* 34(4): 488–495.

Ferguson J (2005) Seeing like an oil company: Space, security and global capital in neoliberal Africa. *American Anthropologist* 107(3): 377–382.

Ferguson J (2007) *Global Shadows: Africa in the Neoliberal World Order.* Durham, NC: Duke University Press.

Gabrys J (2009) Sink: The dirt of systems. *Society and Space* 27: 666–681.

Gillon S (2009) Environmental governance for energy independence in Iowa: The making of ethanol patriots, land stewards and rural landscapes. Paper presented at the Association of American Geographers Annual Meeting, 18 April, Washington, DC.

Glassman J (2007) Neoliberal primitive accumulation. In: Heynen N, McCarthy J, Prudham S, and Robbins P (eds) *Neoliberal Environments: False Promises and Unnatural Consequences*. Abingdon: Routledge, 94–97.

Haas J (2008) Law and property in the mountains: A political economy of resource land in the Appalachian coalfields. PhD dissertation, Ohio State University.

Harvey D (2003) *The New Imperialism*. Oxford: Oxford University Press.

Hornborg A (2006) Footprints in the cotton fields: The Industrial Revolution as time–space appropriation and environmental load displacement. *Ecological Economics* 59(1): 74–81.

Howitt R (2001) *Rethinking Resource Management: Justice, Sustainability and Indigenous Peoples*. London: Routledge.

Huber M (2009a) Energizing historical materialism: Fossil fuels, space and the capitalist mode of production. *Geoforum* 40(1): 105–115.

Huber M (2009b) The use of gasoline: Value, oil, and the 'American way of life'. *Antipode* 41(3): 465–486.

Hudson R (2001) *Producing Places*. New York: Guilford Press.

Kallis G, Martinez-Alier J, and Norgaard R (2009) Paper assets, real debts: An ecological-economic exploration of the global economic crisis. *Critical Perspectives on International Business* 5(1/2): 14–25.

Kaup B (2008) Negotiating through nature: The resistant materiality and materiality of resistance in Bolivia's natural gas sector. *Geoforum* 39: 1734–1742.

Knox-Hayes J (2010) Constructing carbon market space-time: Climate change and the onset of neo-modernity. *Annals of the Association of American Geographers*. doi:10.1080/00045608.2010.500554.

Labban M (2008) *Space, Oil and Capital*. New York: Routledge.

Lansing D (2010) Carbon's calculatory spaces: The emergence of carbon offsets in Costa Rica. *Environment and Planning D* 28: 710–725.

Le Billon P and Cervantes A (2009) Oil prices, scarcity, and geographies of war. *Annals of the Association of American Geographers* 99(5): 836–844.

Levi P (1985) *The Periodic Table*. New York: Schocken Books.

Liverman D (2009) Conventions of climate change: Constructions of danger and the dispossession of the atmosphere. *Journal of Historical Geography* 35: 279–296.

Lohmann L (2005) Marketing and making carbon dumps: Commodification, calculation and counterfactuals in climate change mitigation. *Capitalism Nature Socialism* 14(3): 203–235.

Lovbrand E and Stripple J (2006) The climate as political space: The territorialisation of the global carbon cycle. *Review of International Studies* 32: 217–235.

Lovell H and Liverman D (2010) Understanding carbon offset technologies. *New Political Economy* 15(2): 255–274.

Lovell H, Bulkeley H, and Liverman D (2009a) Carbon offsetting: Sustaining consumption? *Environment and Planning A* 41: 2357–2379.

Lovell H, Bulkeley H, and Owens S (2009b) Converging agendas? Energy and climate change policies in the UK. *Environment and Planning C: Government and Policy* 27: 90–109.

Manning R (2004) The oil we eat: Following the food chain back to Iraq. *Harper's Magazine* February: 37–45.

Margonelli L (2007) *Oil on the Brain: Petroleum's Long, Strange Trip to Your Tank*. New York: Broadway Books.

Martinez-Alier J (2002) Ecological debt and property rights on carbon sinks and reservoirs. *Capitalism Nature Socialism* 13(1): 115–119.

Melo-Escrihuela C (2008) Promoting ecological citizenship: Rights, duties and political agency. *ACME: An International E-Journal for Critical Geographies*. Available at: http://www.acme-journal.org/vol7/CM-E.pdf

Mitchell B (1980) Models of resource management. *Progress in Human Geography* 4(1): 32–56.

Mitchell T (2009) Carbon democracy. *Economy and Society* 38(3): 399–432.

Mol A (2010) Environmental authorities and bio-fuel controversies. *Environmental Politics* 19(1): 61–79.

Munton R (1983) Resource management and conservations. *Progress in Human Geography* 7(1): 126–132.

Neumann R (2009) Political ecology: Theorizing scale. *Progress in Human Geography* 33(3): 398–406.

Neumann R (2010) Political ecology II: Theorizing region. *Progress in Human Geography* 34(3) 368–374.

North P (2010) Eco-localisation as a progressive response to peak oil and climate change – a sympathetic critique. *Geoforum* 41(4): 585–594.

Owens P and Owens S (1987) Resource management. *Progress in Human Geography* 11(4): 580–589.

Owens P and Owens S (1989) Resource management. *Progress in Human Geography* 13(1): 107–117.

Paterson M and Stripple J (2010) My space: Governing individuals' carbon emissions. *Society and Space* 28: 341–362.

Perreault T (2006) From the Guerra Del Agua to the Guerra Del Gas: Resource governance, neoliberalism and popular protest in Bolivia. *Antipode* 38(1): 150–172.

Perreault T and Valdivia G (2010) Hydrocarbons, popular protest and national imaginaries: Ecuador and Bolivia in comparative context. *Geoforum* 41(5): 689–699.

Polanyi K (2001 [1944]) *The Great Transformation: The Political and Economic Origins of Our Times.* Boston, MA: Beacon Press.

Prudham S (2009) Pimping climate change: Richard Branson, global warming and the performance of green capitalism. *Environment and Planning A* 41: 1594–1613.

Reed K (2009) *Crude Existence: Environment and the Politics of Oil in Northern Angola.* Berkeley, CA: University of California Press.

Reed M and Christie S (2009) Environmental geography: We're not quite home — reviewing the gender gap. *Progress in Human Geography* 33(2): 246–255.

Retort (2005) *Afflicted Powers: Capital and Spectacle in a New Age of War*. London: Verso.

Robbins P (2007) Carbon colonies: From local use value to global exchange in 21st century postcolonial forestries. In: Raju S, Kumar S, and Corbridge S (eds) *Colonial and Postcolonial Geographies of India*. London: SAGE, 279–297.

Roston E (2008) *The Carbon Age*. New York: Walker and Company.

Rutland T and Aylett A (2008) The work of policy: Actor networks, governmentality, and local action on climate change in Portland, Oregon. *Society and Space* 26: 627–646.

Sacks O (2001) *Uncle Tungsten: Memories of a Chemical Boyhood*. New York: Vintage Books.

Sadler D (2004) Trade unions, coalitions and communities: Australia's Construction, Forestry, Mining and Energy Union and the international stakeholder campaign against Rio Tinto. *Geoforum* 35(1): 35–46.

Sawyer S (2010) Human energy. *Dialectical Anthropology* 34(1): 67–77.

Scott J (1998) *Seeing Like a State*. New Haven, CT: Yale University Press.

Simmons IG (1977) Natural resources and their management. *Progress in Human Geography* 1(2): 319–326.

Simmons IG (1979) Resource management and conservation. *Progress in Human Geography* 3(2): 273–277.

Simmons IG (1980) Resource management and conservation. *Progress in Human Geography* 4(1): 86–90.

Simmons IG (1982) Resource management and conservation. *Progress in Human Geography* 6(1): 102–105.

Smil V (2005) *Energy at the Crossroads: Global Perspectives and Uncertainties*. Cambridge, MA: MIT Press.

Spash C (2010) The brave new world of carbon trading. *New Political Economy* 15(2): 169–196.

Spronk S and Webber J (2007) Struggles against accumulation by dispossession in Bolivia: The political economy of natural resource contention. *Latin American Perspectives* 34(2): 31–47.

Staddon S (2009) Carbon financing and community forestry: A review of the questions, challenges and the case of Nepal. *Journal of Forest and Livelihood* 8(1): 25–32.

Swyngedouw E (2010) Apocalypse forever? Post-political populism and the spectre of climate change. *Theory, Culture and Society* 27(2/3): 213–232.

Tomei J and Upham P (2009) Argentinean soy based biodiesel: An introduction to production and impacts. *Energy Policy* 37: 3890–3898.

Valdivia G (2008) Governing relations between people and things: Citizenship, territory, and the political economy of petroleum in Ecuador. *Political Geography* 27: 456–477.

Watts M (with Kashi E, photographer) (2008a) *The Curse of the Black Gold*. New York: Powerhouse Press.

Watts M (2008b) Imperial oil: The anatomy of an oil insurgency. *Erdkunde* 62(1): 27–39.

Watts M (2010) Now and then. In: Castree N, Chatterton PA, Heynen N, Larner W, and Wright MW (eds) *The Point Is To Change It: Geographies of Hope and*

Survival in an Age of Crisis. Oxford: Wiley-Blackwell, 10–26.

Wescoat J (1991) Resource management: The long-term global trend. *Progress in Human Geography* 15(1): 81–93.

Wescoat J (1992) Resource management: Oil resources and the Gulf conflict. *Progress in Human Geography* 16(2): 243–256.

Wescoat J (1993) Resource management: UNCED, GATT, and global change. *Progress in Human Geography* 17(2): 232–240.

While A, Jonas A, and Gibbs D (2010) From sustainable development to carbon control: Eco-state restructuring and the politics of urban and regional development. *Transactions of the Institute of British Geographers* 35(1): 76–93.

Wolf J, Brown K, and Conway D (2009) Ecological citizenship and climate change: Perceptions and practice. *Environmental Politics* 18(4): 503–521.

Yusoff K (2009) Excess, catastrophe and climate change. *Society and Space* 27: 1010–1029.

Zalik A (2009) Zones of exclusion: Offshore extraction, the contestation of space and physical displacement in the Nigerian Delta and the Mexican Gulf. *Antipode* 41(3): 557–582.