ROUTLEDGE STUDIES IN
ECOLOGICAL ECONOMICS

Ecology and Power

Struggles over land and material resources in the past, present, and future

Edited by
Alf Hornborg, Brett Clark, and
Kenneth Hermele

ROUTLEDGE

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Power and social inequality shape patterns of land use and resource management. This book explores this relationship from different perspectives, illuminating the complexity of interactions between human societies and nature. Most of the contributors use the perspective of "political ecology" as a point of departure, recognizing that human relations to the environment and human social relations are not separate phenomena but inextricably intertwined. What makes this volume unique is that it sets this approach in a transdisciplinary, global, and historical framework.

The twenty-six contributors represent a spectrum of academic fields including anthropology, sociology, geography, economics, economic history, historical archaeology, human ecology, development studies, and sustainability science. In presenting local case studies from all over the world, the contributors develop a global understanding of these politicized environments. They generally apply a broadly conceived world-system approach to issues of land use, resource management, and environmental change. Examples discussed in this book include the cultivation of various crops such as wheat, rice, sorghum, coffee, sugarcane, Jatropha, and safflower; the raising of livestock such as llamas and cattle; and other extractive activities such as forestry, mining, energy production, and the trade in guano and ivory.

The volume also adds a deep historical dimension to political ecology. Collectively, it argues that a long-term, historical understanding of how local and global power struggles shape the trajectories of human–environmental relations is crucial to the emergent field of political ecology. This point applies, for example, to the past two centuries of fossil-fuelled capitalism, during which human dependency on land appears to have become less tangible than in pre-industrial times. Against this background, several chapters discuss the implications of the anticipated return to biofuels, which would transform the rationality of conventional land use and regenerate contradictions between food and energy production in regions of the world that have largely been spared such contradictions over the past two centuries.

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Introduction

Ecology and power

Alf Hornborg, Brett Clark, and Kenneth Hermele

Power and social inequality shape patterns of land use and resource management. This book explores this relationship from different perspectives, illuminating the complexity of interactions between human societies and nature. Most of the contributors use the perspective of "political ecology" as a point of departure, recognizing that human relations to the environment and human social relations are not separate phenomena but inextricably intertwined (Peet and Watts 1996; Bryant and Bailey 1997; Low and Gleeson 1998; Paulson and Gezon 2005; Biersack and Greenberg 2006; Peet *et al.* 2011). What makes this volume unique is that it sets this approach in a trans-disciplinary, global, and historical framework.

The 26 contributors represent a spectrum of academic fields including anthropology, sociology, geography, economics, economic history, historical archaeology, human ecology, development studies, and sustainability science. They have been recruited from two international research networks recently established by the Human Ecology Division, Lund University, Sweden. The first network includes participants in the international conference *Ecology & Power: Critical Perspectives on Sustainability and Resilience*, organized and hosted by the Human Ecology Division on September 17–19, 2008, with most of the funding from the Bank of Sweden Tercentenary Foundation. The second network involves participants in the research project *Power, Land, and Materiality: Global Studies in Historical Political Ecology as a Framework for Assessing Policies for "Sustainable Development"*, funded by the Swedish Research Council for Environment, Agricultural Sciences and Spatial Planning (FORMAS). What unites all these researchers from various disciplines is the recognition that power asymmetries and social inequalities shape patterns of land use and the management of natural resources. Together, they apply a variety of interconnected perspectives to this core theme of political ecology. Whether applying concepts and methods of economic historians, sociologists, or geographers, the authors demonstrate how human interactions with the land are intertwined with global, regional, or local power structures. They analyze phenomena that range from the asymmetries of global capitalism, international trade, and empires to the politics of development, ethnic divisions, and even household organization. The spectrum of approaches represented in this book thus illustrates ways of bridging the divide between the tangible materiality of uneven resource flows and societal metabolism, on one hand, and the less tangible, symbolic dimension of social stratification, ethnicity, race, and gender, on the other. As a result, this scholarship indicates that an attribution of decisive significance to material parameters in reproducing power structures should not imply downplaying the role of socio-cultural categories in organizing such structures.

In presenting local case studies from all over the world, the contributors develop a global understanding of these politicized environments. They generally apply a broadly conceived world-system approach to issues of land use, resource management, and environmental change. This theoretical framework provides unity of understanding in the midst of disciplinary diversity. Viewing local struggles over land and resources through the lens of the global entails highlighting conditions and causal relationships that tend to be neglected in public discourse. Examples discussed in this book include the cultivation of various crops, such as wheat, rice, sorghum, coffee, sugarcane, Jatropha, and safflower; the raising of livestock such as llamas and cattle; and other extractive activities such as forestry, mining, energy production, and the trade in guano and ivory. As many of these production systems require substantial investments in so-called landesque capital, some chapters discuss the social conditions under which such investments are made.

Finally, the volume as a whole adds a deep historical dimension to political ecology. Collectively, it argues that a long-term, historical understanding of how local and global power struggles shape the trajectories of human–environmental relations is crucial to the emergent field of political ecology. This point applies, for example, to the past two centuries of fossil-fuelled capitalism, during which human dependency on land appears to have become less tangible than in preindustrial times. Against this background, several chapters discuss the implications of the anticipated (re)turn to biofuels, which would transform the rationality of conventional land use and regenerate contradictions between food and energy production in regions of the world that have largely been spared such contradictions over the past two centuries. Other chapters reveal how much of the logic of world trade today can be understood as historical transformations of resource flows established by ancient empires such as Rome, China, and the Inca. Together, the chapters in this volume examine a very wide range of environmental changes, as mediated by various asymmetries and types of power, throughout the world.

The chapters

The contributors were asked to provide chapter titles focusing on one or two words denoting concrete, material phenomena that served as keys toward unraveling specific aspects of global power relations. Inevitably, however, some chapters are more theoretical in nature, and their keys less concrete. Nonetheless, together these contributions provide a comprehensive account of the range of social relations that influence environmental change. In Part I, Alf Hornborg, in Chapter 1, outlines a theoretical approach to understanding how material and cultural conditions interact in processes of accumulation and unequal exchange. He also suggests that biophysical, non-monetary metrics may help illuminate how specific kinds of trade can generate distinctive types of environmental degradation – and diverse conditions for technological growth – in different sectors of the world system. In Chapter 2, Brett Clark and Richard York examine how the inclination toward "technological fixes", i.e. obsessive attempts to solve problems by using new technologies without changing social relations, is intrinsic to the capitalist system. Rather than solving ecological problems, these technological fixes generally create new problems or simply displace old ones. Together, these two chapters indicate that modern technological systems are primarily means of redistributing resources and risks in global society, rather than merely ways of organizing human–environmental relations at the local level (cf. Hornborg 2011).

Janken Myrdal, in Chapter 3, compares two ancient empires, Rome and China, in terms of the extent to which they were able to control land areas, populations, and flows of bulk goods. After discussing the need of strict source criticism in writing global history, he reveals that large pre-industrial cities required long-distance imports of substantial volumes of food to sustain urban populations. By the time industrialized agriculture in proximate regions appeared more capable of supporting large cities, he concludes, industrialization itself demanded an unprecedented expansion of global material flows (cf. Chapter 5). Again, industrial technology emerges as a new social strategy, under specific social relations, for appropriating distant resources. Although it seems vastly more democratic and benevolent than imperial tribute, its underlying rationale may be quite similar.

In Chapter 4, Eric Clark and Huei-Min Tsai focus upon the historical political ecologies of island societies in an effort to juxtapose durable improvements to land – so called landesque capital, commonly assumed to be inherently positive and sustainable – with ecologically unequal exchange. The histories of three islands in Taiwan over several centuries suggest that accumulation of landesque capital can be geared either to local demand or to extraction for distant markets, produced through either local or distant initiatives, and viewed either as charity or as exploitation. These island cases show that formation of such capital can contribute to land degradation either in the location of infrastructural "improvement" (e.g., landesque capital for extraction of salt), or in other places from which resources are taken to realize the enhanced productivity of land (asymmetric flows of resources from abroad). Their analysis furthermore suggests that destruction, abandonment, and devaluation of landesque capital are often generated by, and thus constitute a significant dimension of, ecologically unequal exchange. The two processes, complex in their own right, are enmeshed through regional and global power relations.

As Brett Clark and John Bellamy Foster discuss in Chapter 5, the international guano trade in the nineteenth century is an exceptionally concrete illustration of ecologically unequal exchange. The guano trade involved stripping the islands off the Peruvian coast of their deposits of bird dung to be used as fertilizers in European and North American agriculture. A system of de facto slavery emerged, as indentured manual labor from China was forced to mine the guano. This particular technological fix of early industrial agriculture exemplifies how the metabolic rift, which Marx identified as dividing city from countryside in the nineteenth century, was extended to the global level, generating massive abuse of labor and ecological impoverishment in the periphery of the world system (cf. Foster *et al.* 2010).

Because money prices represent all market exchange as fundamentally symmetrical, the identification of unequal or asymmetric flows of resources in the modern world requires other metrics than money. This point becomes less of an ideological hurdle when we are investigating the tribute-based metabolism of ancient empires. In Chapter 3, Myrdal's comparison of imperial metabolism in Rome and China is based on units of weight, as in material flow analysis (Fischer-Kowalski 1998). In Chapter 6, Ragnheiður Bogadóttir uses concepts and methods for calculating "time–space appropriation" (Hornborg 2006) to demonstrate how the Inca economy in the sixteenth century can be understood in terms of the appropriation of labor (time) and land (space) embodied in key valuables such as cloth. Inca textiles woven from cotton or camelid fleece were pivotal goods used for tribute, trade, and the accumulation of wealth. Like other goods circulated in the past and present, beyond their symbolic and economic significance, Andean textiles represented quantities of embodied labor and land. In estimating how the imperial power structure of *Tawantinsuyu* was maintained through uneven flows of embodied "time" and "space", Bogadóttir presents a way of understanding very different economic systems in comparable, biophysical terms.

In Chapter 7, Mats Widgren explores the relationship between accumulation of landesque capital and slavery in pre-colonial West Africa. In a previous publication, Widgren (2007) has shown that such accumulation need not be attributed to hierarchical political structures but can be the result of the long-term labor investments of local communities, particularly under conditions of relative security. In his chapter in this book, he pursues the issue further through a comparison of three different instances of agricultural intensification in West Africa, concluding that the Atlantic slave trade may be implicated in all three cases, even where intensification occurs in egalitarian societies only indirectly affected by the economic and political repercussions of the slave trade.

Andreas Malm, in Chapter 8, examines the adoption of coal-fuelled steam power in nineteenth-century Britain. He depicts the adoption of an industrial, fossil-fuel technology as a logical consequence of capitalist development and a powerful symbolic confirmation of the superiority of European over non-European peoples. Early nineteenth-century Europe represents a point in time and space where the modern notion of "technological progress" was established. Fundamental to this concept of technology, then as now, is its dissociation from both economy and ecology. There seem to have been few qualms among the ruling classes in nineteenth-century Britain about the distant economic and ecological correlates of its steam-powered textile industry, e.g., the Atlantic slave trade, colonialism, and soil degradation on the cotton plantations (not to mention the future threat of global warming).

If the footprints of British textiles at this time were formidable, the history of world trade offers plenty of precedents. N. Thomas Håkansson, in Chapter 9, reviews some of the major social and ecological repercussions in East Africa of the global ivory trade. In the nineteenth century, ivory, like slaves, was generally paid for in cloth and beads, and Håkansson suggests that local pastoralists in turn exchanged cloth for cattle. The ivory trade thus stimulated an accumulation of cattle and expansion of specialized pastoralism on the savanna, with obvious ecological consequences. The pastoralists also appear to have exploited neighboring cultivators and foragers through various forms of unequal exchange.

In Chapter 10, Mats Mogren discusses the symbolic significance of colonial lawns and gardens as indicators of European superiority and domination. Examining historical evidence particularly from Ceylon (contemporary Sri Lanka), Mogren suggests that the layout of colonial botanical gardens served primarily as strategic displays of dominance. This mode of organizing ecological space in nineteenth-century Ceylon communicated the power of British imperial rule to control nature as well as society. Mogren's chapter illustrates how patterns of land use, while often serving as material instruments for covert power structures, may conversely assume a primarily symbolic dimension, communicating conspicuous messages about power and superiority.

The first chapter in Part II marks a shift from historical to modern cases. Andrew Jorgenson and Brett Clark, in Chapter 11, apply concepts and statistical methods from environmental sociology to illuminate the ecological consequences of modern consumption patterns and ecologically unequal exchange between nations. They find that both economic growth and military expenditures are positively correlated with environmental degradation. The statistical evidence indicates that affluent nations of the global North tend to have larger ecological footprints per capita and to benefit from unequal exchange with less-developed nations in the South.

In Chapter 12, Michael Sheridan investigates the reasons for the deterioration of indigenous irrigation systems in the North Pare Mountains of Tanzania since independence in 1961. He compares two alternative frameworks for explaining this deterioration – resilience theory and the concept of "adaptive cycles" versus power and political history – and finds the latter more useful. Resilience theory tends to be founded on functionalist assumptions stemming from systems ecology, and thus naturalizes social relations of power, inequality, and exploitation. With analyses incorporating power, the resilience of traditional irrigation systems in North Pare can be accounted for in terms of the ability of older men to control the labor of women and younger men. When agricultural modernization in Tanzania reorganized this gendered political economy, Sheridan concludes, the processes of change cannot be fully analyzed in terms of "adaptive cycles".

Food occupies an important place in political ecology. In Chapter 13, Ulf Jonsson focuses on the expansion of meat consumption throughout the world in order to assess recent trends within the agro-food system. As vegetable and meat production increasingly become decoupled, the commodity chains associated with various foods become increasingly complex. Jonsson shows how the industrialization and mass production of food has created global supply chains, where animal feed, such as soybeans, are grown in one part of the world – such as Argentina – to be shipped to another part – such as China – to fatten chickens and pigs for domestic consumption. Through vertical and horizontal integration, new food giants have emerged on the world stage. The particular history, power structure, and conditions of countries, such as Brazil and Argentina, can lead to very different outcomes, as illustrated by the expansion of soybean production to support the meatification of diets throughout the world.

In Chapter 14, Pernille Gooch analyzes how changes in state power and policy – such as British colonial rule and recent "conservation" efforts of the Indian state – have impinged on the traditional practices and lives of the Van Gujjars, migratory forest pastoralists in the Himalayas. Under different regimes, political and economic interests sought control of forest resources, disregarding local populations. British colonial policy in India imposed scientific management of the forests, which entailed the commodification of timber, the establishment of tree plantations, and the degradation of local ecosystems. Recent conservation efforts and the park system have attempted to establish "pristine nature" by excluding the local population. Such actions have engendered numerous conflicts. The Van Gujjars continue to challenge attempts to eliminate their traditional rights, which involve access to use forest resources for themselves and their buffalo herds and seasonal migration in and out of forests.

E. Gunilla A. Olsson and Lennart Bångens, in Chapter 15, address how state power is transforming the land and largely subsistence-based communities in eastern Tanzania. Local populations graze animals and extract resources (such as food, fiber, fertilizers, medicines, firewood, etc.) from the *miombo* ecosystem – a dry tropical grassland and woodland. The Tanzania government views this land as unproductive and underutilized; it is thus promoting the production of biofuels as a source of economic revenue for the country. This form of economic development involves dispossessing the local population and redistributing the land to private, commercial interests. Establishing biofuel plantations involves the loss of biodiversity due to monocropping, an increase in fertilizer and pesticide use, and the disruption of migratory routes for large mammals, such as elephants. This form of agricultural production also demands an extensive irrigation system in a region with water scarcity, creating an additional ecological problem to address.

In Chapter 16, Cristián Alarcón Ferrari highlights how forest companies are strategically exploiting concerns regarding climate change in order to expand forest harvests and capital accumulation. He presents the distinct historical development of the forest industry in Chile and in Sweden, noting the ecological contradictions associated with "sustainable" developments. In Chile, industrial tree plantations involve displacing native forests, decreasing the biodiversity. In Sweden, high-yield varieties are planted, using increased amounts of fertilizers.

Ironically, these companies emphasize the importance of forests as carbon sinks, neglecting the role they play in turning deforested land into a source of carbon dioxide. The promotion of biomass as a green source of energy has also increased the commercial exploitation of the forests. Recent mergers between international forest companies have concentrated the power of this industry.

The struggle over resources also plays itself out in conflicting interpretations of what a resource is. Marie Widengård, in Chapter 17, uses the example of Jatropha – a feedstock for biodiesel – to disentangle the various interpretations of this bush and its capacity to contribute to "sustainability", "climate stability", and socio-economic "development" for small-scale farmers. She sees Jatropha as a "floating signifier" which can be construed to carry positive characteristics that fit the various needs of the economic and political actors that foment the spread of Jatropha, from national governments and international agencies to transnational enterprises and environmental NGOs. In this construction of Jatropha, the real bush is replaced by an imagined resource, which the proponents present as the solution to all that is problematic with the more traditional agrofuels such as palm oil plantations: instead of large-scale it is small-scale; instead of causing deforestation it is grown on marginal lands which have no alternative uses; instead of benefiting agro-businesses it strengthens the peasant economy. Widengård shows that while discourse presents a "magic bullet" – a "win–win" proposition – detailed case studies reveal it is fraught with problems and drawbacks.

The construction of environmental arguments is also the focus of Chapter 18 by Bengt G. Karlsson. He shows how the discussion on dangers of nuclear power has been couched in mystifying language from its very beginning, primarily by the proponents of the industry, while counter-arguments have been classified as based on sentiments and not on science. Nuclear power is seen as "green", "safe", or "peaceful", depending on the audience, and the reasoning has been surprisingly consistent over the decades and in spite of the nuclear accidents and catastrophes that have occurred along the way. There were fundamental continuities between the arguments in favor of nuclear power that arose regarding New Mexico in the 1940s, France in the 1960s, or Chernobyl in the 1980s, regardless of whether the nuclear power plants are placed in Europe or in Asia, or if the test sites are found in an American desert or in Micronesia. Many of the concerns raised in the chapter materialized in the 2011 Fukushima disaster, and Japanese people again have to live under the spell of radiation contamination. The analysis invites further questions about where the international discussion on the dangers of nuclear power will lead after Fukushima. Although the first reactions suggested at least the possibility of a re-evaluation of the pros and cons of nuclear power, and although the catastrophe caused a turn-about in the German policy and a decision to terminate its nuclear power program, the historical record indicates that the pro-nuclear lobby will soon reformulate its arguments in geopolitical, environmental, and security terms.

Returning to agricultural development policy in Africa, Wilhelm Östberg, in Chapter 19, focuses on the Kondoa district in central Tanzania, where safflower has been introduced as a cash crop holding out the promise to ease the precarious situation of the farmers of the district, whose traditional food crop is millet. Like Jatropha, safflower is promoted as a crop that does not compete for land with other crops, as it is planted later than the food crop and can grow on marginal and otherwise unproductive lands. The promoters are a mixture of local and international entrepreneurs, encouraged by the Ministry of Agriculture. The campaign, Östberg argues, should be understood against the backdrop of a general change of development strategy that affected Tanzania as well as most other countries of the periphery over the past two decades, which transferred power from the state to the market, i.e. from the public to the private sector. This change explains why the local branch of the Ministry of Agriculture has had only a subsidiary role in the spread of safflower in Kondoa, leaving the initiative and the power in the hands of a private company, which is the only buyer of safflower from the Kondoa peasants. Still, safflower could play an important role for the survival strategy of the peasants, if in the final analysis the farmers get a fair price and the promise holds true that the new crop will not exhaust land and unduly compete with other agricultural activities. Here, Östberg concludes, the peasants would have needed the support and protection from the ministry before safflower was adopted; now they alone carry all the risks.

Concepts of race and racism developed in processes associated with power, social inequality, and access to land. As a result, they are social and historical, political and economic, in their origin. In Chapter 20, Susan Paulson describes particular historical changes in policies and practices that articulate race with the appropriation of resources in colonial and contemporary Latin America. She notes that race and racism evolved in conjunction with European conquests of distant lands, in order to implement and justify differential rights, the dispossession of indigenous peoples, and the exploitation of land and people. She indicates how race was variously employed to deny certain people access to land, sometimes by identifying them as Africans, and to grant other populations different kinds of rights to land, based on their identification as Europeans or Native Americans. Paulson focuses on how racialized biopolitics have changed within Latin America. Various nations, such as Bolivia following the 1952 revolution, attempted to overcome racial politics, but these efforts often ended up undermining indigenous communities and peoples, given the existing political-economic structures. At the end of the twentieth and beginning of the twenty-first centuries, communities have foregrounded ethnoracial identities in social movements calling for and ushering in socio-ecological changes in many Latin American countries. In this, race remains intertwined with social, political, economic, cultural, and ecological relations.

Chapter 21, by Anne Jerneck and Lennart Olsson, presents a local perspective, discussing ways to stimulate change on the village and family level by inclusive planning practices. The problems related to inefficient and polluting domestic wood-stoves are well-known – ranging from the time spent by women and children to gather firewood and dung, to the respiratory diseases caused by the smoke – and they have long been the object of projects financed by aid donors throughout the world. However, Jerneck and Olsson argue that the issues related to inefficient and dangerous kitchen stoves do not receive the attention they merit, especially not when compared to international high-profile programs fighting diseases such as HIV/AIDS, tuberculosis, or malaria. The reason for this, they maintain, is that the kitchen is a highly gendered space, and that the interests and needs of women and children are given less priority by governments as well as by national and international aid donors. They view the kitchen and its stove as embedded in deeper social relations and structures where a gendered division of labor, space, and decision-making play a dominating role. Based on practical experiments and fieldwork in western Kenya, they show that these conditions can be changed for the better by including the men in the discussion of how to construct and install improved stoves that reduce health risks, and that simultaneously improve energy efficiency, thus easing the workload of women and children.

In the final chapter, Kenneth Hermele returns to the task of disentangling the political, economic, and ecological practices, relations, and representations of agrofuels. This time the example is Brazilian sugarcane ethanol. The various representations of this fuel provided by the sugarcane plantations, the ethanol industry, and the Brazilian state are shown to be tailored to the respective needs of these and other stakeholders. Hermele shows that geopolitical and energy security considerations are the main drivers behind the expansion of sugarcane ethanol in Brazil during the last 40 years. After the oil price hikes of 1973–1974, Brazil began promoting sugarcane ethanol in its Pro-Alcóol program. More recently, the United States has used a similar reasoning to promote large volumes of ethanol on the US market, the feedstock being primarily maize. However, Hermele makes the case that other arguments in favor of agrofuels play a supportive role, such as the various attempts to brand and certify agrofuels as "sustainable". Here, a combination of commercial and non-commercial actors have joined forces to define sugarcane ethanol as a clean and fair agrofuel, most notably in the Roundtable of Sustainable Biofuels. Such collaborations help legitimize a fuel that in fact lacks most of the environmental credentials that are pinned to it. The Roundtable thus risks becoming primarily an exercise in "greenwashing".

From the earliest empires to modern development policy, the more or less covert strategies of power elites have shaped the human use of land and material resources. Such strategies for accumulation of power and wealth have always had symbolic as well as material dimensions, masking uneven resource flows and environmental load displacements in ideologically potent discourses on social superiority, technological progress, development, and even conservation. People whose labor and natural resources have been exploited by means of these strategies and ideologies through the centuries have been classified in terms of slavery, race, gender, tradition, indigenousness, or underdevelopment. Today, arguments for "green energy" and sustainable development can similarly serve to promote extraction and accumulation by more powerful groups and individuals, while marginalizing social groups by diminishing their control of land and its resources. From their various vantage-points, the contributors to this volume thus demonstrate a fundamental continuity in how ecology and power are intertwined.

The book is primarily aimed at three categories of readers: academic researchers in trans-disciplinary fields such as political ecology, human ecology, environmental history, and sustainability studies; students within a number of related disciplines such as anthropology, sociology, geography, economics, economic history, and historical archaeology; and environmentally engaged citizens pursuing more profound understandings of the relations between ecology and power. The editors hope that this collection will prove useful in these and other contexts.

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Part I

Theoretical perspectives on historical political ecology

1 Accumulation

Land as a medium of domination

Alf Hornborg

In conventional Western thought, 'nature' and 'society' have been perceived as separate categories, justifying distinct analytical approaches. Studies of ecosystems, land use, and human–environment relations have gravitated towards natural science, while studies of social structures have remained couched in social science. In several ways, and for many reasons, this dichotomy is currently being challenged. It has become increasingly obvious not only that the biophysical constitution of landscapes to a large extent is a product of social processes, but also that the organization of social systems to a large extent relies on the distribution of biophysical resources. This recursivity between natural and societal systems has taken many forms over the course of human history, yet appears to have been increasingly ignored in the context of globalized, capitalist extractivism. This chapter reviews some of the main ways in which the management of land and land-based resources can serve as strategies for social domination, from more obvious cases of local land tenure through the political demarcation of national and colonial boundaries to unequal global flows of natural resources. In examining such strategies, it is important to identify not only measurable net transfers of energy, materials, hectare yields, or labour time, but also the specific symbolic and ideological images by which unequal exchanges are represented as reciprocal and fair.

Central to a world-system perspective is the concern with accumulation, i.e. the strategies of different groups to enrich themselves through various kinds of exchange. The concept of accumulation (as opposed to the notion of 'growth') is generally taken to presuppose some kind of unequal exchange, and unequal exchange in turn tends to be defined in terms of asymmetric transfers of some kind of 'value'. For Karl Marx and his most orthodox followers, the notion of 'surplus value' accumulated by capitalists is thus founded on a theory of labour value, while for the earliest proponents of a theory of *ecologically* unequal exchange (Bunker 1985, 2007; Odum 1988; Odum and Arding 1991), accumulation is tantamount to a net transfer of energy or 'natural values'.

As opposed to such conceptual dependencies of theories of 'accumulation' and 'unequal exchange' on the notion of 'value', I believe that it is imperative to maintain an analytical distinction between the material/biophysical and the cultural/semiotic dimensions of exchange. It is obvious that the 'value' or attractiveness of a commodity for a given consumer hinges on the cultural preferences of that consumer (Baudrillard 1972; Sahlins 1976; Bourdieu 1984), rather than on the investments of labour or energy made in its production, and that the former cannot be reduced to the latter. Any history of consumption will make it abundantly clear that the first condition for accumulation is that there is a cultural demand for the commodity in question (Wolf 1982; Pomeranz and Topik 1999). In this respect, economists of all persuasions should be in agreement. But, contrary to mainstream economists, we must recognize that a second condition for accumulation is the material organization of production. It is this biophysical dimension of economic processes that the mainstream economists' preoccupation with 'utility' neglects, and that has been the common denominator of the many materialist challenges to this preoccupation from Karl Marx to ecological economics. A crucial task is to offer such a challenge, which acknowledges the biophysical dimension but without equating it with 'value'.

Rather than posit an 'unequal exchange of value', accounts of accumulation need to combine, on one hand, (1) an understanding of the requisite cultural constructions of consumption and market demand, and on the other, (2) an analysis of the specific organization of material resources employed to cater to those demands. This combination of qualitative/semiotic and quantitative/biophysical knowledge is rarely fostered in the current division of labour between disciplines, yet it is essential for understanding the relations between culture, economy, and ecology. Accumulation, and by extension global environmental history, hinges precisely on these relations.

For several millennia, trade has been driven by the aspirations of various groups to enrich themselves, i.e. to accumulate. Long-distance traders saw opportunities to profit from geographical discrepancies between different cultural valuations of commodities. Local elites were enthusiastic consumers of exotic imports that helped to communicate their privileged social positions. In the regions of the world-system where these imports originated, local producers were encouraged to invest labour and transform landscapes to increase their income in response to such distant demand. This general understanding of world economic history is applicable to a very long list of traded commodities over the past few millennia, including a wide variety of exotic foodstuffs, spices, drugs, animal parts, textiles, dyes, metals, and manufactures such as porcelain (cf. Pomeranz and Topik 1999). The social and environmental impacts of such export production, particularly over the last five centuries, have no doubt affected most of the land surface of the Earth. We need only think of the vast impacts of the trade in cotton, silk, sugar, coffee, tea, tobacco, silver, and furs. However, although equally systemic, the environmental impacts of global, long-distance exchange are not as immediately obvious as those of local or regional exchange.

In order to analytically clarify the changing environmental dimensions of the history of world trade, it is useful to distinguish between two main strategies for enhancing accumulation through investments in capital. 'Capital' is here defined as investments of labour time and natural resources for the purpose of increasing the productivity of land or labour. The universal incentive for capital accumulation is to increase output, but the extent to which such increases are relative to inputs of labour time or of landscape space depends on circumstances. The rationality of different strategies for capital accumulation, in other words, is socially constructed. With the integration of increasingly wider global markets, the ambition to increase productivity has generally been connected to the imperative to increase competitiveness, which usually means producing commodities at a relatively low cost per unit produced. Measures to lower costs may include increasing efficiency of production (e.g. through mechanization) as well as minimizing costs for labour, land, energy, and raw materials. To increase efficiency generally means to increase the volume of production in order to benefit from so-called economies of scale.

Capital accumulation for the purpose of increasing the productivity of land has been referred to by Harold Brookfield as 'landesque' capital (cf. Widgren 2007). This category includes inalienable modifications of land such as irrigation or drainage canals, terraces, raised fields, forest clearance, stone clearance, and soil improvement. In non-industrial societies throughout history, all such changes of the land have required considerable inputs of human labour. Their rationale has universally been to increase output per unit of land, even if it should imply increasing inputs of labour. The accumulation of landesque capital has often been recursively connected to the concentration of human populations in larger communities with more complex divisions of labour, including processes of urbanization. The increased agricultural output per unit of land has made such demographic concentration and socio-economic complexity possible. Conversely, in representing a valuable resource coveted by militant neighbours, the investment in landesque capital has required access to larger populations for purposes of defence. Larger populations have in turn demanded more socio-political complexity and agricultural output, and so on. Even if, as Widgren (ibid.) points out, landesque capital has often permanently improved the conditions for sustainable human land use, there are also examples of adverse effects. Among the diverse environmental impacts of various forms of landesque capital are salinization, deforestation, drainage of wetlands, depletion of groundwater, eutrophication, carbon dioxide emissions, and erosion following abandonment.

If landesque capital is defined as non-detachable investments in land for the purpose of increasing its productivity, what we usually think of as 'capital' (pertinently referred to by Amartya Sen as 'labouresque' capital) should be defined as investments for the purpose of increasing the productivity of labour. This category of investments can be subdivided into two analytically distinct but interrelated types: (1) education and training resulting in specific types of competence and skill; and (2) technology, widely defined. Beyond the sophisticated local efficiencies of pre-industrial technologies and 'traditional ecological knowledge', the accumulation of labouresque capital has generally been recursively connected to a successful engagement in trade, measured as a net appropriation of biophysical resources such as energy, embodied land, or embodied labour. A continuous net gain in access to such resources can be converted into technological growth, as illustrated by the contemporary imports of fossil fuels to the United States, or by nineteenth-century imports of cotton fibre to England (Hornborg 2006). If the accumulation of landesque capital has been recursively connected to population growth, then the accumulation of labouresque capital is recursively connected to unequal exchange. It would be superfluous to exemplify the environmental impacts of technological intensification, whether in the vicinity of industrial factories, the distant sources of their raw materials, the disposal of garbage, or the atmosphere.

This is not the place to rewrite the global history of human–environment relations in terms of capital accumulation and unequal exchange. Suffice it to say that such a project would be both feasible and essential. Once we rid ourselves of the ambition to ground our understanding of unequal exchange in some putatively objective notion of 'value', we can focus on the objectively quantifiable net transfers of energy, embodied land, and embodied labour in world trade. Such material transfers have historically been geared to production processes catering to the most diverse cultural desires, whether porcelain from China, cotton textiles from Gujarat (or British imitations thereof), hats from Canadian beaver, ornaments from African ivory, or the taste of Moluccan nutmeg, Mexican cacao, or Virginia tobacco. Global histories of cultural desire are continuously being written, but so far there is no systematic global history of the environmental impacts of these desires, and of the production processes organized to cater to them. The cultural attribution of 'value' to commodities such as sable, silver, cinnamon, coffee, or Coca-Cola should not be analytically confused with the biophysical changes in ecosystems subjected to their production. This, of course, applies no less to modern industrial exports such as cars, mobile phones, and computer software. A truly global environmental history would need to systematically examine: (1) how particular constellations of cultural demand have encouraged specific strategies of accumulation and export production; (2) how such interconnected strategies of accumulation have entailed net transfers of energy, embodied land, and/or embodied labour; and (3) how these processes of extraction, production, and transport have affected societies and environments in different parts of the world-system. It would also need to distinguish between environmental problems deriving, respectively, from biophysical impoverishment versus biophysical overload. While extractive zones will tend to experience loss of biodiversity, topsoil, fish stocks, and other vital assets, world-system centres have historically suffered from smog, acidification, eutrophication, accumulation of heavy metals, and problems with the disposal of solid waste. Whereas the former problems result from removal of resources, the latter are associated with a concentration of the use of matter and energy. The emission of carbon dioxide from combustion of fossil fuels is a tangible illustration of the global displacement of entropy associated with capital accumulation. The issue of 'climate justice' (Roberts and Parks 2007, 2009) is founded on the fact that such emissions are largely the result of technological accumulation and energy use in the North, whereas their deleterious consequences disproportionally afflict the South. Using the atmosphere as a sink for carbon entropy, in other words, is yet another example of environmental load displacement. Such environmental inequalities, of course, recur at various levels of scale within the North as well as the South, but a truly global environmental history must acknowledge that the metabolic rift (Foster 1999; Foster *et al.* 2010) ultimately polarizes populations and landscapes at the planetary level.

Over the long term, diverse combinations of 'landesque' and 'labouresque' capital have been accumulated to cater to the demands of markets at varying distances. At our current point in historical time, of course, it is particularly important to scrutinize the role of fossil fuels in the past two centuries of capital accumulation and environmental change, but the general pattern has precedents going back several millennia. The large-scale environmental impacts of the earliest urban civilizations in Mesopotamia, India, and China were generally restricted to deforestation and salinization resulting from agricultural production and the demand for timber, firewood, and charcoal. Timber was required for urban construction as well as ship-building, while firewood and charcoal were used for heating, brick-making, metallurgy, and various other kinds of proto-industrial manufacture. Although not as geographically extended as in more recent societies, the polarization of centres of accumulation and impoverished extractive zones was evident even in these early civilizations. Such processes became more pronounced with the Roman Empire, in which the distant appropriation of energy in the form of slaves and grain generated social and ecological impoverishment over much of the Middle East, North Africa, and Europe. Landscapes in many areas of the Old World were successively transformed by export production of goods such as wheat, wine, olive oil, wool, cotton, rice, silk, and spices. In the Middle Ages, the continued long-distance exchange of manufactures and preciosities across the extent of the Old World stimulated, for instance, the industrial manufacture of porcelain and silk in China, cotton textiles in India, and glass and woollens in northern Italy, as well as the extraction of ivory and gold in Africa and amber and furs along the Baltic. All such activities had ecological repercussions, whether intentionally (e.g. spices, silk, cotton, sheep) or not (e.g. ivory, charcoal, overhunting). Growing human populations also exerted an increasing pressure on available agricultural land and wood fuel. By the fifteenth century, several areas of the Old World were experiencing serious ecological constraints. The geographical position of Europe in the sixteenth century gave it access to New World silver, furs, forests, and agricultural land, which over the next five centuries stimulated new and expansive strategies for capital accumulation through long-distance trade, colonialism, slavery, and industrialization. The British shift to fossil energy for industrial production decisively changed the conditions for accumulation, but was a logical fusion of older industrial technologies in metallurgy (coal combustion) and water-powered textile production (the mechanical conversion of linear to rotating movement). The use of fossil energy in mechanization importantly decoupled energy use from land constraints, encouraged a vastly expanded trade in bulk goods (including food) across the world, and enabled European industry to oust its competitors (including the Indian textile industry) on the global market.

This very brief synopsis of five millennia of capital accumulation is neither new nor particularly controversial, but the important point is that a world-system perspective should prompt us to view the various environmental changes precipitated by these processes as systematically interrelated. For example, deforestation and environmental transformations associated with landesque capital have for millennia in various parts of the world been inextricably linked to distant markets for timber, charcoal, and agricultural products, which in turn have been linked to urbanization, marine trade, industry, and various kinds of consumption. The ecological impoverishment of North Africa and much of the Mediterranean area was directly related to the accumulation of infrastructure, armies, and slave labour in urban Rome. The environmental changes associated with sheep, cotton plantations, and silkworms have been causally connected to textile industries in Europe, India, and China, and to their distant markets. The European and Asian markets for elephant ivory transformed the ecology of East Africa (Håkansson 2004, 2007). Since the economic integration of the Old and New Worlds in the sixteenth century, complex webs of connections have intertwined the environmental consequences of silver mining in Bolivia, sugar plantations in the Caribbean, and the trade in North American furs, Baltic timber, African slaves, Indonesian spices, and Chinese tea.

If a world-system perspective is crucial for understanding the local details of environmental history, ecology is thus no less fundamental for understanding world-system history. To trace the metabolic flows of world-systems requires a basic familiarity with their biophysical aspects, such as the use of energy and land, the displacement of entropy (including carbon dioxide emissions), and ecologically unequal exchange (Hornborg 2001; Frank 2007; Jorgenson and Clark 2009). It also requires a radical rethinking of our everyday conception of technology as an accumulation of material infrastructure, or capital, that should be understood more as the product of a global zero-sum game than as a cornucopia.

From a comparative, historical perspective, it is obvious that different kinds of environmental load displacement (through trade) will accompany specific kinds of capital accumulation. We thus need to use different measures of ecologically unequal exchange for different historical and geographical contexts. What they all have in common is a concern with the factor of production referred to as *land*, a factor which has been largely neglected by mainstream economists over the past two centuries. Different kinds of environmental load displacement reflect the different kinds of technological infrastructures that are being accumulated, as well as the particular resource endowments offered by specific geographical circumstances. Thus, the concern with land must include not only embodied, eco-productive hectares, but also embodied energy, materials, carbon dioxide emissions, environmental degradation, water, etc. (cf. Jorgenson and Clark 2009). Different factors will be crucial bottlenecks at different times and different places. For example, nineteenth-century Europe was in great need of additional eco-productive hectares (Wilkinson 1973; Pomeranz 2000), but was more than self-sufficient in mineral energy (Bairoch 1993). Conversely, twenty-first-century United States is in great need of imported energy, but is more than self-sufficient in agricultural land. Against this background, it is completely logical that European colonial wars were fought over land, while contemporary American wars in the Middle East are being fought over oil. Biophysical trade balances indicate that Europe, the United States, and Japan all import significantly more materials than they export, while the converse applies to most South American countries. It is well known that per capita ecological footprints and carbon footprints are similarly skewed in favour of developed nations. Taking all these different circumstances into account is difficult but necessary, if we wish to generate a coherent understanding of ecologically unequal exchange.

Let us conclude with a final observation on the historical relation between energy and embodied land, arguably the two most likely metrics for studies of ecologically unequal exchange. Up until the Industrial Revolution, energy and land were one and the same, converging in the production of food for human labour and fodder for draft animals. For two centuries now, the age of fossil fuels has kept land requirements and energy requirements distinct from each other, making it possible for historians such as Bairoch (1993) to seriously propose that European expansion had no need for extractive peripheries. But it is important to recognize that although ecologically unequal exchange has not always involved net transfers of energy, nor of embodied land, it has always involved net transfers of *one* of these resources. As we are currently contemplating that peak oil and climate change may prompt us to turn to biofuels, we are in fact imagining a future where land requirements and energy requirements will once again coincide. Once again, it seems, it will be possible to calculate the costs of transport distances in terms of eco-productive space. What this might entail in terms of our total worldview and global social metabolism is beyond the scope of this chapter, but if we shall once again see competition over scarce land for food, fodder, fibres, and fuel, we may rest assured that the realities of ecologically unequal exchange and environmental load displacement will be recognized as very tangible conditions of human existence. In such a future, also, ecologically unequal exchange will again involve concerns with *both* energy *and* embodied land. In terms of economic theory for understanding the course of history, this would amount to the bankruptcy of capitalist concepts of labour value in favour of a cosmology more akin to pre-industrial Physiocracy.

Suffice it to observe, at this point, that if the United States were to import best-practice, Brazilian ethanol (disregarding here the extent to which this ethanol is in fact subsidized by fossil fuels) to replace its current net *imports* of fossil fuels, it would require approximately 187 million hectares of Brazilian sugarcane,[1] which is more than seven times the agricultural area within the United States presently devoted to export production. The current land area in Brazil devoted to sugarcane ethanol is around four million hectares. The long-term implications of the global energy shifts we shall be witnessing over the next few decades may very well lead to the conclusion that much of what we have come to know as modern or industrial technology is feasible only when it requires less land area than the same work conducted by humans and draft animals. This has indeed been the case through two centuries of fossil fuel energy, but at the moment we have no reason to believe that this specific kind of rationality will extend beyond the fossil fuel era.

It is beginning to be possible to discern, in retrospect, the specificity of fossil fuel rationality. Access to fossil fuels – acreages of the past (cf. Catton 1980) – in the early nineteenth century obscured our fundamental dependence on land. When acreages for horse fodder and food for workers could largely be replaced with coal mines and oil wells, present-day land became – practically as well as conceptually – a substitutable factor of production. A (re)turn to biofuels should transform economic theory in the reverse direction. We have seen that it is quite feasible to calculate the land equivalent of fossil fuels, measured in the energy content of best-practice biofuels. In fact, *all* energy use is analytically convertible to land area, whether human labour (hectares of food and other aspects of a labourer's ecological footprint), draft animals (hectares of animal fodder), biofuels (hectares of energy crops), or fossil fuels (once hectares of ancient biomass, but now possible to calculate in terms of the equivalent biofuels). This may sound like a kind of reductionism no better than the monetary reductionism of the economists, but it does provide us with possibilities of rationally challenging predominant economic rationality with figures anchored in the objective constraints of the biosphere. The question we must put forward today remains: Was the rationale behind the transition to fossil fuels (the 'Industrial Revolution') that work performed by machines required less land (and was thus less expensive) than the same work performed by humans or draft animals? (And will this always be the case in the future?)

So as not to provoke undue anxiety about the prospects of a post-petroleum society, I want to add that it is a common misconception that fossil fuels are presently feeding the world. Fossil fuels in parts of the world tend to replace the work elsewhere previously done by humans and draft animals, but there is no fossil energy in food. Moreover, only about half of the 1.5 billion hectares globally of agricultural land is currently used for basic food production for humans – the rest is devoted to fibres, lubricants, biofuels, animal fodder, tobacco, colonial beverages such as coffee and tea, luxury fruits, etc. Of the food actually produced, perhaps as much as half is wasted or discarded. If all of us were vegans, there would actually be room for 30 billion humans on the planet.[2] Using organic gardening and recycled nutrients, these land areas are ample for feeding the current and even a growing global population without any fossil fuels.

Conclusions

To understand our current dilemmas of 'sustainable development', it is crucial to establish new theoretical connections between social and natural science. Land use may seem a field where such connections should have an obvious justification, but there are still important insights to develop at this interface of society and nature.

In all human societies, access to land, and how it is used, has been a basis for relations of power. This is most obvious in the case of various regulations of property rights and land use within demarcated areas, whether traditional territories for hunting and fishing, private land ownership, or the territorial claims of nation-states. Such claims regulate resource management within a bounded geographical space such as a farm, a nation, or an empire. It defines the persons or social groups who have the primary rights to use the area's resources. But at various levels of social inclusiveness there have also been flows of resources *across* the boundaries of such areas, whether in the form of gift exchange, tribute, or international trade.

Resource flows within and between geographically delineated units at different spatial scales are difficult to map, but they are of fundamental significance for the capacity of individual units to grow economically, develop new technologies, manage their resources, and protect their environments.

A primary reason why both historical and modern resource flows are difficult to map is that the available statistics generally apply metrics that are inadequate for calculating the biophysical contents and consequences of these flows. Most of the statistics used in economics and economic history, for instance, are couched in the language of monetary exchange values (market prices), which often requires extensive research in order to be translated into biophysical measures such as embodied energy, material flow, hectare yields, or invested hours of labour. But when such translations are made, they can provide a completely different picture of the exchange relations and technological systems with which they are associated.

For example, in the year 1850, by exchanging £1,000 worth of cotton textiles for £1,000 worth of raw cotton fibre on the world market, the newly industrialized textile districts of England were able to exchange around 4,000 hours of labour in a British factory for over 32,000 hours of mostly slave labour in tropical cotton plantations – including the ecological footprints that these human years represented – and simultaneously for the productive capacity of over 58 hectares of colonial land (Hornborg 2006). Such arrangements laid the foundation not only for the Industrial Revolution, but also for the modern science of economics, the conceptual framework of which is simply not concerned with the translation of market value into hectares of land or hours of labour. Thus it continues to escape us how economic growth and technological progress in some areas may be indissolubly linked to the impoverishment of people and environments in other parts of the world. For the same reason, we continue to struggle with the scientific question, posed repeatedly by the anthropologist Maurice Godelier (e.g. Godelier 1986), of how different societies through history have managed to represent unequal exchanges of resources as reciprocal and fair.

Notes

1 Kenneth Hermele, personal communication, 2011.
2 Kenneth Hermele, personal communication, 2010.

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2 Techno-fix

Ecological rifts and capital shifts

Brett Clark and Richard York

The primary driver of global environmental change over the last several centuries has been human actions. Natural scientists warn that humanity is threatening to undermine the relatively stable, interglacial geological epoch that has supported human civilization, as business-as-usual operations transgress "planetary boundaries" (Rockström *et al.* 2009: 472). Humans fundamentally changed the structure of major biogeochemical cycles, accelerated species extinction, transformed the land cover of the earth, altered the chemical composition of the atmosphere, and caused a decline in the availability of freshwater (Vitousek *et al.* 1997). The global capitalist system remains at the nexus of environmental problems, as it influences the "metabolic interaction" between humans and nature.

As the scale and diversity of environmental problems increases, the dominant economic forces rally to offer "solutions." The ecological crisis is presented as a technical problem that can be fixed within the current economic system, through better ingenuity, technological innovations, efficiency, and the operation of the market. In other words, there is no need to radically transform the social order, as the market will ensure that a technological fix is created to address each environmental challenge. For example, the proposed remedies for global climate change include the development of new nuclear power plants, coal plants that will capture and sequester carbon underground, and agrofuels that will emit less carbon dioxide when burned. Each of these options maintains the existing social relations of production within the current economic system.

The technological panacea obscures the anti-ecological tendencies of the capitalist system. The growth imperative of capitalism entails the systematic subordination of nature to the endless pursuit of profit, generating ecological rifts and environmental degradation. When confronted with such concerns, capital pursues a series of technological fixes and capital shifts in order to "solve" these problems. These fixes and shifts typically have unintended consequences, such as creating additional ecological rifts, and fail to address the root of socio-ecological problems: the social metabolic order of capital. In what follows, we elaborate on these issues, presenting the nature of capitalism and a few of the ecological contradictions it produces. We illustrate the rifts, shifts, and technological fixes employed by capital in the production of food, energy, and water.

The social metabolic order of capital

Metabolic analysis illuminates the interchange of materials within organisms, as well as between organisms and their environment. Karl Marx employed a metabolic approach to examine the interpenetration of society and the natural world, whereby the former is dependent upon the latter for its sustenance. He noted that natural systems, such as the nutrient cycle, have their own metabolism, which operates in relation to human society, allowing for its regeneration and/or continuance. Humans actively interact with and transform nature. Each mode of production organizes human actions and the interchange of matter and energy between society and nature, creating a particular social metabolic order that influences the reproduction of society and ecosystems (Foster 2000; Marx 1976).

The rise of capitalism imposed a new social metabolic order that dominates the society–nature relationship. Capitalism is an inherently expansionary system. It progressively eliminates non-capitalist modes of production throughout the world, as it establishes an integrated social-economic system composed of interacting subsystems held together through conflicting forces and long-term historical processes. While economically unified, this system creates social and ecological divisions and contradictions that facilitate the unequal accumulation of capital (Baran 1957; Baran and Sweezy 1966). The capitalist system has a limited conception of wealth that is built around the "realization of capital on an extended scale" (Mészáros 2006: 30). As a result, it imposes a particular logic, system of accounting, and form of efficiency, whereby everything is evaluated in terms of maximizing profit. Marx presented the circuit of capital in terms of his M–C–M′ formula. Money capital is used to purchase both labor power and means of production (such as raw materials) in order to produce commodities that are sold for more money capital at the end. This process is repeated over and over, as profit (surplus value) is invested in the next round of production to capture even more money the next time. Marx (1976: 342) explained how this system influences social relations:

> As a capitalist, he is only capital personified. His soul is the soul of capital. But capital has one sole driving force, the drive to valorize itself, to create surplus-value, to make its constant part, the means of production, absorb the greatest possible amount of surplus labour. Capital is dead labour which, vampire-like, lives only by sucking living labour, and lives the more, the more labour it sucks. The time during which the worker works is the time during which the capitalist consumes the labour-power he has bought from him. If the worker consumes his disposable time for himself, he robs the capitalist.

In this profit-oriented system, qualitative social relations – such as those with natural conditions – are not part of its accounting. Instead, as István Mészáros (1995: 107) points out, "Quantity rules absolute in the capital system." In this system of generalized commodity production, capital is constantly metamorphized into more capital, which includes surplus value (profits). The law of the land, under capitalism, is to amass more wealth.

Capitalism does not recognize boundaries; any social or natural barriers that it confronts are merely obstacles to be overcome:

> The capital system constantly redefines and extends its own *relative limits*, pursuing its course under the changing circumstances precisely in order to maintain the highest possible degree of surplus-labor extraction which constitutes its historic *raison d'être* and actual mode of functioning.
>
> (Mészáros 1995: 46)

As a result, capital is "an *ultimately uncontrollable … social metabolic*" order (Mészáros 1995: 41). Its tendency is to violate the natural conditions that maintain the vitality of ecosystems. It simplifies natural conditions, imposing a division of nature to increase economic efficiency that "tends to destabilize ecological balances in hazardous ways" (Burkett 1999: 87). It also freely appropriates nature and its bounty, since these resources are "purely a matter of utility." The exploitation of nature and labor serve "as a means to the paramount ends of profit-making and still more capital accumulation" (Sweezy 2004: 92). As a result, the expansion and intensification of the social metabolic order of capital generates ecological rifts in natural cycles and processes, forcing a series of technological fixes and capital shifts.

Metabolic rifts, capital shifts, and technological fixes

Human societies exist as part of, and because of, ecological processes. Human beings, like other animals, are dependent upon ecosystems and other species, as biogeochemical cycles and food webs provide the necessary support to sustain life. Biophysical constraints influence social organizations and processes, at the same time that human actions transform nature. While environmental degradation has long been part of human history, the inner logic of capital generates ecological destruction, creating ecological rifts in natural cycles, systems, and processes. In response, capital offers technological fixes and capital shifts as potential solutions to environmental problems. These efforts to address ecological contradictions within the existing system generally mask and/or displace one problem while creating others. Here we will briefly flesh out the relationship between these issues and concepts.

Marx's concept of social metabolism captures the complex interpenetration and interchange of matter and energy between human beings and nature (Foster 2000). His metabolic analysis emerged out of his studies of agriculture. Drawing upon Justus von Liebig's critique of modern agriculture, Marx noted that in order for crops to grow, the soil must contain specific nutrients, such as nitrogen, phosphorus, and potassium. As crops grow, plants absorb these nutrients. In non-capitalist societies, the produce of nature was generally recycled back to the land as fertilizer after it was consumed, enriching the soil. But this cycle, this metabolic interchange, was radically transformed with the emergence of capitalist relations.

The enclosure movement and the concentration of land that accompanied the development of capitalism created a division between town and country, as peasants sought employment in cities (Marx 1976: 637). This population shift and new agricultural practices altered the soil nutrient cycle. Food and fiber – as well as the soil nutrients embodied in these goods – were shipped from the countryside to distant markets to feed urban populations. Rather than being returned to the countryside to maintain soil fertility, these essential nutrients accumulated as waste and pollution (Foster 2000).

The social metabolic order of capital developed intensive agricultural practices, including the use of mechanical power, to increase the yield of food and fiber. Large-scale, industrial agriculture and long-distance trade only exacerbated the ecological contradictions. Marx (1976: 637) explained that this type of production "disturbs the metabolic interaction between man and the earth" and "it prevents the return to the soil of its constituent elements consumed by man in the form of food and clothing." As a result, it creates "an irreparable rift in the interdependent process of social metabolism, a metabolism prescribed by the natural laws of life itself. The result of this is a squandering of the vitality of the soil, which is carried by trade far beyond the bounds of a single country" (Marx 1991: 949). Stated differently, it creates a metabolic rift in the nutrient cycle, diminishing the nutrients that are necessary to sustain the growth of specific plants, in this case crops for market.

As a result of the unrelenting impulse to accumulate, the social metabolism of capitalism is increasingly placed in opposition to the requirements that support/sustain natural cycles and ecosystems. The result is the creation of metabolic rifts, which are particular to specific ecosystems and natural cycles, and environmental degradation. In response to ecological problems and contradictions, capital pursues a series of shifts and technological fixes, in order to sustain the accumulation process. Shifts and fixes can take a variety of forms. For instance, capital may attempt to "solve" a problem by incorporating new resources into the production process, such as manufacturing products out of plastic instead of wood. Capital may also change the location of production. This geographical shift may involve the exhaustion of natural resources in one location, which forces relocation or extraction from another part of the world. It may also be driven by the ability to obtain necessary resources at a cheaper rate, which would lower production costs and increase profit. Capital may also offer a technological fix, a type of capital shift, as a means to address ecological problems.

At the heart of the modernization project and capitalist ideology is the doctrine of technological optimism, with its promise of a world of endless bounty that is free from toil. Such a position proposes that technological breakthroughs will serve as the means to address each and every environmental problem that arises, allowing society to overcome natural limits and all socio-ecological challenges. For example, it is assumed that any shortages of fossil fuels will be met through new discoveries of deposits and advances in energy efficiency; that artificial and natural substitutes will be developed to meet future needs; and that air and water pollution will be engineered away through pollution-control devices. The list of wonders that modern science and technology are expected to deliver seems endless. Each solution is offered under the guise of working with nature to meet human demands without changing the economic system (York and Clark 2010).

How capital shifts and technological fixes are employed vary depending on the specific circumstances, but the social metabolic order of capital influences the process. The constant drive to accumulate capital demands the ceaseless exploitation of the physical world. Isolated metabolic rifts increase in scale, becoming generalized ecological rifts, as the capitalist system threatens to violate planetary ecological boundaries. As a result, persistent shifts, technological fixes, and ecological rifts characterize capitalist development, turning one environmental problem into another, as we will illustrate in a brief discussion of food, energy, and water production.

The metabolic rift in the nutrient cycle and technological fixes

The metabolic rift in the nutrient cycle led to an intensification of the social metabolism and a series of rifts and shifts. The development and expansion of capitalist relations, whether through colonialism, imperialism, or market forces, created a global metabolic rift in the nutrient cycle, as distant regions were brought into production to serve the interests of capitalists in core nations. While incorporating distant lands into the global economy – a form of geographical shift – helped displace some of the demands placed on agricultural production in core nations, it did not serve as a remedy to the metabolic rift (Hornborg 2009). Instead, more of the natural world was transformed by the dictates of capital, expanding the environmental degradation associated with capitalist food production. Various technological fixes and shifts have been employed to address the rift in the nutrient cycle. To the myopic observer, capitalism may appear at any one moment to be resolving an ecological contradiction, since it does on occasion mitigate an environmental problem. However, a more far-sighted observer will recognize that new problems spring up where old ones are supposedly eliminated.

In the 1800s, intensive agricultural practices were employed in an attempt to increase yields. Given the rupture in the nutrient cycle, farming required massive inputs of fertilizers to enrich fields, furthering the transformation of food production into a manufacturing operation (Thompson 1968). As a result, agriculture became dependent upon industrial operations and materials. Even in his day, Marx (1993: 527) recognized the socio-ecological transformations taking place in agriculture and noted:

> Agriculture no longer finds the natural conditions of its own production within itself, naturally, arisen, spontaneous, and ready to hand, but these exist as an independent industry separate from it – and, with this separateness the whole complex set of interconnections in which this industry exists is drawn into the sphere of the conditions of agricultural production.

The expansion of capitalist industrialized operations only increased the scale of exploitation and environmental degradation, subjecting nature to the rapacious logic of capital:

> Large-scale industry and industrially pursued large-scale agriculture have the same effect. If they are originally distinguished by the fact that the former lays waste and ruins labour-power and thus the natural power of man, whereas the latter does the same to the natural power of the soil, they link up in the later course of development, since the industrial system applied to agriculture also enervates the workers there, while industry and trade for their part provide agriculture with the means of exhausting the soil.
> (Marx 1991: 950)

One of the attempts to fix the metabolic rift in the nutrient cycle was the formation of an international guano trade (see Clark and Foster, this volume). Islands off the coast of Peru had massive deposits of guano (bird droppings) with high concentrations of phosphate and nitrogen. From the 1840s to the 1880s, guano was deemed the most valuable fertilizer for enriching exhausted land. An international scramble for guano ensued, as core nations experiencing the loss of soil nutrients sought to acquire access to this resource. Anthony Gibbs & Sons, a British company, secured rights over the sale of Peruvian guano on the global market throughout much of this period (Skaggs 1994).

Millions of tons of guano were extracted in Peru by imported Chinese "coolies" who worked as "beasts of burden," choking on dust, laboring under duress. The guano was shipped to Britain, the United States, and other core capitalist nations. The necessity to import fertilizer reflected an ecological contradiction in capitalist agriculture, but this shift in fertilizer did not mend the metabolic rift in the nutrient cycle. In fact, the guano trade directed a natural resource that had been used for centuries to enrich the soils of Peru to the global market, rapidly diminishing the reserves on the islands (Clark and Foster 2009).

While European nations increasingly imported food (and the soil nutrients embodied in the food) from distant lands, soil degradation continued to plague core capitalist nations, causing persistent fertilizer needs. Just before World War I, Fritz Haber, a German chemist and nationalist, devised a process for fixing nitrogen from the air. This technological fix led to a radical shift in agriculture, as artificial nitrogen fertilizer was produced in large quantities and applied to soils.

Chemical processes and inputs were initiated in agriculture to duplicate, replace, and/or reproduce natural operations. Synthetic fertilizer was widely introduced to sustain and increase agricultural production, but it did not resolve the metabolic rift in the nutrient cycle. Karl Kautsky (1988: 215), drawing upon the work of Marx and Liebig, explained that artificial fertilizers

> allow the reduction in soil fertility to be avoided, but the necessity of using them in larger and larger amounts simply adds a further burden to

> agriculture – not one unavoidably imposed on nature, but a direct result of current social organization. By overcoming the antithesis between town and country … the materials removed from the soil would be able to flow back in full. Supplementary fertilisers would then, at most, have the task of enriching the soil, not staving off its impoverishment. Advances in cultivation would signify an increase in the amount of soluble nutrients in the soil without the need to add artificial fertilisers.

Kautsky identified the creation of a fertilizer treadmill, whereby a continuous supply of artificial fertilizer was needed to produce high yields on land that was exhausted. The loss of soil nutrients forced capital to shift its operations in order to continue production. Rather than solving the problem, this shift and the ones that followed created additional environmental problems, escalating the magnitude of the ecological crisis (Magdoff 2011).

Food production has increased through expanding agricultural production to less fertile land – depleting the nutrients in these areas – and through the incorporation of large quantities of oil in the agricultural process, used in the synthesis of chemical fertilizers and pesticides, contributing to global climate change as well as myriad other environmental problems. Constant inputs are needed simply to sustain this operation, given the depletion of soil nutrients (Magdoff *et al.* 1997). Genetically modified crops are developed in order to grow in arid, depleted soils, with the help of artificial fertilizer. Each step is an attempt to overcome barriers for the sake of accumulation, regardless of the ecological implications.

The incorporation of the technological fix of artificial nitrogen fertilizer has created additional ecological rifts and other environmental problems. The production of synthetic fertilizer produces airborne nitrogen compounds that increase global warming. Nitrogen runoff overloads marine ecosystems with excess nutrients, which compromise natural processes that generally remove nutrients from the waterways. The increased concentration of nutrients within the water causes eutrophication, which leads to oxygen-poor water and the formation of hypoxic zones – otherwise known as "dead zones."

The drive to increase agricultural production, the separation of town and country, and the loss of soil nutrients produce a metabolic rift in the nutrient cycle. In an attempt to overcome natural limits, capital engages in a series of shifts and fixes to sustain production, importing natural fertilizers and producing artificial fertilizer. As a result, the social metabolism is intensified, as more of nature is subjected to the demands of capital, and additional ecological problems are created.

Energy, techno-solutions, and climate change

The exploitation of energy under capitalism demonstrates similar patterns of capital shifts, technological fixes, and ecological rifts. Biomass, particularly wood, has been one of the primary energy sources humans have depended on throughout history. The smelting of metals and other energy-intensive production processes increased the energy demands of societies and the pressure on forests. Even before the Industrial Revolution, vast stretches of forests were cleared to feed the fires. The new machinery of the industrial age, which transferred the motive power of production from humans to machines, required increasing amounts of fuel to operate on a growing scale. Wood became scarce, especially in areas close to major sites of production (Smil 1994; Williams 2003). But, since capitalists sought further accumulation, which came from energy-intensive industrial production, coal came to serve as the standard fuel of industry. Here, capital side-stepped the fuel-wood crisis by incorporating the burning of fossil fuels as a technological fix to maintain and expand production. At the same time, this move set the stage for exponential economic growth and the exploitation of nature in order to power machines. Marx (1976: 497) pointed out:

> An increase in the size of the machine and the number of its working tools calls for a more massive mechanism to drive it; and this mechanism, in order to overcome its own inertia, requires a mightier moving power than that of man, quite apart from the fact that man is a very imperfect instrument for producing uniform and continuous motion.

The tension between the desire of the capitalist owners of the new industrial technologies for expanding the accumulation of capital and the biophysical limits of the earth were apparent from the start of the Industrial Revolution. However, capitalists did not concern themselves with the ecological contradictions of capitalism, except insofar as they were barriers to be transcended. Despite the shift to fossil fuels to power industry, the forests continue to fall as new demands on this resource emerge.

The growth imperative of the capitalist system intensifies the social metabolism. Economic expansion of generalized commodity production requires that “the store of raw materials must grow” at the same time (Marx and Engels 1975, volume 6: 431; see also Burkett 1999: 108–112). All of this requires increasing the quantity of matter-energy throughput, for the accumulation of capital on a greater scale – which deepens the exploitation of nature. Marx (1992: 218–219) highlighted these developments:

> The material forms of existence of the constant capital, however, the means of production, do not consist only of such means of labour, but also of material for labour at the most varied stages of elaboration, as well as ancillary materials. As the scale of production grows, and the productive power of labour grows through cooperation, division of labour, machinery, etc., so does the mass of raw material, ancillaries, etc. that go into the daily reproduction process.… There must always be a greater store of raw material, etc. at the place of production than is used up daily or weekly.

Capitalist growth has become increasingly reliant on the burning of fossil fuels – coal, oil, and natural gas – to power the machinery of production. As a result, capital broke the solar-income budget by mining the earth for stored energy and releasing massive quantities of carbon dioxide (Daly 1977: 23). At the same time, the absorption capacity of carbon sinks is being diminished due to deforestation, increasing the concentration of carbon dioxide in the atmosphere. As a result, the carbon metabolism of capitalism is driving global climate change (Clark and York 2005).

As concerns regarding global climate change have increased, an array of technological fixes have been presented as a means to solve this ecological problem. While many of these proposals (of which we point to six here) are rooted in a real concern regarding the state of the environment, each of them frames climate change as a technical problem that can be engineered away. One, scientist and Nobel laureate Paul Crutzen (2006) advocates engineering the atmosphere to avoid climate change by injecting sulfur into the stratosphere to increase the reflectivity of Earth, so as to let in less of the sun's energy. Two, some scholars have suggested fertilizing the world's oceans with iron in order to stimulate carbon-absorbing phytoplankton blooms. Three, physicist Freeman Dyson (2008) suggests replacing one-quarter of the world's forests with genetically engineered carbon-eating trees. Four, some researchers propose re-designing coal-burning power plants to facilitate the capture and storage of carbon in geologic formations. Five, nuclear power is supported by many politicians and scientists as a carbon-free alternative to fossil fuel energy. Six, high-tech agrofuels are frequently advocated as a sustainable alternative to fossil fuels.

These technological fixes generally rely on the application of modern technology, while ignoring the social barriers to adoption, the underlying socio-ecological operation of the capitalist world-system, and the ecological contradictions associated with the technological fixes (Carolan 2009; Li 2008; York and Clark 2010). Furthermore, this type of technological optimism is potentially very dangerous, given that if a problem is assumed solvable through technological development, it is also assumed that it is unnecessary to take actions to preserve forests, curtail the burning of fossil fuels, transform agricultural production, and change the political-economic conditions that have created these problems.

Each of the proposed solutions identified above entails numerous unintended ecological consequences and would, therefore, likely set off another wave of environmental crises that will need to be addressed in the future. For example, injecting sulfur into the stratosphere would generate acid rain. Replacing natural forests with genetically engineered trees would undermine biodiversity and alter ecosystems. Iron fertilization, which would probably be ineffectual at removing significant quantities of carbon from the atmosphere, would alter marine ecology (Strong *et al.* 2009). Expanding nuclear power increases the amount of radioactive waste that must be stored safely for thousands of years and, as recently highlighted by the events in Japan after the major earthquake and tsunami, generates risks of catastrophic meltdowns (Smil 2003). Agrofuels, which may not help to reduce carbon emissions appreciably, may drive unsustainable industrial agricultural practices, increasing the rift in the nutrient cycle and spurring deforestation

(Fargione *et al.* 2008; Magdoff 2008; Searchinger *et al.* 2008). Proposals for power plants that capture carbon and store it underground require technology that is not even in operation and ignore the ecological destruction associated with extraction of fossil fuels (Kintisch 2007; Palmer *et al.* 2010; Schiermeier 2006). Furthermore, even proponents acknowledge that there are many technical barriers to widespread development of carbon storage power plants and, even if successfully implemented on a large scale, it would take decades before these hypothetical power plants played much of a role in reducing carbon emissions to the atmosphere (Haszeldine 2009).

These techno-solutions fail to address the dynamics of the social metabolic order of capital, and how it is largely structured around burning fossil fuels in order to constantly renew itself on a larger scale. Capitalism, by necessity, systematically subordinates nature in its pursuit of endless accumulation. Its appetite is insatiable, as it attempts to overcome, surmount, and/or conquer whatever social and natural obstacles it confronts in its development. Even if the proposed solutions were implemented, the social relations driving ecological degradation are still in place, continuing to generate problems. The adoption of alternative fuels, such as agrofuels, does not necessarily displace the burning of fossil fuels, given the ongoing increase in energy consumption to support economic growth (York 2006, 2007).

The commodification of water and techno-ecological contradictions

The earth has a finite supply of freshwater. Natural scientists warn that human consumption of freshwater is increasingly pushing against planetary boundaries. Annual global consumption of freshwater increased from 415 km^3 in 1900 to approximately 2,600 km^3 today (Gleick 2003; Rockström *et al.* 2009; Shiklomanov 2003). The threshold beyond which irreversible degradation and potential collapse of terrestrial and aquatic ecosystems becomes likely is 4,000 km^3 (Rockström *et al.* 2009). In relation to the hydrologic cycle, human societies appropriate surface water and water held in shallow aquifers (Postel *et al.* 1996). Industry, factory farms, and agriculture are the primary sectors consuming water. Industries in core nations are responsible for "59 percent of total water withdrawals" (Barlow 2007: 32). Irrigation redirects water for use on crops, decreasing the availability of runoff. Streams and lakes are contaminated with pesticides, animal waste from factory farms, and dangerous chemicals from industry. Urban sprawl has reduced the availability of green spaces that absorb and keep water in local ecosystems. The social metabolic order of capital has polluted and diminished the supply of freshwater. Water has become a prized commodity in the global market, as corporations seek to control the production and distribution of this resource.

In the 1990s the World Bank and International Monetary Fund actively encouraged poor nations to privatize national water systems. By mid-2000, loans for water development were directly linked to requirements to privatize this sector (Barlow 2007; Goldman 2005). Corporations from the global North control much of the water market in the South. A general trend has developed: water prices have increased; service is eliminated for families who can no longer afford water; and overall, the availability of water in poor nations has decreased (Barlow 2007). Along with the privatization of the water sector, capital has offered a variety of technological fixes to address the decline in freshwater supplies.

Both water diversions and desalination plants are in operation, creating a unique set of ecological contradictions. Water diversions involve the construction of massive pipelines to transport water from one location with an abundance of water to locations that suffer water shortages. Both core and periphery nations have proposed or are constructing such diversions. These pipelines remove a vital resource from one ecosystem, disrupt the web of life, increase the prospect of water depletion, contribute to desertification, and pit rural communities against urban centers (Barlow 2007). Desalination plants remove salt from seawater through the use of filters and/or evaporation. Few countries can afford to construct these energy-intensive plants. Archer (2005) indicates that a proposed plant in Sydney would produce over 255,000 tons of greenhouse gases each year. Daily it would desalinate 100 megaliters of water. Perhaps most disconcerting is that every liter of fresh water produced in these desalination plants creates a liter of waste that is "a poisonous combination of concentrated brine mixed with the chemicals and heavy metals used in the production of freshwater to prevent salt erosion and clean and maintain the reverse osmosis membranes" (Barlow 2007: 27). This waste material is released into the oceans, where it "reduces the oxygen content of the water" (Barlow 2007: 27). Like the technological fixes in the production of food and energy, these so-called solutions fail to address the social forces causing the decline in the availability of freshwater. Instead, these fixes create additional ecological rifts in ecosystems, furthering environmental degradation.

A revolutionary shift in metabolic relations

The growth imperative of capitalism actively organizes the world to further the accumulation of capital. As a result, the system creates a series of ecological rifts in natural cycles and processes. Whenever it confronts barriers to the accumulation process, it employs a variety of shifts to overcome these obstacles. In its expansion, it degrades the conditions of nature. Marx (1971: 301) noted that capital turns to problems with "the land only after its influence has exhausted it and after it has devastated its natural qualities." And at this point, it proposes technological fixes to attend to the pressing concern, without addressing the fundamental crisis, the force driving the ecological crisis – capitalism itself.

Capitalism is incapable of regulating its social metabolic relation with nature in an environmentally sustainable manner. The constant drive to renew the capital accumulation process increases the scale of degradation, imposing the needs of capital on nature, regardless of the consequences to natural systems.

Capitalism continues to play out the same failed strategy again and again. The solution to each environmental problem generates new environmental problems (while often not curtailing the old ones). One problem follows another, in an endless succession of failure, stemming from the internal contradictions of the system. Public wealth, which includes the conditions of nature, is diminished in the process of creating private riches (Foster *et al.* 2010). While there are numerous environmental problems, the global reach and transformations of capital are transgressing the planetary ecological boundaries. If we are to solve the ecological crisis, we need to go to the root of the problem: the social relation of capital itself, given that this social metabolic order undermines the vital conditions of existence.

Resolving the ecological crisis thus requires in the end a complete break with the logic of capital and the social metabolic order it creates, which does not mean that we cannot take beneficial actions *within* the present system – although these will necessarily go against the *internal logic* of the system. In other words, a revolutionary shift in our metabolic relations is necessary. Marx proposed that a society of associated producers served as the basis for potentially bringing the social metabolism in line with the natural metabolism, in order to sustain the inalienable condition for the existence and reproduction of the chain of human generations. We need to establish a new social metabolic order that allows for nature to replenish and restore itself within timescales relevant to its continued reproduction.

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3 Empire

The comparative study of imperialism

Janken Myrdal

World history is largely concerned with empires. This chapter discusses some fundamental aspects of empires, such as their size and population, and compares two examples (Rome and China) of bulk transport from the imperial periphery to its center. I define "empire" as a nation that conquers other nations and makes them into provinces. Though all states transfer valuable goods to the center, not all of them transport huge volumes of materials to core areas.

Control and influence

The geographical extension of states is a historical phenomenon that can be followed far back in history, from 3000 BC until today. One reason why we have data from such a long period is that rulers were interested in the extent of their realm. Written documents and archaeological findings give us indications of state control. Another reason is that historians have long been interested in political history. Historical atlases are a manifestation of this interest, and they can form the basis for estimations of size.

For example, the Roman empire covered *c.*4.4 million square kilometers and the Mongol empire controlled *c.*23.5 million square kilometers at the peak of their expansion. The largest empire ever was the British, which spanned over 35.5 million square kilometers. As the total landmass of Earth is around 133 million square kilometers, not including the Antarctic, Britain thus controlled more than one-quarter of the Earth.

The first attempt to quantitatively compare the largest states was conducted by Rein Taagepera (1978, 1997). He wrote several articles on this topic in the 1970s and a sequel in the 1990s. The data came from atlases published in the 1950s and 1960s. The atlases he used included five English atlases and four German atlases from the 1950s to the 1960s, and one Finnish atlas from 1974. The most important for him was the well-known and detailed *Grosser Historischer Weltatlas* (Engel 1953–1970). His data for the three largest states throughout history has been quite widely used (e.g., Eckhardt 1992; Sanderson 1995: 264; Chase-Dunn and Hall 1997: 111; Christian 2004: 319).

Although Taagepera's database includes states as different as the Egyptian kingdom in 3000 BC and the Soviet state in AD 1950, it has been held as a rough indication of increasing political and military control. The Persian empire, established in the sixth century BC, is generally held as the first real empire, even though it had important forerunners. Persia was soon followed by other empires in Eurasia. However, these large political entities were of different kinds, from loosely organized to strictly centralized, differences which do not show up in the database.

For a few states Taagepera provides somewhat inconsistent information in different articles; Figure 3.1 only includes the smallest size for specific states, as he often overestimates the size. In revising his dataset, I have also excluded "states" that probably did not exist as political entities, such as the "Harappa", and have added data from recent decades, covering the demise of the Soviet Union. The diagram is semi-logarithmic, so a ten-fold increase is represented as a duplication in the curve, and the *y*-axis is also adjusted so that the earliest intervals (3000, 2800, 2500) are separated by hundreds of years, followed by a series of 50-year intervals from 1500 BC until AD 1900, and finally 25-year intervals in the twentieth century.

The curve in Figure 3.1 is, however, similar to the curves presented by Taagepera, and he offered three interpretations: (1) it is exponential, approximating a straight line in the semi-logarithmic curve, and by 2200 the whole Earth would be united; (2) it may be S-formed, finally flattening out, implying that a global empire is beyond reach; but his preferred interpretation was that (3) it

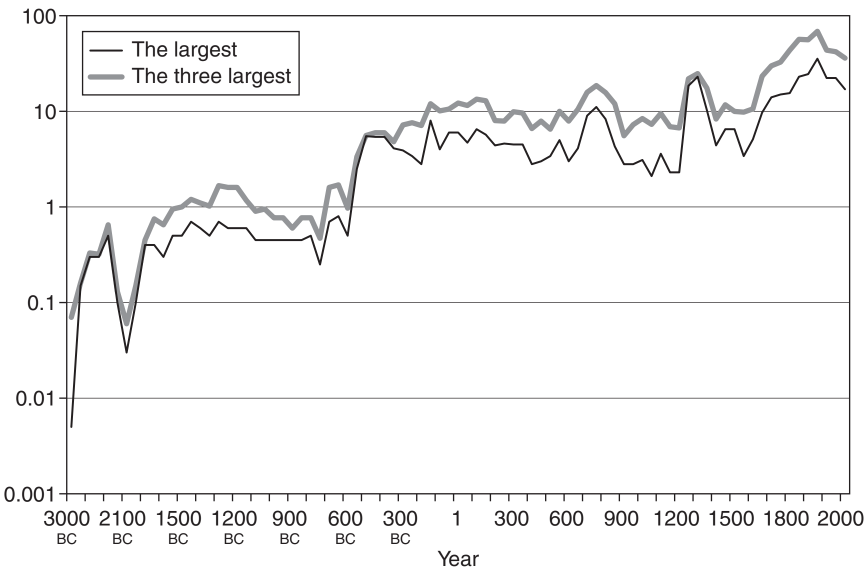

Figure 3.1 The three largest (upper curve) and the largest (lower curve) states, measured in million square kilometers, semi-logarithmic scale (source: based on articles by Taagepera, who worked with atlases from the 1950s and the 1960s, and supplemented with data from the last three decades).

shows different phases caused by various organizational breakthroughs: the period before 2900 BC features only small political entities, 2900–700 BC medium-sized states, 500 BC–AD 1600 true empires, and after 1600 European domination (Taagepera 1978: 118–122). Stephen Sanderson (2000: 194–195) has remarked that an increase in long-distance trade also corresponds to the step-wise increase in state size.

Since the late 1990s a new generation of atlases has been produced, in which a decisive change was the abandonment of the earlier dominant Eurocentric perspectives. In my investigation I have used nine atlases: six of these atlases are English, two are German and one is French. For the period after AD 1000 there are almost no differences between the new set of atlases and the 40–50-year-old ones. For the first 3,000 years, however, another picture emerged. The sizes represented as under direct control of early states were much smaller in the modern atlases than in Taagepera's dataset, on average 5–15 times smaller. Estimates for earlier periods, of course, are notoriously difficult. Sizes sometimes vary between 1 : 2 and 1 : 3 in different newer atlases. Taagepera, however, did not discuss differences between the older atlases, but claimed that consensus about size prevailed. For the period 500–1 BC, Taagepera's estimates are, on average, 15–30 percent higher than those in the new generation of maps, but in the first centuries of our era only 5–10 percent higher (except for some nomadic empires).

Why are the new atlases more cautious? One obvious reason is that research has advanced. A number of new methods have been developed in archaeology and intensive discussion is ongoing (Trigger 2003: 71–91; Yoffee 2005). In his textbook on world history, Patrick Manning (2003: 190) discusses the difference between core areas and outlying territories. There is also an ideological explanation for the more conservative estimates. When the first historical atlases were constructed, in the late nineteenth century, colonial powers were allocating the world, and contemporary maps showed the world in colors representing these major powers: purple for France, pink for Britain, etc. This was how the world was understood, and it seems that this understanding was projected onto the image of ancient states and empires.

Partly as a consequence of decolonization, a new conceptualization of ancient political geography emerged. Not only were the "areas under control" depicted as smaller, but the new atlases began to represent "spheres of influence". The number of such maps is not large, but some general conclusions can be drawn. The area "under influence" is sometimes depicted as 5–10 times larger than the core area, and in several cases the influence zone is represented as considerably larger than Taagepera's estimates for early states.

The early states can be visualized as islands in an ocean of tribal communities. They could wield a strong influence over their neighbors, but did not have the means to control them. This pattern is even more evident in the newest atlases. In the atlas of *Der Neue Pauly*, the major encyclopedia of Antiquity, published in 2007 (Wittke *et al.* 2007), political maps from 1500–900 BC invariably show core zone and influence zone for a number of smaller and larger states.

The map of the Middle East in 900 BC shows 26 different states, some overlapping in conflict zones. The region was on the verge of turning into a mosaic of strictly organized and territorially bounded states, and eventually into an empire (i.e., the Persian empire).

The research is still in a formative phase, and maps over influence will always be tentative. The curve in Figure 3.2 thus has a running average covering four periods. This means that the average covers 400 years (or more) before 1500 BC, while from 1500 BC up to 1900 the running average covers 200 years, and finally only 100 years in the contemporary period. Figure 3.1 continues to be more informative for periods after the beginning of our era, but before that time it is incorrect. On the one hand Figure 3.1 should no longer be used for periods before *c.*500 BC; on the other hand, Figure 3.2 needs to be much more refined.

An interesting conclusion can be drawn at this point. If there is a beginning of the period within which states were more strictly demarcated, there could also be an end. If a historian in AD 2300 would like to make a historical map for our period he or she would probably describe the United Sates/NATO and the Soviet Union/Warsaw Pact in a similar way as modern atlases describe the Hittite heartland/Hittite sphere of influence. The specific historical reasons for a division into "core" versus "influence region" are of course different in 1300 BC and 1950 AD, respectively, but the basic reality is similar: dominant states have rarely been able to totally control their subjugated states and make them into provinces.

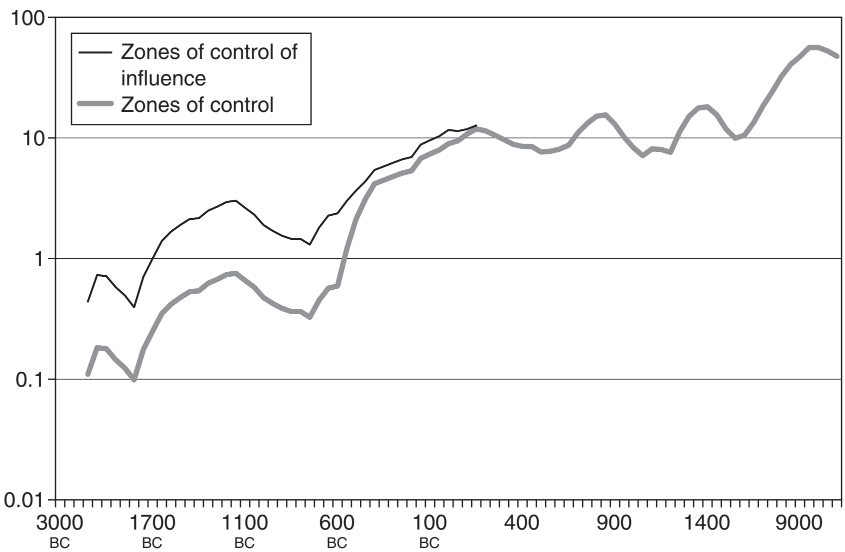

Figure 3.2 The three largest states' zones of control (thick, grey curve) and of control plus influence (thin, black curve), showing a running average over four periods, measured in million square kilometers, semi-logarithmic scale.

The geographical extent of states

Since the eighteenth century, most of Earth's land mass has been under the control of medium-sized or small states. A diagram can be compiled for the aggregated geographical extent of all states. In the new generation of global atlases, two have data on all areas under what approached state control: the Dorling Kindersley *Atlas of World History* (Black 1999) and *The Cassell Atlas of World History* (Haywood *et al.* 1997) (Figure 3.3).

Already in 1992 William Eckhardt presented a similar dataset, mainly based on material from Taagepera, but he only published summaries century for century (Eckhardt 1992: 32, 221, 223–224). I will not discuss his data in detail, only to comment on the differences compared with the data in Figure 3.3. For the earliest times (2500–500 BC) both sets of data estimate that only 1 percent of the land mass was under state control. Then an increase to about 10 percent followed in the period 500–300 BC. In Eckhardt's estimation this number remained around 10–15 percent until the thirteenth century, and then began to increase, most markedly in the eighteenth and nineteenth centuries. In the new atlases, on the other hand, the increase continued throughout the first millennium, reaching 20–30 percent in the period AD 500–1000. One reason for the divergence in estimates is that states in Africa and other parts of the periphery (in relation to empires and states in Eurasia) were underestimated in the older atlases for the period before AD 1500. A reason for the differences is once again that we are getting better data as research on non-European countries is advancing. And

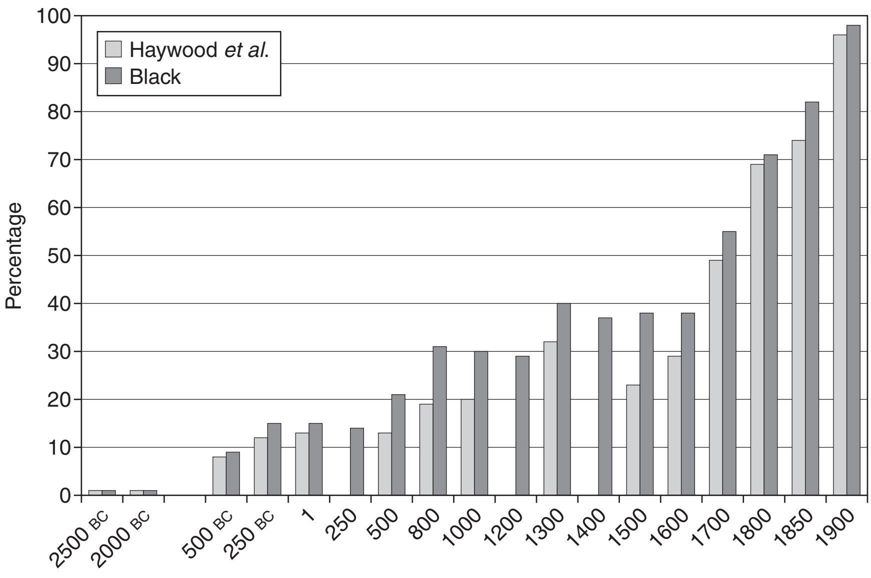

Figure 3.3 All states' control of land mass, as a percentage of the total land mass of Earth, based on two modern atlases (Haywood *et al.* 1997; Black 1999).

again we can suspect an ideological aspect. If conquered territories on other continents were perceived as unorganized tribal communities, the European expansion could be represented more as a civilizing project than if they were depicted as states.

Admittedly, European powers conquered not only states but also tribal regions in their struggle for global control. The marked expansion in state organization in the eighteenth and nineteenth centuries was partly an effect of European expansion, and later decolonization.

Demography

At first, Taagepera (1978: 111) decided not to investigate the population size of empires because he considered the information insufficient. In a later article (Taagepera 1997; cf. Taagepera 2008: 140–146) he included population, but only as an exponential function of the "number of polities" and the tendency toward demographic concentration. He depends heavily on McEvedy and Jones' (1978) study on the history of world population. Taagepera's conclusion is that there is an ongoing concentration of population until around AD 100, but then the tendency toward concentration of population in a few entities has been "essentially stationary" for 2,000 years.

Colin McEvedy and Richard Jones (1978), in their eminent book, also presented a diagram showing the population of top-ranking empires from 400 BC until today. Most of the time, from about 200 BC, China was the most populous empire, except for a period from the early third to late sixth centuries, when the Roman empire was generally larger, and a short period in the early twentieth century when the British empire had a population of nearly 650 million people. China at that time had 100 million fewer inhabitants (McEvedy and Jones 1978: 126–127).

I agree with Taagepera that demographic information is scant and often obscure, and for some regions we have to resort to guessing. I will thus only present data for every second century and no data at all from the period before 400 BC. In Table 3.1, the relative proportion of world population is estimated for the largest and second largest empires, but only when the second largest held more than 15 percent of the world's population. Among those excluded second-ranked empires are Eastern Rome, which in AD 600 had about 13 percent of the world population, as well as the Caliphate, which in AD 800 had 12 percent of the global population. Among third-ranked empires are the Ottoman empire and the Habsburg empire, with about 6–7 percent of the world population each in 1600.

I have used the data presented by McEvedy and Jones (1978) as they are the only authors who provide a total dataset for all regions. In later discussions on world population it seems that they have underestimated the total population during the centuries around the birth of Christ. According to comparisons presented on the website of the US Census Bureau, for the year 1, the lowest estimate is McEvedy and Jones' figure of 170 million, while several other scholars

Table 3.1 The two largest empires' shares of world population in percent (only if larger than 15 percent)

	Largest empire	*Second largest empire*
400 BC	15	<15
200 BC	26	18
1	29	21
200	32	21
400	18	16
600	23	<15
800	20	<15
1000	24	<15
1200	21	<15
1400	21	<15
1600	28	18
1700	26	25
1800	36	<15
1900	26	24
2000	18	17

suggest 200–300 million. If McEvedy and Jones' estimates for empires are correct, but their estimates for world population too low, the proportions of the largest and second largest empires in Table 3.1 should be overestimations. The correct numbers would be around 20–25 percent and 15 percent, respectively, for the two largest from 200 BC to AD 200, rather than the 5–10 percent higher figures in Table 3.1.

A first general conclusion is that throughout history, China is almost always the largest empire, and the second largest is generally an empire controlling northern India. These are regions with dense populations and intensive agriculture. A more unexpected general conclusion is that there is no relative increase in the largest empires' share of world population. This conclusion is similar to what Taagepera wrote in his most recent article. Another conclusion is that the two largest empires' share of the world population has generally been remarkably high, mostly 30–40 percent of the world population, and sometimes even higher.

When empires are able to manage larger geographical regions, it is a sign of efficient organization of trade and warfare. When they can handle an increasing number of inhabitants, it indicates a growing capacity to handle social complexity. As the largest empires' shares of the world population neither significantly increased nor decreased over the course of history, their administrative capacity kept pace with a growing social complexity in the world. The empire was a primary political option available from around 700 BC.

However, other options for organizing continents and subcontinents were available: Territories could be divided among smaller and larger nations, as in Europe, or sometimes under the control of an empire, sometimes not, as in India. This example has been thoroughly discussed in *A Historical Atlas of South Asia*

(Schwartzberg 1978), with statistical analyses of political history similar to those performed by Taagepera. The authors remark that the diffusion of knowledge on statecraft under certain circumstances could undermine and divide the great powers (Schwartzberg 1978: 254–262).

Transports of grain in empires

Short-lived empires, like Alexander's, could be plunder-based, and many empires were built ruthlessly in their expansion phase (e.g., the Mongols, the Spaniards). However, they could not exist for a longer period of time without an internally regulated flow of goods and people, organized under the auspices of the empire. Christopher Chase-Dunn and Thomas Hall (2000: 89) have identified four types of networks of exchange in world-systems (including empires): those conveying bulk goods, prestige goods, political-military contacts, and information.

Many empires controlled a flow of precious and expensive goods, such as for millennia along the Silk Road or over the oceans after the fifteenth century. Such flows necessarily had sufficient value to support the costs for military control, in order to be the economic basis for empire. These flows of preciosities will be left aside in this text, however, as I will concentrate on bulk transports.

Grain was the most important energy resource that was transported over great distances in pre-industrial times. The grain trade reveals an important part of many empires' "metabolism", or more precisely the "material flows" of these empires. The use of the term "metabolism" in social sciences (Fischer-Kowalski 1998–1999) converges with Wallerstein's (1974: 15–16) discussion of empires as the earliest world-systems with bulk transports. The two most famous cases of grain transports in empires are the Roman trade over the Mediterranean and the Chinese trade along the Grand Canal.

Example 1: the Roman empire

Already in the early Greek market, grain transports to the cities were extensive, but Peter Garnsey (1988: 273) warns against overestimating the grain imports to Athens. This was merely a prelude to the expansion of grain transports in Roman times. From the late third century, Sicily was the main source of grain imports to Rome, and gradually from then to the middle of the second century, northern Africa was included among the provinces. Together with Sicily and Sardinia, it produced the surplus of grain needed in Rome. In the time of Augustus, Egypt was drawn into this long-distance grain export to Rome. The city then had around one million inhabitants to feed (Garnsey and Saller 1987: 82; Garnsey 1988: 191), but the estimates vary between 0.75 and two million. Only about 10 percent of the grain consumption in the city of Rome was covered by Italian production (Garnsey and Saller 1987: 58).

Estimates of the total annual import of grain vary. Garnsey argues for an annual requirement of at least 200,000 tons, based on a rather low assumption of calorie intake (1,700 calories per day). He estimates the total import to have been between 200,000 and 400,000 tons (Garnsey and Saller 1987: 83–86). Other authors estimate an annual import of up to 400,000 tons (Debeir *et al.* 1991: 35–36). These higher estimates are based on a small number of contemporary texts, and have been criticized (Garnsey 1988: 231–232).

One of these contemporary texts, from the middle of the first century of our era, mentions that one-third of the grain imports to Rome came from Egypt and two-thirds from northern Africa. This account neglects other important regions. Regions of special importance to the capital, with approximate distances as a crow flies, were Sardinia (*c.*300 km), Sicily (*c.*500 km), north Africa (c.450–1,000 km) and Egypt (*c.*1,500 km). Other regions with significant surplus production were Crete, southern Spain, northern Morocco, the northern coast of the Black Sea and Mesopotamia, but surplus from these regions was not transported to the capital.

Not only the city of Rome, but a number of other cities as well had to be supplied with grain; the army also claimed a large quantity. It has been estimated that the army around year 1 annually consumed around 100,000 tons (for 300,000 soldiers), and 200 years later 150,000 tons (Garnsey and Saller 1987: 89–90). These estimates assume a daily consumption of 1 kg per person. Most of this grain came from local production and from the regions nearest the legions, such as provisioning the Rhine army using southern Britain and northern France.

The total population of the Roman empire during these centuries was probably 40–45 million, but higher numbers have been suggested. Estimates vary between 40 million (McEvedy and Jones 1978: 126) and 54–75 million (van der Leeuw and de Vries 2002: 214). Maddison (2007: 32–37) refers to this discussion and argues for a population around 44 million. Even if only a few percent of the total grain production in the empire were transported through long-distance trade, it travelled a fairly long way and in this respect can be compared to industrial bulk trade.

The empire could coerce its provinces rather sternly in order to appropriate the grain. In his classical but somewhat dated book on the Roman economy, Rostovtzeff (1957: 201, 207–209) gives a number of illustrative examples of how the emperors tried to secure the grain trade. It was prohibited to export corn from Egypt to any place other than Rome, and in Sicily and Sardinia the Romans restrained urbanization in order to maintain these islands as granaries for Rome.

With the barbarian invasions, the grain trade to western Rome faded out. When the Vandals conquered Carthage in 439, grain exports to Rome were stopped (Wickham 2005: 87–88). Even before that date, the grain flows from the eastern Mediterranean had been redirected to Constantinople. Under Justinian, in the sixth century, about 180,000 tons of grain reached Constantinople, most of it from Egypt and the Black Sea area (McCormick 2001: 97; cf. maps of grain transports in the fifth century in Wickham 2005: xvii).

Figure 3.4 shows the catchment area for grain sent to Rome around AD 100.

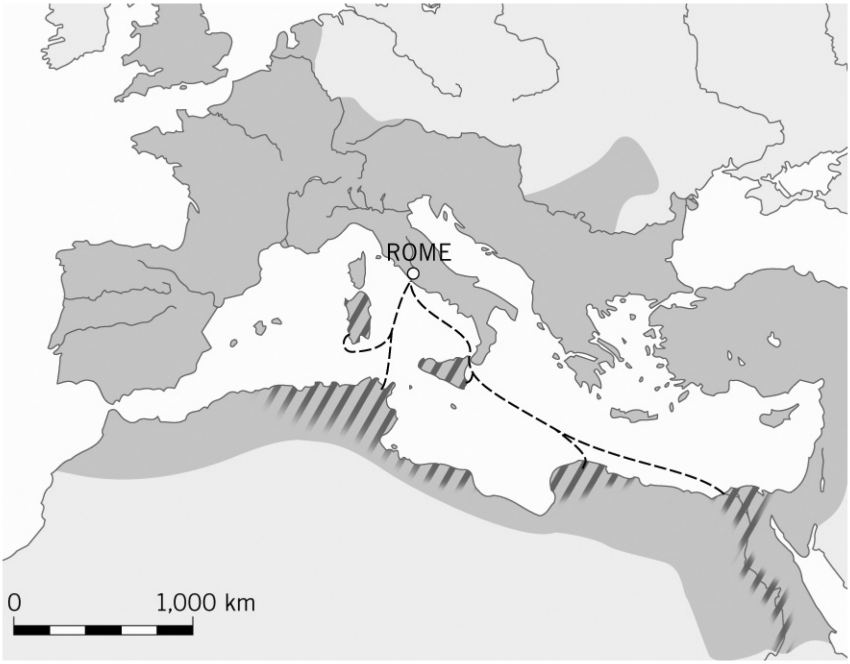

Figure 3.4 The Roman empire *c.* AD 100 and the “catchment area” for grain sent to Rome. For data on surplus production of grain in the Roman empire, see, e.g., Wittke 2007: 200–201 and Putzger 2005: 39.

Example 2: the Chinese empire

The Japanese scholar Hoshi Ayao (1969) has written the most comprehensive work on state-organized grain trade in China. Already during the Han dynasty, *c.*200 BC–AD 200, grain was transported from the lower reaches of the Yellow River to the capitals of Ch’ang-an and later Loyang. The amounts have been estimated at between 20,000 and 40,000 tons annually (Ayao 1969: 1), considerably less than in Rome at this time.

After a breakdown and division of the empire into several kingdoms in the following centuries, the Chinese grain trade developed stepwise with the restoration following the Sui and Tang dynasties in the sixth and seventh centuries. The tax records give an idea of the total volumes, estimated at 1,600 million liters of grain annually in the eighth century and between 13,500 and 16,500 million liters in the eleventh century (Bray 1984: 415). Most of this grain was consumed locally, and only a small proportion was destined for long-distance trade.

The system of canals between the Yangzi and Huang (Yellow) Rivers was the main artery of transport. The first canal complex was built in the seventh century, and in the eighth century canals from rice-producing areas in southern Yangtze helped to support armies at the northern frontier (see the map in Elvin 1973: 58–59). Ayao (1969: 1–2) has estimated that the average quantity transported annually to the capital Kaifeng was around 100,000 tons at this time.

A rapid expansion of rice production occurred in the south around AD 1000, at the same time as the empire was being pressed southwards by the nomadic tribes and warriors in the north. The Song dynasty built the "Grand Canal", and the capital Kaifeng on the lower Huang was provided with around 300,000 tons annually (Blunden and Elvin 1998: 104). The distance to the southern rice-producing area was around 1,000 km or more as the crow flies.

With the Mongols and the Yuan dynasty, the capital was moved further north to Beijing, and the lower course of the Huang was redirected, so the Grand Canal had to be supplemented with a long extension from the new course of the Huang to Beijing. Under the Yuan dynasty, rice was also exported over the Yellow Sea. The transport distance increased to 1,500–2,000 km, and up to the eighteenth century much of the rice sent to the capital came from surplus areas south of the Yangzi (Blunden 1973: 104; Blunden and Elvin 1998: 104–105).

During the early Ming period an economic recovery followed, and data from the fifteenth century show that the average annual transport to the capital in the early 1420s was around 150,000 tons, which rose to around 300,000 tons in the 1430s, and then fell again to between 200,000 and 250,000 tons in the 1460s and 1470s (Ayao 1969: 14, 62). During the following centuries this level seems to have been normal, but in the middle and late Qing (Manchu) dynasty, the state grain transport along the Grand Canal started to decay, and in the nineteenth century sea transport again began to dominate (Ayao 1969: 98). The Grand Canal accounted for half of Beijing's food supply in the mid-eighteenth century, but fell to one-third by the mid-nineteenth century (Pomeranz 2009: 125).

In addition to the long-distance transports along the Grand Canal, other long-distance trade in rice developed in China. For instance, imports to towns in southern China, mostly from the Yangzi region but also from Taiwan, amounted to between 170,000 and 280,000 tons annually in the early eighteenth century. However, this was commercial exchange, not controlled by the imperial administration (Eastman 1988: 106). Pomeranz (2000: 34) argues that a conservative estimate of the total volume of long-distance trade in China in the eighteenth century was around two million tons (30 million *shi* – every *shi* of rice weighed about 160 lbs or 72 kg), but most of this was not directed to the imperial capital.

The population of China was over 100 million in the eleventh century, and following a decline under the Mongols to about 70 million, increased to around 100 million in the fifteenth century and to 160 million around 1600. The basic pattern was the same as that for Rome: only a few percent of the total production were transported in long-distance trade, but that trade could cover very long distances in order to support the imperial center.

Figure 3.5 shows the "catchment area" for grain sent to Beijing in the eighteenth century.

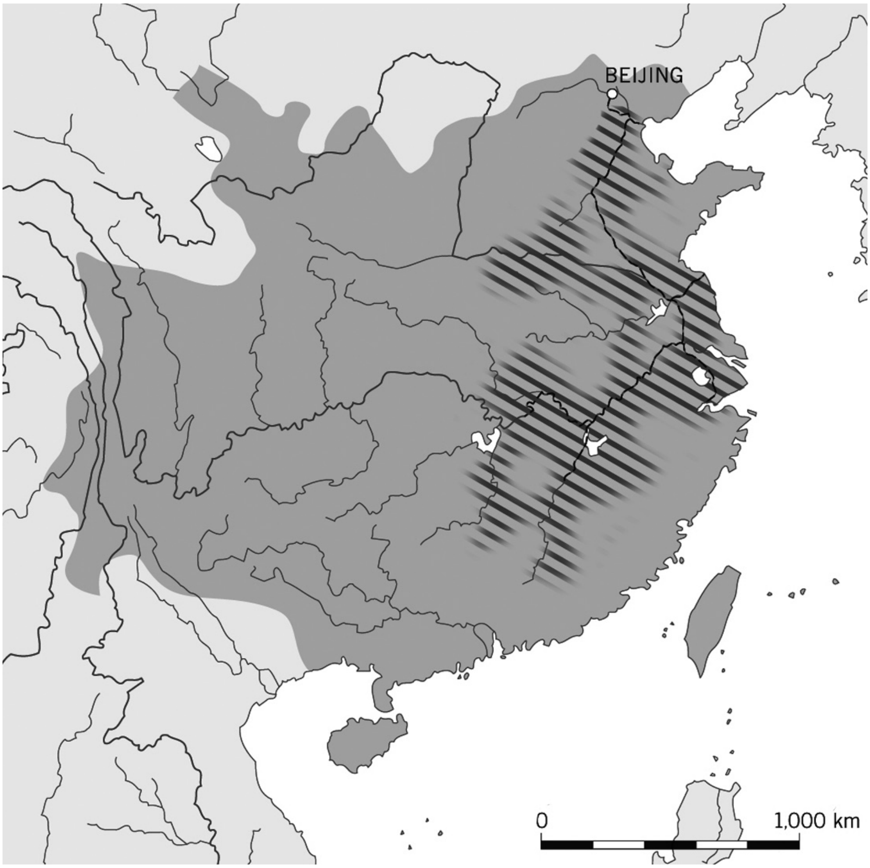

Figure 3.5 The Chinese empire in the eighteenth century, and the "catchment area" for grain (rice) sent to Beijing (source: Blunden and Elvin 1998: 104).

Pre-industrial energy flows through long-distance trade with grain in large states

Less than 10 kg of grain per capita (at most 400 million kilograms) were conveyed through long-distance transports from periphery to core (the capital) in the Roman empire, and only one-third to half of this in China under the Song and early Ming dynasties. Even if we concentrate on a specialized production area such as Egypt, the per capita volume sent to Rome was low.

Similar examples can be found elsewhere. In the seventeenth century a small Swedish empire was established around the Baltic, which organized grain transports from conquered provinces to the capital, Stockholm. Imports from the provinces amounted to less than one-tenth of the total production in the old provinces of Sweden (Myrdal 2007: 87–89). For medieval Europe, Bruce Campbell has estimated the "catchment area" for grain transports to London and Paris. Grain was transported overland to London from up to 30 km away, when only land transport was available, but from a maximum distance of up to 100 km along waterways. Paris had a "catchment area" with a radius of around 60 km as the crow flies. The impact on the countryside was considerable, even if the share of the total production was small. Only around 1.5 percent of total food production in the country went to London (Campbell *et al.* 1993: 44–45, 173).

A conclusion is that even if the core area was of minor importance for the total flow of materials in early empires (Hornborg 2007: 20), the elite were forced to exert strong pressure on agricultural producers to enable transports of grain over considerable distances to support the core. No single region could provision the first really large imperial capitals, and it was not until the agrarian and Industrial Revolutions in the eighteenth and nineteenth centuries that the immediate regions around large cities could sustain the urban populations.

The radical expansion of urbanization under industrialism demanded global material flows of totally new dimensions and character. Britain as a nation became dependent on food imports from the whole world (Pomeranz 2000: 218), while productivity in agriculture expanded to the point where many countries could industrialize and sustain a growing population at the same time. The dominant energy flows changed from mainly agrarian products to fossil energy for fuel, first coal and then oil. A new world-system emerged, in some ways fundamentally different from those of earlier empires.

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4 Islands

Ecologically unequal exchange and landesque capital

Eric Clark and Huei-Min Tsai

Islands have played important roles in the weave of existence. In the long view, islands have been key scenes in the generation of global biodiversity and cultural diversity. More recently – as oceanic hubs and laboratories of colonial enterprises, way stations for provisioning, sources of resource extraction, military outposts, effective spaces for incarceration, convenient sites for dumping waste, strategic geopolitical cornerstones, nodes of the global tourism industry, pockets of escape, and havens for laundering money, evading taxes and accumulating financial wealth – islands have become key places in the operational nuts and bolts of world-systems and arenas of struggles over land and natural resources. As predominantly coastal land, islands are sites from which resources are drawn from oceans and seas, a characteristic they share with continental coastal zones, which account for the bulk of continental populations. Oceanic islands have served as colonial stepping stones en route to distant lands. Continental islands are often closely connected with and form part of the cultures and economic activities of coastal regions, occasionally becoming centers of power – most strikingly Manhattan, Hong Kong and Singapore, so bridged, populated and connected that they do not count as islands by some classifications.

Imaginary sites of utopian and dystopian social experiments and exercises in moral philosophy are commonly islands (Manguel and Guadalupi 1999; Gillis 2004). More concretely, islands have been preferred sites for exercising powers of social and socio-ecological engineering, and in the process have given rise to environmentalism and doctrines of nature conservation (Grove 1995). With more or less rigor, scientific tales of island human ecologies provide insight into real social experiments and (one would hope) less fictional guidance increasingly relevant to planetary sustainability and human survival on Earth Island (e.g., Kirch 1997; Gowdy and McDaniel 1999; Erickson and Gowdy 2000; Clark 2004). As a metaphor for bounded matter, amplifying perspectives of inside and outside, the 'island' represents systemically coherent entities from the scale of microbiology to astronomy – meso-scale communities and geopolitical units of collective action being more relevant to our concerns here. The hoary chestnut of just "what is an island?" suggests that what island studies can reveal about historical-political ecology stands to be relevant to broader continental contexts.

Through the gaze of continental centers of power, islands are objectified from the outside as sites of various potential, not least in terms of resource extraction, but also for strategic land uses serving functions for which boundedness is an advantage – e.g., fortresses, prisons, dumps, pastures. The inside perspective of people who call an island home is very different, indeed often diametrically opposed (Hau'ofa 2008). Tensions between interests from the inside and the outside are perennial forces of island dynamics, as are tensions within island societies. Struggles for power over the entry of entities and events into space and time constitute island life every bit as much as continental life (Hägerstrand 1986). Though often the peripheral and weaker part in the historical struggles that make ecology political, island societies are not powerless and island cultures are not without resilience.

Our purpose in this chapter is to give a brief perspective on islands in global historical-political ecology, focusing on ecologically unequal exchange and the formation of landesque capital. We emphasize how these processes are intertwined and recursively connected in broader contexts of uneven development. Empirical examples draw on our research into the historical-political ecology of islands and archipelagos which have since 1949 been geopolitically part of Taiwan, the Republic of China: Kinmen (Quemoy) Island off the southeast coast of China; the Penghu Archipelago (Pescadores) in the Taiwan Strait; and Pongso no Tau (Lanyu, Orchid Island), a northern outlier of the Batanes Islands, southeast of Taiwan (Figure 4.1). The aim is not so much to draw comparisons between these cases as to draw connections, both between the processes of ecologically unequal exchange and formation of landesque capital, and between the peripheral islands and the global political economy/ecology of which they are part.

Ecologically unequal exchange and landesque capital

Island life does not unfold in absolute isolation, however much relative isolation is a defining characteristic of insularity. Material flows – some intentional, some unintentional, and others with "natural" movements of air, water and (non-human) animals – contribute to the constitution of all places, but we see this more clearly in the bounded room of islands. Trade and other forms of material exchange have been, with few historical exceptions, the *sine qua non* of human life on islands.[1] Goethe was not the first to remind us that every living being lives by means of things outside of it. Maintaining societal metabolism on a small island requires material flows beyond its shores. In this sense, exchange is commonly beneficial to sustaining island communities. But as the growing literature on ecologically unequal exchange – including ecological footprints, material and energy flow analysis, metabolic rift, physical trade balance, environmental load displacement and global commodity chains – makes clear, exchange can entail quite different ecological consequences at both ends, and often severely degrading impacts at one end. It is a matter of power on which side of the exchange a place lands. Boyce (2002: 8–9) usefully distinguishes between five dimensions of power in the political economy of the environment:

> *Purchasing power* is the dimension of power that underpins the notion of "consumer sovereignty" … the ability and willingness to pay for various goods determines what gets produced.… *Decision power* – the ability to prevail in contests where different people prefer different outcomes.… *Agenda power* is the ability to determine which issues enter into the arena of public decision-making at all.… *Value power* is the ability to influence what others want, what they themselves will choose if given the power to decide. *Event power* is the ability to alter the circumstances in which people make choices, rather than directly determining the choices themselves.

Figure 4.1 Location of Kinmen, Penghu and Pongso no Tau (Orchid Island) (source: Royle and Tsai 2008).

Some places successfully brand themselves as green and sustainable eco-cities, while the global flows of exchange upon which their environmental qualities and quality of life rest bring land degradation, toxic waste and environmental impoverishment to other places, the sites of extraction and production underlying the environmental cleanliness of the so-called eco-cities (which rely on myopia to be believed) (Anderberg and Clark 2011).

Trade is generally understood by economists as necessarily equal. Those who trade voluntarily exchange what they possess for currency or goods which they assess to be of at least equal value: otherwise they would not trade. Trade, we are told, benefits all, through comparative advantages, specialization and spatial divisions of labor. Critical economic historians have problematized this view of trade with the notion of unequal exchange, based on uneven development between core and periphery and inequalities between societies engaging in trade. Unequal exchange entails "moving accumulated capital from politically weak regions to politically strong regions" (Wallerstein 2004: 28). Leaving the issue of value aside, the concept of ecologically unequal exchange focuses instead on material flows of trade, especially in terms of embodied labor, embodied land and environmental degradation. To paraphrase Wallerstein, it entails moving the ecological burden of politically and economically strong regions to politically and economically weak regions (Hornborg 1998, 2001).

In emphasizing material flows, ecologically unequal exchange problematizes localized analyses of sustainability and environmental improvement or degradation that lack connectivities to broader regional and global contexts. Given the global reach of interdependencies and commodity chains, how might we reasonably understand the sustainability of one place, unless through thorough consideration of the multitude of material flows upon which the metabolism of the place depends? Extractive and productive activities in a central place or core metropolitan region result in a set of ecological consequences for that territory. The set of ecological consequences of total consumption in the same place will, however, be considerably greater, as much of what is consumed is extracted or produced elsewhere. At the other end, in the global periphery, environmental loads and degradation are often greater than what corresponds to consumption. In other words, "domestic environmental conditions are not necessarily an accurate reflection of the environmental burdens engendered by domestic standards of living and rates of material consumption" (Rice 2007: 63).

However multifarious the variables of these environmental conditions may be, we can nevertheless grasp ecologically unequal exchange in such a straightforward way. Not so with landesque capital, which as Bayliss-Smith (1997: 149) suggests, is theoretically "a relatively under-developed concept." Landesque capital is variously defined as: "any investment in land with an *anticipated* life well beyond that of the present crop, or crop cycle" (Blaikie and Brookfield 1987: 9); "landscape manipulation *designed* for long-term gains in productivity ... [that] allows labor to be environmentally banked" (Fisher and Feinman

2005: 64); and "inalienable modifications of land for the *purpose* of increasing its productivity" (Hornborg 2011) (italics added in all quotes). Marx (1981: 756) referred to *la terre-capital* as capital

> fixed in the earth, incorporated into it, both in a more transient way, as is the case with improvements of a chemical kind, application of fertilizer, etc., and more permanently, as with drainage ditches, the provision of irrigation, levelling of land, farm buildings, etc.

Most research into landesque capital focuses either on pre-historical and pre-colonial contexts or on societies in the periphery of the world-system where the great transformation (commodification of and the forced creation of markets for land and labor (Polanyi 2001)) had not yet penetrated and radically transformed social relations, or where this process of dislocation is underway. It emphasizes either the relations between agricultural intensification (landesque capital being innovations for intensification) and population, or relations between the hierarchically stratified versus egalitarian characteristics of societies and the formation of landesque capital, or both (e.g., Brookfield 1984; Kirch 2007; Widgren 2007; Håkansson and Widgren 2007). Our focus here will rather be on recursive connections between ecologically unequal exchange and the formation of landesque capital, as articulations of broader forces of uneven geographical development (Harvey 2006; Smith 2008; Clark 2009). However accurate and insightful work on pre-colonial landesque capital may be for its purposes, it fails to provide much guidance in analyzing relations between landesque capital and other forms of capital imposing land-use change. For this, we find the work of Bayliss-Smith (1997) especially valuable.

Bayliss-Smith's analysis of historical change, from taro field to market garden to pineapple plantation to resort and golf course, brings the formation and abandonment of landesque capital into relation with other forms of capital that displace landesque capital, along with the communities and cultures that produced it. It allows us to connect analysis of landesque capital with issues concerning the impacts of vagabond capitalism on social reproduction (Katz 2001), the powerful mechanism of rent gaps (Clark 1988; Smith 1996) and the "singular principle power" of "landed developer interest" (Harvey 2010: 180–181).[2] Bayliss-Smith bridges landesque capital within (pre)historical agricultural change with broader analyses of land-use change, landed developer interests, built environments (these are also durable immobile manipulations of landscape designed for the purpose of increasing the productivity of land) and finance capital (see Table 4.1). He argues that

> the key variable in explaining contrasts in Pacific Island land use today is socio-political organization … what matters is … how widespread has been the adoption of those types of social organization that allow different forms of capital to penetrate into the agricultural sector.
>
> (Bayliss-Smith 1997: 144)

Table 4.1 Land use, forms of capital and social organization

Land use	*Main form of capital*	*Social organization*
Taro garden	Landesque	Local subsistence and surplus for chiefs
Market garden	Landesque and productive	Peasant production for urban markets
Pineapple plantation	Productive and finance	National agri-business
Resort and golf course	Finance	Multinational tourist industry

Source: Bayliss-Smith 1997.

There is a normative dimension to landesque capital that offers potentially valuable instruction, but also renders the concept slippery. Brookfield (2001: 185) argues that "Just as human use can have the effect of stripping and gullying soils, so it can also create enduring beneficial changes that yield capital for use by future generations." Widgren (2007: 63) emphasizes this normative dimension of "improvement," arguing that the concept of landesque capital "confronts stereotyped images of relations between humans and nature" in so far as it

> acknowledges the role of humankind in improving "natural" conditions. In many areas of the world, humans may have altered conditions for future sustainable use for the better, and not only for the worse, as is often the unproven assumption in much writing on environmental history.

Enduring beneficial change creeps into the very definition of landesque capital. There are human practices such as the formation of landesque capital that contribute to sustainable development, and then there are practices which contribute to stripping and gullying soils and other forms of land degradation.

While it is useful to make this distinction, it introduces tensions and contradictions with the very definition of landesque capital. What about all those investments in land with an *anticipated* life well beyond that of the present crop and all those inalienable modifications of land *designed* for the *purpose* of increasing its productivity, which result in stripping and gullying soils or other forms of environmental degradation? Anticipations, designs and purposes do not always pan out. Ditches and dams are commonly considered landesque capital. But are all ditches and dams landesque capital – even those which generate land degradation? There seems to be a jump to conclusions from the recognition that the concept acknowledges the *potential* role of humankind in improving environmental conditions to an assumption that all durable investments that increase productivity of land *actually* fit nicely into this category.

The following nutshell histories of ecologically unequal exchange and formation of landesque capital in three small island societies focus on their recursive relations as manifestations of power relations positioning these societies in a regional- and world-system. We will argue that the formation of landesque capital *here* can be part and parcel of socio-ecological degradation *elsewhere* through ecologically unequal exchange, and that the destruction, abandonment or devaluation of landesque capital is an important element in the balance sheet of ecologically unequal exchange.

Kinmen Island

Kinmen (or Quemoy, *c.*135 km^2, population *c.*89,000) lies in Xiamen (Amoy) Bay off the southeast coast of China, 8 km east of the island and harbor city of Xiamen and nearly 200 km west of Taiwan. The history of the island is closely tied to that of the coastal region of Fukien (Ng 1983). Early historical records suggest the island was wooded and fertile, and that early settlers invested considerable labor in the formation of landesque capital, including coastal dikes and irrigation works, to enhance agricultural productivity. Designated in the fourteenth century as one of seven major centers of salt production along the Fukien coast, much of the island's forest was cut for firewood in order to increase the volume and pace of production. After only a few decades, large areas of land became barren and sandy, and production shifted from boiling brine to utilizing tides and sun-drying techniques. Nine salt fields were established, covering nearly one-third of the island (Hung 1568). During the seventeenth century, Kinmen became a strategically located military base for launching attacks on Dutch-occupied Taiwan. Much of the remaining timber was used to construct battleships. The environment eventually became so barren and sandy that moving sand dunes buried whole villages. All but one salt field were abandoned during the nineteenth century (Huang 2003).

A decisive battle of the Chinese Civil War was fought on Kinmen in 1949, ending with a wall through the archipelago, cutting off Kinmen's connections with Fukien. Positioned on a critical frontier between the 'free world' and the 'communist world', Kinmen would come to be "affected by outside events tied to international politics by decisions made in Beijing, Washington, Moscow, and elsewhere" (Szonyi 2008: 4). From its new distant power of Taipei it came to be seen as a stepping stone for the nationalist government of the Republic of China in Taiwan to recover control over mainland China and as a site of defense against the People's Republic of China. Self-sufficiency became militarily important in the event of a blockade. Accordingly, policies were implemented to improve the island's capacity to secure provision of food and water. These policies included intensive reforestation, digging water reservoirs and ponds, soil improvement, and the introduction of drought-resistant sorghum for large-scale production of liquor for export.

However much for military purposes, the practical consequences of these programs amounted to a remarkable increase in formation of landesque capital. The island was transformed. More than 65 million saplings were planted between 1955 and 1994, with 35 million reaching maturity (Wang *et al.* 1994; Kinmen Forest Bureau 1998). Wooded land now covers over half of the island. Soldiers stationed on Kinmen (in the early decades commonly more than twice the civilian population) were assigned tree care duties to secure survival of saplings in the dry environment. Fifteen water reservoirs, 141 small dams and 449 ponds with accompanying irrigation systems were dug and built, securing drinking water and enhancing soil productivity. Imported fertilizers were complemented by careful management and use of manure and vegetative waste to further improve soil quality. About one-tenth of the island's land area became fertile farmland (Tsai 2003; Clark and Tsai 2009). In the 1950s, sweet potato and peanut was about all that could grow on the barren island. In the 1990s, sorghum accounted for over 50 percent and wheat for over 40 percent of cultivated land (*Quemoy Gazetteer* 2009).

Penghu Archipelago

The Penghu Archipelago (or Pescadores, *c.*128 km^2, population *c.*96,000) consists of 90 small, flat, low-lying, windswept islands in the Taiwan Strait. The abundance of marine resources in the archipelago is not matched on land, where basalt and coral rock, sandy infertile soil and lack of freshwater present challenges to agriculture. Agriculture on Penghu is based on anthropogenic soils built up over generations of fertilizing with seaweed, manure and compost. Walls of coral and basalt rock are built up around small fields to protect against wind erosion, resembling and therefore called "beehive" fields. Only drought-resistant crops are grown, such as peanut, sweet potato, cabbage, gourd, pumpkin, corn and aloe (Tsai 2009).

Fishing has always been the primary livelihood in the archipelago. Receiving abundant sunshine and rich in plankton and nutrients, the tidal flats support a highly diverse marine ecosystem. Utilizing the significant difference between high and low tides (up to 2–3 meters) and the extended shallow shore banks within the inter-islands sea, the islanders developed an ingenious technique for catching fish: stone weirs built with basalt and coral rock. Instead of going out in boats to fish, they let the fish come to them. The stone weir is covered by sea water at high tide, when fish ride the tidal currents in search of food. As the tide goes out, the fish are trapped in the weirs (Chen 1996; Liao 2009). This special form of landesque capital, using the same basalt and coral rock as for the beehive fields, is like extending farmland into the sea. Fish catches were so great that they not only supplied daily food, but also a surplus, serving as a major source of income for many households (Hung 1998).

In use at least since the seventeenth century, there are 589 stone weirs in Penghu, ranging from several meters to over 1 km in length. Building stone weirs is an occupation requiring skill (the construction needs to withstand the sea during storms) and considerable collaborative effort. Each stone weir is named by the villagers who work together in its construction, and is owned in common (Chen and Lin 2003; Lin 2004; Tsai 2009).

Another resource Penghu is richly endowed with is coral, in near-shore coral reefs and deep at sea. During the Japanese occupation (1895–1945), extraction of coral for the lucrative jewelry market intensified. A technique for harvesting deep-sea coral was introduced in the 1920s, followed in the 1960s by introduction of drag-net machinery. The destruction of coral reefs and deep-water coral resulted in loss of habitat for fish and other marine life, and consequently declining populations.

During the 1960s, heavy investments in large-capacity fishing boats resulted in dramatic increases in volumes of fish catch and in economic growth. Subsequent over-fishing to satisfy Taiwanese and world markets led to equally dramatic decline in volumes of fish catch less than a decade later. This provided incentives to develop cage aquaculture during the 1980s. The high density of cage aquaculture impacted negatively on marine water quality (Ueng and Yu 2000). Cage aquaculture proved to be economically risky as well. In February 2008 a sudden drop in water temperature resulted in a devastating mass-death of caged fish, with corresponding economic loss (Liu 2008).

Seeking alternatives to fishing, and drawing upon strong economic growth in Taiwan, the 1980s also saw large flows of investment into tourism infrastructure in Penghu. In order to position themselves to take advantage of economic opportunities associated with tourism and large motorized fishing boats, each village demanded its own harbor. This was supported by the central government in Taipei. Most of Penghu's 69 harbors (one for every 1,400 residents, some harbors in villages with less than 200 inhabitants) were built or substantially expanded since 1990 (Chen and Lin 2003). Two-thirds of the coastline has been concreted, diminishing the sand beaches expected to attract tourism.

With declining fish populations, the unique stone weirs were largely reduced to tourist attractions, but tourism income from the stone weirs is not sufficient to stem continued out-migration. Wealthy landed developer interests proposed the construction of casino resorts. A heated 2009 local referendum – highlighting the negative social and natural impacts on one hand and the need for alternatives to fishing on the other – ended with these casinos narrowly missing out on approval. However, huge hotels have already been constructed in expectation of the casinos.

Pongso no Tau

Pongso no Tau (or Lanyu,[3] *c*.45 km^2, population *c*.3,000) is a small volcanic island peaking at 548 meters, situated 65 km east of Taiwan and 105 km north of its closest Batanes neighbor. The Tau (or Yami) came from the Batanes Islands, settling the island about 800 years ago (de Beauclair 1957). Any early contact with Batanes relatives across the deep Bashi Channel was soon discontinued and linguistic and anthropological research suggests the Tau have been unusually isolated from their neighbors for centuries (Li 2001).

The Tau settled in patches of alluvial plains scattered along the coast. Taro root, the main element in their diet, is wet-cultivated in stone-walled fields connected with irrigation channels. Yams, millet and sweet potato are grown in small hillside patches. Fish is the main source of protein. Pigs, chickens and goats are eaten primarily at rituals and festivities. Fishing is done from boats made from specially selected trees in the steep forest. A boat launch is a big ceremony, for which the family prepares by raising pigs and sheep and cultivating yams and taro to share. Diving and spearing fish is another common practice to harvest food. The Tau may eat over 100 species of fish during a year, but the most significant fish is the flying fish, which come in abundance between February and May (Wei and Liu 1962).

Anthropological studies paint a consistent picture of a highly egalitarian and peaceful society. Leach (1937: 423–424) says:

> In every field of activity the society manifests an eager consciousness of the social equality of individuals … age and experience are respected, but not wealth or inheritance.… This extreme peacefulness … springs naturally from a state of economic security and isolation in which all forms of competition are lacking … it is a pleasant, easy-going life, filled with a plenitude of laughter.

With rocky coasts and a reputation for head-hunting savages (clearly false), ship wrecks and malaria, the island was bypassed by Europeans as well as closer neighbors. Colonialism came late to the island, first Japanese (1895–1945), then Taiwanese (since 1945). The Japanese initially kept the island as an anthropological research site. Leach observed that barter was just being introduced by the Japanese, who were also exercising the Tau in the use of currency. There are elders today who were born into a community unaccustomed to practicing barter, let alone trade through currency.

Colonial influence escalated with Taiwanese culture assimilation policy (1947), dispossession of land (1951), establishment of a prison largely for political dissidents (1958–1979), topocide of traditional villages (1966–1980), exploitative tourism (since 1967), strip-logging roughly half the forest (1970s) and dumping nuclear waste (since 1982). Taiwan's gaze on Pongso no Tau accurately fits James C. Scott's (1998: 4–5) description of *Seeing like a state*:

> The most tragic episodes of state-initiated social engineering originate in a pernicious combination of four elements … administrative ordering of nature and society … a high-modernist ideology … an authoritarian state that is willing and able to use the full weight of its coercive power to bring these high-modernist designs into being … [and] a prostrate civil society that lacks the capacity to resist these plans.

Not understanding what private ownership of land means, not knowing what radioactive waste is, not having any tradition of powerful leaders or competitiveness, the Tau capacity to resist these events was weak, however resilient their culture is otherwise. Pongso no Tau appears to be on the verge of becoming yet another "local, capital-intensive, and sustainable system … abandoned as a direct consequence of colonial expansion" (Widgren 2007: 68). In recent years, however, the Tau have begun to turn the tide in efforts to regain power over their island home.

Power: relating landesque capital and ecologically unequal exchange

Each of the processes of ecologically unequal exchange and formation of landesque capital highlighted in these historical synopses can be analyzed in more detail as manifestations of power relations positioning them in a regional- and world-system, in terms of dimensions of power (Boyce 2002) and competing forms of capital (Bayliss-Smith 1997). Early environmental degradation of Kinmen reflects above all the decision power of core over periphery: Thou shall produce salt! The extraction of open access resources on Penghu, both coral and fish, appear also to reflect decision power, though value power exercised in marketing coral jewelry in distant markets is also involved, as well as agenda power deployed to keep coral extraction and over-fishing out of public debate. The struggle over casino development was largely determined through wielding agenda power and value power, though the premature construction of large hotels may be seen as an expression of event power, altering the circumstances in which the Penghu citizens had to choose (impressive buildings, already there – they may as well be put to good use). Environmental load displacement from Taiwan to Pongso no Tau, extraction of timber, comprehensive dispossession and the wholesale destruction and abandonment of landesque capital on the island display striking asymmetry in power relations across all dimensions.

Much of the landesque capital referred to in these nutshell histories draws on local resources and appears to fulfill the normative requirement of "enduring beneficial changes" suggested by Brookfield (2001: 185): the beehive fields and stone weirs on Penghu; the taro fields and selective forestry for boats on Pongso no Tau. But Kinmen presents two significant deviations. First, the landesque capital invested in to produce salt – modifications of land for the purpose of increasing its productivity – clearly contributed to land degradation, turning the island into a veritable desert. Second, and more interesting, are the massive investments in landesque capital from the 1950s to the 1990s, especially in reforestation and water management. Much of the cement for construction of water management works and fertilizers for soil improvement was extracted or produced on Taiwan, involving localized environmental degradation there. The massive amounts of labor required for reforestation likewise came from Taiwan – again, ecologically unequal exchange, with environmental benefits in the formation of landesque capital to Kinmen, environmental burdens to Taiwan. It is not difficult to find examples where the formation of landesque capital in one place is related to socio-ecological degradation elsewhere, through flows of matter and power (see Table 4.2).

But the connections do not stop there. On both Penghu and Pongso no Tau it appears that an analytically quite distinct consequence of ecologically unequal exchange involves abandonment of landesque capital. On Penghu, the environmental burden of reduced fish stock carried by Penghu was exacerbated by the devaluation and abandonment of landesque capital in stone weirs. On Pongso no Tau, exchange with Taiwan drives out-migration. Decline in available labor

Table 4.2 Landesque capital in relation to ecologically unequal exchange

Island	*Landesque capital*	*Ecologically unequal exchange*
Kinmen	Facilities for salt production	Degradation of environment due to resource extraction for export to mainland
Kinmen	Reforestation, water management infrastructure, soil improvement	Improvement of environment through import of labor, cement, fertilizers, etc. from Taiwan
Penghu	Anthropogenic soils, field walls, fish weirs	Initially locally generated improvements with little exchange; later abandonment due to excessive extraction by fisheries
Penghu	Cage aquaculture, harbors	Degradation of environment due to resource extraction for export, and to import of cement
Pongso no Tau	Stone-walled fields with irrigation channels	Initially locally generated with almost no exchange; later abandonment due to out-migration, remittances and compensation payments, and imports

power to maintain landesque capital results in deterioration and abandonment, aggravated by remittances and compensation payments for nuclear storage in combination with import of groceries. Destruction, abandonment or devaluation of landesque capital is an important element in the balance sheet of ecologically unequal exchange.

Another form of environmental degradation exemplified on Pongso no Tau is related neither to exchange nor to landesque capital, but is rather straightforward environmental load displacement, e.g., establishment of a prison and a nuclear waste storage site on the island. Finally, we should recognize that much ecologically unequal exchange is generated by the penetration of productive and finance capital into spaces where landesque capital has historically prevailed. The impact of competing forms of capital on the management or abandonment of landesque capital may be analytically distinguished from relations between landesque capital and ecologically unequal exchange, but in the historical political-ecological contexts of capital flows and struggles over place, they are highly enmeshed.

Torsten Hägerstrand suggested that "Modes of acquiring, keeping and using space is the key to how the weave of existence is formed into the future"; he went on to argue that "Within the living world, reach may be considered a phenomenon of similar rank as gravity in physics" (Hägerstrand 2009: 135, 163; our translation). The ways we presently reach out are not sustainable. Though certainly not limited to islands, we see this more clearly in island contexts. Islands provide valuable learning from experiences of alternative modes of acquiring, keeping and using space, and more sustainable ways of reaching out for desired resources. It is crucial, in order to facilitate this learning (and for other good reasons as well), that island development be in the hands of islanders.

Notes

1 Historical examples of island cultures that have evolved in near-total isolation for centuries include Nauru, Easter Island and Pongso no Tau. These are exceptions to the rule that the human history of the Pacific Islands involved regular exchange between islands (Terrell 1986) based on navigational knowledge and seafaring skills beyond the conceivable realm of recognition for early European explorers (Davis 2009).

2 Harvey identifies the landed developer as "a singular principle power that has yet to be accorded its proper place in our understanding of … the historical geography of capitalism." He continues:

> The power of land and resource owners has been much underestimated, as has the role of land and resource asset values and rents in relation to the overall circulation and accumulation of capital.… [R]ent has to be brought forward into the forefront of analysis … Only in this way can we bring together an understanding of the ongoing production of space and geography and the circulation and accumulation of capital.
>
> (Harvey 2010: 180–183)

Space does not allow for a fuller consideration of the place of landesque capital in land rent theories. The notion of durable improvements to land contributing to land rents goes as far back as William Petty's *Political Arithmetick* (1690). See Clark (1987) for a historical overview of land rent theories.

3 The island figures on Chinese, Japanese, Dutch, Portuguese and British maps with various names, most commonly Koto-sho (Japanese) or Botel Tobago (British and American). The ROC government named it Lanyu (Mandarin for Orchid Island, currently its English name) in 1946.

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5 Guano

The global metabolic rift and the fertilizer trade

Brett Clark and John Bellamy Foster

The appropriation of resources from distant lands for commerce and war has long been part of human civilization and has been associated with various forms of environmental degradation. However, since the late fifteenth century, capitalism has been the hegemonic economic system, influencing social relationships, transforming landscapes, and shaping patterns of material exchange. It is a system predicated on the constant accumulation of capital. Its internal laws propel it forward, subsuming the world to the logic of capital – all the while generating contradictions and divisions. Capitalist expansion determines relationships of exploitation, ecological degradation, and unequal ecological exchange. While the specific forms and manifestations of these conditions depend upon the historical context and the demands of economic production, the ecologically unsustainable nature of the capital system is evident in how it employs land, resources, and labor in the accumulation process.

Ecological degradation is influenced by the structure and dynamics of the world capitalist system, whereby a single world economy is divided into numerous nation-states, competing with one another directly and via their corporations. Nations occupy fundamentally different positions in the international division of labor and in the world system of dominance and dependency. The transfer of economic values in the accumulation process also involves material–ecological flows that transform ecological relations between regions, especially the core and periphery. Control of monetary and material exchange generates social and environmental inequalities. Stephen Bunker (1985) examined how the extraction and export of natural resources from periphery countries involved the vertical flow of not only economic value, but also energy and matter to developed countries. These trade arrangements, influenced by the dynamics of the global economy and positions within the world-system, negatively affected and undermined the socio-ecological conditions in extractive countries. In other words, core capitalist nations compensate for the degradation of their own environments through the even more rapacious exploitation of the natural resources of periphery countries, creating an "environmental overdraft" that benefits the former at the expense of the latter (Elvin 2004: 470; Hornborg 2003; Jorgenson 2006).

In this chapter we employ metabolic analysis to consider how the unsustainable practices of capitalist agriculture produce environmental problems that generate global asymmetries in the exploitation of the environment and contribute to unequal ecological exchange. In what follows, we present the metabolic character of capital. We detail how the metabolic rift in the nutrient cycle in Britain and other capitalist states in the nineteenth century led to the rise of the international fertilizer trade in guano. We then discuss the guano rush and the trade of this prized fertilizer. We also examine the exploitation of land and labor that accompanied this trade.

Capitalism, metabolism, and metabolic rifts

The concept of metabolism was established within both chemistry and biology in the early nineteenth century for studying the chemical processes within organisms and the biological operations of organisms. It captures the complex biochemical processes of exchange, through which an organism draws upon matter and energy from its environment and converts these by various metabolic reactions into the building blocks of growth. The metabolism concept allowed scientists to document the specific regulatory and relational processes that direct interchange within and between systems – such as organisms digesting organic matter. Marx incorporated this concept, but in a much broader context, into all of his major political-economic works, using it to analyze the social metabolism of the capital system and, by extension, the dialectical interchange between humans and their environment. By necessity there is a "metabolic interaction" between humans and the earth, as the latter supports life. Through the labor process, humans transform the world and themselves. For Marx (1975: 209), labor is "an eternal natural necessity which mediates the metabolism between man and nature, and therefore human life itself." Such a conception is two-sided. It captures both the social character of labor, associated with such metabolic reproduction, and its ecological character, requiring a continuing, dialectical relation to nature.

Marx's conception of the metabolic process conforms to modern science. As the great physicist Erwin Schrödinger (1945: 71–72) wrote in *What Is Life?*:

> How does the living organism avoid decay? The obvious answer is: By eating, drinking, breathing and (in the case of plants) assimilating. The technical term is *metabolism*. The Greek word … means change or exchange. Exchange of what? Originally the underlying idea is, no doubt, exchange of material.

Marx's metabolic analysis viewed socio-ecological systems as dependent for their regeneration upon specific metabolic processes involving complex historical relationships of interchange and reproduction (Foster 2000). Natural systems, such as the nutrient cycle, have their own metabolism, which operate independently of and in relation to human society. Due to the interpenetration of society and nature, humans have the potential to alter the conditions of life in ways that undermine the reproduction of natural systems. Each mode of production imposes a particular system of labor and exchange that shapes the society–nature relationship.

In assessing actual metabolic interactions, Marx examined the constantly evolving set of needs and demands that arose with the advent and development of the capitalist system, which transformed the social interchange with nature, directing it toward the constant pursuit of profit. He highlighted this change in *A Contribution to the Critique of Political Economy*, explaining that

> the exchange of commodities is the process in which the social metabolism, in other words the exchange of particular products of private individuals, simultaneously gives rise to definite social relationships of production, into which individuals enter in the course of this metabolism.
>
> (Marx 1972: 51–52)

Use of the concept of metabolism here was meant to draw attention both to the metabolic exchange between nature and humanity – the underlying condition of human existence – and also to the reality of social metabolic reproduction. The latter expresses the fact that social formations as organic systems have to be seen as continuing and developing processes. They therefore need to be analyzed in terms of the totality of the relations of exchange (and relations of social production/reproduction) that constitute them. The constant reproduction of capital on an ever-larger scale intensifies the metabolic demands on nature, necessitating new social relations and forms of socio-ecological exchange. As capital subsumes the world to its logic of accumulation, due to the persistent pursuit of profit, it runs roughshod over the regulatory processes that govern complex relationships of interchange within natural systems and cycles (Mészáros 1995).

Capitalism, as a social metabolic order, produces various global inequalities and ecological contradictions. Marx (1976: 915) detailed how the process of primitive accumulation during the rise of capitalism as a global economy established divisions between the core and periphery, as the wealth of distant lands was appropriated and transferred to core nations using various forms of labor exploitation, such as slavery. In its drive to constantly expand and replenish itself, capital seeks to overcome whatever social and natural barriers it confronts (Marx 1993: 409–410). It often transforms landscapes in one location to further capital accumulation, only to exhaust the desired resources, before moving to another location to repeat the same process. As a result, distant lands, ecosystems, and labor become mere appendages to the growth requirements of the advanced capitalist center. For Marx, England, as the leading capitalist country at the center of a world-system, was "the metropolis of landlordism and capitalism all over the world" drawing on the resources of the globe. A whole nation like Ireland could be turned into "mere pasture land which provides the English market with meat and wool at the cheapest possible prices" (Marx and Engels 1972a: 290–292). Nothing so demonstrated this unequal ecological exchange in the nineteenth century as the international guano trade that arose to compensate for the "environmental overdraft" that characterized industrial agriculture in Europe and the United States.

In order to understand the emergence of the international fertilizer trade, it is necessary to present how industrial agriculture in Britain and other nations created an environmental problem – the depletion of soil nutrients – for which guano was deemed a solution. In the 1840s, Germany's leading chemist, Justus von Liebig, along with other agricultural chemists and agronomists, sounded the alarm with respect to the loss of soil nutrients – such as nitrogen, phosphorus, and potassium – through the transfer of food and fiber to the cities. Rather than being returned to the soil to replenish it, as in traditional agricultural production, these essential nutrients were shipped hundreds, even thousands, of miles and ended up as waste, polluting the cities and waterways.

John Chalmers Morton (1859), who studied the application of mechanical power in agriculture, noted that agricultural improvements increased the uniformity of land, making it easier to increase the scale of operations and to employ industrial power within agricultural operations. Marx (1976: 497–498) was a devoted student of Liebig's work and studied Morton when writing *Capital*. He incorporated a metabolic analysis into his critique of political economy, indicating that an economic system premised on the accumulation of capital led to intensive agricultural practices to increase the yield of food and fiber for markets. Just as this system had imposed a division of labor, it simplified natural systems and created divisions within nature, within natural cycles. Thompson (1968) indicates that during this transformation of agriculture, farmers increasingly had to purchase inputs – due to the loss of nutrients – to maintain operations. In this, farming increasingly took the form of "a manufacturing industry," which increased the "intensity of cultivation" (Thompson 1968: 64). Marx (1991: 950) lamented how capitalism degraded labor and nature under these conditions:

> Large-scale industry and industrially pursued large-scale agriculture have the same effect. If they are originally distinguished by the fact that the former lays waste and ruins labour-power and thus the natural power of man, whereas the latter does the same to the natural power of the soil, they link up in the later course of development, since the industrial system applied to agriculture also enervates the workers there, while industry and trade for their part provide agriculture with the means of exhausting the soil.

The accumulation process and the division between town and country influenced the transfer of nutrients and the conditions of the soil. Marx (1976: 637) pointed out that capitalist agriculture

> disturbs the metabolic interaction between man and the earth, i.e. it prevents the return to the soil of its constituent elements consumed by man in the form of food and clothing; hence it hinders the operation of the eternal natural condition for the lasting fertility of the soil.

In other words, a metabolic rift in the nutrient cycle was created under these productive relations, which squandered of the riches of the soil, undermining the everlasting nature-imposed conditions of human existence.

Horrified by the scale of soil degradation, Liebig (1859: 130–131) exclaimed,

> Truly, if this soil could cry out like a cow or a horse which was tormented to give the maximum quantity of milk or work with the smallest expenditure of fodder, the earth would become to these agriculturalists more intolerable than Dante's infernal regions.

He explained that British high farming (early industrialized agriculture) looted the soil of its nutrients. Upon exhausting its soil nutrients, Britain then sought to compensate for this by robbing other countries of the means needed to replenish their own soil. He wrote:

> Great Britain deprives all countries of the conditions of their fertility. It has raked up the battle-fields of Leipzic, Waterloo, and the Crimea; it has consumed the bones of many generations accumulated in the catacombs of Sicily.... Like a vampire it hangs on the breast of Europe, and even the world, sucking its lifeblood without any real necessity or permanent gain for itself.
>
> (Quoted in Mårald 2002: 74)

Marx, too, referred to the imperialist exploitation of the soil nutrients of whole countries – developing out of the metabolic rift in the nutrient cycle. "England," he observed, "has indirectly exported the soil of Ireland, without even allowing the cultivators the means for replacing the constituents of the exhausted soil" (Marx 1976: 860). As capitalism expanded, increasingly importing food and fiber from abroad, so did the metabolic rift. Marx (1976: 579–580) indicated that capitalist growth serves the interests of the "main industrial countries, as it converts one part of the globe into a chiefly agricultural field of production for supplying the other part, which remains a pre-eminently industrial field." In this, the abuse and "misuse" of "certain portions of the globe ... depends entirely on economic conditions" (Marx 1991: 753).

The degradation of the soil in core nations hastened the concentration of land among a smaller number of proprietors, who adopted even more intensive methods of production, including the mass importation of manures and eventually the application of artificial fertilizers. For Marx (1991: 949), capitalist agriculture, and by extension capitalism in general, created an "irreparable rift" in natural cycles. Successive attempts to address the soil nutrient problem, moreover, transformed this into a global metabolic rift resulting from the disproportionate transfer of matter and energy from the periphery to the core. Put differently, in order to compensate for the effects of their robbing of their own soil, European nations and the United States sought to rob other countries of their soil nutrients, creating a global metabolic rift.

The guano trade

In the nineteenth century, the guano trade brought together China, Peru, Britain, and the United States in a system of extreme resource and human exploitation that stretched across the entire capitalist world economy. Guano was deemed a precious commodity that would help replenish lost soil nutrients in advanced countries. The international guano trade is tied to soil depletion in the core, the advance of soil science, the transformation of landscapes, the transfer of human populations, the exploitation of nature and peripheral nations, and the integration of the global economy. It highlights the environmental overdraft that contributed to European prosperity while hiding the extent of the ecological degradation of industrial capitalism.

The existence and use of guano as fertilizer had been known for centuries in Europe, but its importance to European and US agriculture was not immediate, given the particular economic conditions and the state of agricultural science. In 1604, an English translation of Father Joseph de Acosta's book, *The Natural and Moral History of the Indies*, was published. De Acosta (1880: 281) detailed how important the seafowl and guano were to the indigenous population of Peru:

> In some Ilands and headlands, which are ioyning to the coast of Peru, wee see the toppes of the mountains all white, and to sight you would take it for snow, or for some white land, but they are heapes of dung of sea fowle which seems but a fable. They [the indigenous peoples] go with boates to these Ilands onely for the dung, for there is no other profit in them. And this dung is so commodius and profitable as it makes the earth, yeelde great aboundance of fruite. They cal this dung Gauno, wherof the valley hath taken the name, which they call Lunahuana in the valleys of Peru, where they vse this dung, and it is the most fertile of all that countrie.

In the seventeenth century, the use of guano for agriculture was a subject of endless fascination. However, advances in the science of soil chemistry, specifically the nutrient relationship between soil and plants, did not occur until the nineteenth century.

At the beginning of the nineteenth century, the German explorer Baron Alexander von Humboldt observed how Peruvian farmers used guano to enrich their dry farm lands (Skaggs 1994). He took samples of guano back to Europe in 1803, but there was no drive then to study this particular substance. However, as soil depletion intensified, so did the need for fertilizers, stimulating business interests in the potential application of guano. In the 1820s, tests were conducted to assess the chemical composition of guano in comparison to the requirements of plants and the nutrients lost through crop production. Guano contained high concentrations of phosphate and nitrogen. In 1835, a few cases of guano were imported to Great Britain to test the dung on crops. Guano proved to be a powerful fertilizer. The possibility of high returns seemed promising, given that the increase in yields surpassed what was calculated as the likely costs of guano importation.

Advances in soil science furthered interest in guano. In 1840, Liebig published *Organic Chemistry in its Application to Chemistry and Physiology*, detailing how modern farming practices and the division between town and country contributed to the loss of soil nutrients. In the same year, Alexandre Cochet, a French scientist, discovered that valuable quantities of nitrate of soda could be extracted from guano and nitrates (saltpeter), both of which were abundant in Peru, helping stimulate the rush for guano (Skaggs 1994). Guano was soluble, so it was fast-acting, and provided an immediate influence on the growth of plants. The problem of soil degradation in Britain and the United States sparked the international guano rush, as agriculturalists sought the precious fertilizer to compensate for the soil nutrients they were losing.

Peru had the largest deposits of high-quality guano. Its guano contained the highest concentration of nutrients that were useful to crops. It rarely rained on the coast of Peru, and as a result the nutrients in the guano were not washed away, as they were on other islands and coasts throughout the world. The mountains of guano that de Acosta described were on the Chincha Islands off the coast of Peru. These islands served as a habitat to numerous species of sea birds. The ocean currents surrounding these islands created an upflow of decayed matter, sustaining a massive population of anchovies, which the birds ate and deposited as waste on the rocks. The anchovy diet greatly enriched the usefulness of the dung produced by the birds. The guano deposits, hundreds of feet deep, had accumulated over thousands of years (Peck 1854).

In the 1840s, Peru was still in debt to Britain for monies borrowed during the fight for independence from Spain. Guano offered an avenue for Peru to meet its debt payments and gain foreign exchange through the sale of guano contracts. Lima was at the time the richest city in South America. Although there were a number of contracts between the Peruvian government, acting on behalf of the Lima oligarchy, and European businesses (primarily British, but also French) during the duration of the guano trade, which thrived for 40 years, the dominant trade agreement was between Lima and the British firm Anthony Gibbs & Sons. The company holding the contract with the government had exclusive rights over the sale of guano on the global market. As a result, Britain dominated the global guano trade.

The government of Peru claimed ownership of the guano (Mathew 1972, 1977, 1981). Peruvian subcontractors, who were granted contracts from the government, were placed in charge of the digging and loading process. Lima repeatedly renegotiated the Peruvian guano contracts, trying to get a better deal. In addition to receiving a specified amount of money per ton of guano shipped, the government borrowed money against the contracts. Much of the money made via the sale of guano was directed toward paying off the existing and accumulating debt taken out by the Lima oligarchy, in a classic case of imperial dependency.

In 1841, the first full cargo of guano arrived in Britain. The manure was quickly sold on the market, stimulating interest to secure more guano. An advertising campaign was conducted to promote the use of guano. Gibbs & Sons (1843) published *Guano: Its Analysis and Effects*, which collected the stories of farmers who tested guano fertilizer on their crops. These accounts detail the various techniques of guano application and the results, praising the powers of guano to make plants grow taller, stronger, and more productive. Claims were made that the soil was richer, as the nutrients were retained for several crop rotations. While this book served as a marketing ploy, its conclusion was clear: increased yields could be obtained using a "cheap" fertilizer. Other publications tested guano against other fertilizers, employing Liebig's work on the loss of soil nutrients (Sheppard 1844; Smith 1843; Solly 1843; Trimmer 1843). These tests heralded the triumphs of guano as far as its ability to meet the nutrient needs of crops. Guano became an obsession, seeming to offer an escape from the ecological contradiction that had been created.

Marx (1976: 348) noted that the "blind desire for profit" had "exhausted the soil" of England, forcing "the manuring of English fields with guano" imported from Peru. Industrialized capitalist agriculture had fundamentally changed the nutrient cycle. Agriculture was no longer "self-sustaining" as it "no longer finds the natural conditions of its own production within itself, naturally, arisen, spontaneous, and ready to hand" (Marx 1993: 527). Britain was not the only country confronting severe losses in soil nutrients. Farms in upstate New York and plantations in the southeastern United States were in desperate need of powerful fertilizers (Genovese 1967). Thus, both merchants and agriculturalists from Britain and the United States sought the fertilizer to compensate for the soil nutrients they were losing (Skaggs 1994).

Given the British trade monopoly on Peruvian guano supplies, the United States pursued imperial annexation of any islands thought to contain guano deposits. In 1856, Congress passed the Guano Islands Act, allowing capitalists to seize 94 islands, rocks, and keys around the globe between 1856 and 1903 (Skaggs 1994). "In the last ten years," Liebig observed in 1862, "Britain and American ships have searched through all Seas, and there is no small island, no coast, which has escaped their enquiries after guano." But, in the end, the deposits on the islands of Peru were the best, given the ideal natural conditions to preserve the nutrients.

For 40 years, Peru remained the most important country for meeting European and North American fertilizer needs. During this period, millions of tons of guano were dug, loaded, and shipped from Peru. In 1850, Britain imported over 95,000 tons of guano (Mathew 1968: 562–579). The following year, almost 200,000 tons were imported; by 1858, over 302,000 tons. From 1863 to 1871, the imports per year ranged from 109,000 tons to 243,000 tons. As noted above, guano was not only exported to Britain; from 1866 to 1877, Peru exported between 310,000 and 575,000 tons per year to the world as a whole, helping enrich stressed soils (de Secada 1985: 597–621).

The Chincha Islands, with deep guano deposits, were a site of constant activity. In the early 1850s, a British officer reported witnessing the simultaneous loading of guano on 100 ships, representing 11 different countries, primarily from the United States and Europe, from a single island off the coast of Peru (Dennis 1931; Farcau 2000). Additionally, hundreds of other large ships would be waiting at sea for a turn to be loaded ("Guano Trade" 1856; Nash 1857).

Despite the millions of tons of guano that were exported from Peru, international demand could not be met. Inferior guano deposits on islands throughout the world were mined and sold on the market. Off the African coast, an island with substantial guano deposits had 460 ships on one day, simply waiting to fill up with the cargo. In a short period of time, the "island [was] reduced to nothing but a plateau of bare rock" (Craig 1964: 35–37). The guano trade suffered setbacks, as inferior guano was packaged and sold with false labels, claiming it was Peruvian guano. Farmers became leery of guano on the market, but the necessity for fertilizer remained, given the metabolic rift in the nutrient cycle.

The guano trade transformed Peru in a number of ways. In the early 1800s, silver was the primary export of Peru. After Peru's independence, Britain quickly forged trade relations, importing wool and cotton. While Peru desired trade protection, Britain worked to reduce tariffs and duties, desiring free trade. Once the guano trade was established, this resource became the primary export commodity. Guano supplied 5 percent of state revenue in 1846–1847. In 1869 and 1875, 80 percent of state revenues came from the guano trade (Bonilla 1987: 225). The terms of trade continued to decline, as Peru was forced into accepting liberal policies which favored metropolitan capital in the imperial states (Hunt 1973). The export economy failed to help the domestic economy. The Lima oligarchy spent money on luxury items, rather than social development, on paying interest on loans, and on the building of rails. At the same time, much of the infrastructure of the country, such as its irrigation systems and roads, fell into disrepair (Duffield 1877). It was dependent on foreign nations for general commodities.

During this period, Peru was plagued by the resource curse. It had the most treasured fertilizer in the world, which was needed by core capitalist nations, but Peru remained in debt to bondholders. The Peruvian ruling class profited heavily from the guano trade. Some of the money was used to help rich landowners enlarge their sugar and cotton operations. In particular, Domingo Elías, who handled contracts related to the extraction of guano, purchased more land and extended his plantation operations. He helped transform the agricultural sector into a producer of cash crops (such as cotton and cochineal) for export to Europe and the United States, transferring the riches of the soil to more developed nations (Blanchard 1996; Gorman 1979). Liebig and Marx noted that through incorporation into the global capitalist market and long-distance trade, the earth was robbed of its richness, the soil was depleted of its nutrients, and the separation between town and country increasingly became international. These conditions and consequences were only exacerbated through the exportation of guano and the production of cash crops, increasing the global metabolic rift. In spite of this trade, Peru remained a country in debt and one with vanishing resources.

The guano trade transformed the natural landscape of Peru, especially the islands where guano was mined. In *Peru in the Guano Age*, A.J. Duffield (1877: 89), who took measurements to estimate the remaining guano deposits, describes the changes that had taken place:

> On my return from the south [part of Peru] we passed close to the Chincha islands. When I first saw them twenty years ago, they were bold, brown heads, tall, and erect, standing out of the sea like living things, reflecting the light of heaven, or forming soft and tender shadows of the tropical sun on a

> blue sea. Now these same islands looked like creatures whose heads had been cut off, or like vast sarcophagi, like anything in short that reminds one of death and the grave.

The guano deposits that took thousands of years to accumulate were being depleted. Boussingault (1845: 290), a French soil scientist, noted that since guano had become “a subject of the commercial enterprise of mankind” its reserves were quickly disappearing. The rate of extraction was faster than the rate of natural accumulation. To make matters worse, the prospect for additional excrement was questionable, given that the extraction of guano was executed without regard to the needs of the birds, which were driven away and/or slaughtered in some cases (Murphy 1925: 55–56). The natural fertilizer that had been used for hundreds of years in Peru was being exported and diminished, as the social metabolic order of the capitalist world-system expanded.

Chinese coolies and guano extraction

The guano trade not only involved the shipping industry and the distribution of manure on fields, but also necessitated a labor regime to extract the materials from the islands. In the pursuit of profit, both Peru and Britain contributed to the global movement and exploitation of labor. In the 1840s Peru had a labor shortage for its plantations and mines. The government passed “an immigration law subsidising the importation of contract labourers” (Gonzales 1955: 390–391). Anyone who imported “at least fifty workers between the ages of 10 and 40” was paid 30 pesos per head. Exploiting decades of social disruption due to the Opium Wars and the Taiping Rebellion in China, European merchants began the systematic transfer of Chinese laborers to Cuba and Peru (Hu-DeHart 1989, 2002). Through coercion, deceit, and even kidnapping – often by the same individuals and companies who had engaged in the slave trade – tens of thousands of Chinese “coolies” were contracted for through Macao and Hong Kong (Clayton 1980; Hu-Dehart 1989). The voyage by ship (otherwise known as a “floating coffin”) to Peru took approximately five months. During this passage, the Chinese coolies were provided with a meager ration of rice. The mortality rate during the first 15 years of the trade was 25–30 percent. To escape the horrible conditions, some Chinese in passage “jumped overboard [if and when allowed on deck] to put an end to their sufferings” (Wingfield 1873: 4). Marx and Engels characterized the labor of “Indian and Chinese coolies” as “disguised slavery,” and they reveled in stories of “the very coolies” on ships destined for the Americas and elsewhere rising “in mutiny,” as happened a number of times during passage (Marx 1963: 112; Marx and Engels 1972b: 123).

The first Chinese coolies or indentured manual laborers arrived in Peru in 1849. Between 1849 and 1874, over 90,000 Chinese coolies were shipped to Peru. Around 9,700 died during passage (Gonzales 1955: 390–391). The majority of coolies worked on the sugar and cotton plantations and built the railroads. However, many were forced to work on the guano islands. Of the three realms of employment, the guano islands had the worst labor conditions. For many years, Domingo Elías held the contract for operating the extraction of guano. He employed coolies, but also used convicts, army deserters, and slaves to work the guano islands. The work force on these islands varied through the years, but often involved between 200 and 800 individuals.

The extraction of guano required digging into mounds of excrement that covered rocky islands. The capital outlay for extraction was minimal. The most expensive items were the bags into which guano was loaded. Using picks and shovels, coolies were required to dig through the layers of guano, filling sacks and barrows. Each worker had to load 80–100 barrows each day. Once the barrows were filled, the workers hauled the guano to a chute to transfer it to the ships. If the workers failed to move between two to five tons during the day, they were physically punished. On occasion over 20,000 tons were said to be extracted from the islands in a day ("Guano Trade" 1855; Mathew 1977; Nash 1857).

George W. Peck (1854: 207) visited the islands and noted that the Chinese were "over-worked beasts of burden," forced to "live and feed like dogs." The guano islands, he stressed, "seem to me to be a kind of human *abattoir*, or slaughter-house of men" (Peck 1854: 204). The emaciated bodies of the workers struggled to carry sacks of guano and to push the barrows. A visitor to the islands pointed out that: "The poor coolies have no hope or reward, no days of rest … what a hell on earth these islands must be" ("Chincha Islands" 1854). Acrid dust penetrated the eyes, the noses, and the mouths of workers. The stench was appalling, and sometimes overwhelmed workers. Duffield (1877: 77–78) noted:

> No hell has ever been conceived by the Hebrew, the Irish, the Italian, or even the Scotch mind for appeasing the anger and satisfying the vengeance of their awful gods, that can be equalled in the fierceness of its heat, the horror of its stink, and the damnation of those compelled to labour there, to a deposit of Peruvian guano when being shoveled into ships.

Infractions by workers were met by severe punishment, such as flogging, whipping, or being suspended for hours in the sun. Some workers were branded on the cheeks with hot irons. Suffering from an inadequate diet, physical cruelty, and the inability to escape from the stench of the guano, many Chinese committed suicide by jumping off the cliffs and into the ocean. Peruvian employers attempted to stymie revolt by working with the British to import opium to pacify Chinese workers ("Chincha Islands" 1854; Clayton 1980; Hu-Dehart 1989: 108–109; Wingfield 1873: 5).

Although coolies were not legally slaves, they lived in de facto slavery or worse. As prisoners, unable to leave the islands, they received minimal monetary returns. They lived in barracks that were guarded by armed men (Wingfield 1873: 5). In an account of the Chincha Islands, Alanson Nash (1857) noted that "Once on the islands [a coolie] seldom gets off, but remains a slave, to die there." The cruelty imposed upon the Chinese laborers was inseparable from reports regarding the guano trade. The coolies were driven as expendable beasts: "As fast as death thins them out, the number is increased by new importations" of coolies who are thus "sold into absolute slavery – *sold by Englishmen into slavery* – the worst and most cruel perhaps in the world" ("Chincha Islands" 1854). Working under the whip, the cruelties were "scarcely believable, and very few, if any, of the Chinese survived more than a few months." Workers would fall "exhausted and dying by the side of the shute through which the fertilizer was passed into the hold of the vessel" ("Chinese Coolie Trade" 1862: 221). "Those Chinese who did not commit suicide by some means or other speedily succumbed to overwork, breathing the guano dust, and a want of sufficient food" (Lubbock 1955: 35).

The connection between the fertilized fields of Britain and the exploitation of Chinese workers did not escape the British consciousness. Writing in *Nautical Magazine* in 1856, a correspondent observed that the powers of guano as a fertilizer were well known,

> but few probably are aware that the acquisition of this deposit, which enriches our lands and fills the purses of our traders, entails an amount of misery and suffering on a portion of our fellow creatures, the relation of which, if not respectably attested, would be treated as fiction.
>
> ("Chincha Islands" 1856)

The *Morning Chronicle* wrote that the conditions of labor on the guano islands "seems to realise a state of torment which we could hardly have conceived it possible for man to enact against his fellow man" (Mathew 1977: 44). The *Christian Review* ran a story about the Chinese coolie trade, noting that "the subtle dust and pungent odor of the newfound fertilizer were not favorable to inordinate longevity," creating a constant demand for more workers, given that guano labor involved "the infernal art of using up human life to the very last inch" ("Chinese Coolie Trade" 1862). For Marx, writing in the *New York Daily Tribune* on April 10, 1857, Chinese coolies were being "sold to worse than slavery on the coast of Peru" as a result of British imperialism (Marx and Engels 1972b: 106). Even some shipmasters, upon delivering their cargo of coolies in 1854, were "horrified at the cruelties they saw inflicted on the Chinese, whose dead bodies they described as floating round the islands" (Wingfield 1873: 5).

Despite public outrage regarding the treatment of the Chinese coolies on the guano islands and attempts to end the coolie trade, British merchants continued to transport "hundreds of thousands of … indentured servants to British colonies" around the world (Gonzales 1955: 391). Ironically, in Peru, the success of the guano trade and the cheapness of importing Chinese coolies as workers made it possible for slavery to be abolished in the 1850s. Coolies were simply acquired to replace the freed slaves. Slaveholders, such as Elías, who pushed to pass a bill that would subsidize the importation of Chinese laborers, were compensated for the loss of the slaves that were now free. At the same time, Elías and other businessmen profited from the importation of coolies.

The labor process on the guano islands was quite simple, depending primarily on human labor to make the guano useful. In order to sustain the large profits and control over the workers, the process was not modernized. Despite the millions of tons of guano that were being exported from Peru, international demand could not be met. The asymmetrical movement of natural resources – the unequal ecological exchange of resources – to meet imperial interests was intimately connected to the exploitation of human labor under inhuman conditions.

Conclusion

Intensive, industrial practices in agriculture, along with the divide between town and country, created a metabolic rift in the nutrient cycles in core countries. In order to enrich the soil in Britain and other core nations, an international trade in guano was established, transferring millions of tons of this powerful fertilizer from Peru to the global North. In this "environmental overdraft" the metabolic rift was extended to the global level, as fertilizer and agricultural goods – as well as the soil nutrients embodied in the food and fiber – were transferred to urban centers within the core. Imported labor from China worked as "beasts of burden" mining the guano. These workers were physically beaten and lived short lives to enrich the soils of distant lands. The international fertilizer trade ushered in decades of civil unrest, war, debt, and ecological degradation. Given the global asymmetries in the international hierarchy of nations, the resource curse accompanied this prized commodity. As guano supplies dwindled, nitrates served as the new fertilizer, creating conflict and war between Peru and Chile, which resulted in the British exercising greater control over this vital resource (see Clark and Foster 2009). The Haber–Bosch process that produces ammonia through the fixation of nitrogen allowed artificial fertilizer to be produced on an industrial scale shortly before World War I. This new industry undermined the international trade of guano and nitrates. As a "technological fix" (see Clark and York, this volume), it increased the industrialization of agriculture, without attending to the source of the metabolic rift in agriculture.

Capitalism's endless pursuit of profit continually worsens environmental conditions and presses against ecological boundaries. The worst forms of degradation, as well as the pillaging of resources and the disruption of sustainable relations to the earth, are concentrated in the periphery. Unequal ecological exchange, an outcome of the global metabolic rift, has allowed for the growth of the center of the system at unsustainable rates. The global metabolic rift in the nutrient cycle is simply one manifestation of the ecological problems generated by the social metabolic order of capital. To mend the ecological rifts requires revolutionary transformations in our metabolic relation to nature, surmounting the logic of capital in order to pursue a sustainable social order.

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6 Fleece

Imperial metabolism in the pre-Columbian Andes

Ragnheiður Bogadóttir

The archaeological and historical records of the Andean region of South America hold plenty of evidence of the economic, political, and ritual importance of textiles in the ancient Andes. In the coastal regions textiles were primarily made from cotton, but in the Andean highlands, from where the Incas expanded their realm in the century prior to the European invasion, the favored raw material for textile production was camelid[1] fleece (A. Rowe 1997: 6; Boytner 2004: 133). Setting the phenomenon of late pre-Hispanic textile production into an analytical framework of ecologically unequal exchange, I will approach what we might call the political ecology of fleece in the Andes from a new angle, and make an attempt at measuring quantitatively how much land and labor – *space* and *time* – Inca textile production demanded and from whom. Looking not only at the cultural aspects of textile production and consumption in the Inca empire, but also at its more tangible biophysical aspects, we shall see how cultural strategies of domination are manifested in the material landscape, and thus how ancient as well as present-day landscapes can be read and understood as reflections of cultural strategies of power and domination.

In 1532, when Pizarro and his conquistadors invaded Peru, they had unknowingly landed in the greatest empire ever to have formed in the pre-Columbian Americas. The Inca empire, *Tawantinsuyu*, stretched from Ecuador in the north into Chile and Argentina in the south, and it is believed to have held a population of around ten million people.[2] From archaeological evidence, and from the Spanish chroniclers writing in the years following the invasion, we know that camelids were much more widespread than is the case today (Bonavia 2008; Rostworowski 1999: 197; Novoa and Wheeler 1984; Flores Ochoa 1977). In the Inca storehouses, the so-called *qollqas*, the Spanish invaders found, among other things, enormous quantities of textiles and camelid fleece (Murra 1962: 717). The Spaniards were amazed at the quality of Inca textiles; the chroniclers describe cloth as fine as silk, superior to fabrics produced in Europe at the time (Murra 1980: 66–67). But the socio-economic significance of camelids, fleece, and textiles in Andean society probably evaded the Spaniards' attention, since they were mostly interested in the materials that were of greatest importance in their own contemporary European society – gold and silver. The Incas, on the other hand, were keenly interested in camelids and their fleece. A few years before the arrival of the Spaniards, before embarking on one of his numerous military campaigns, the Inca[3] king *Wayna Qhapaq* received a report on his camelid herds and the quantity of fleece they produced annually (Murra 1980: 53). The reason why this seemingly rather trivial report has survived long enough to reach us today is because camelid fleece was of great importance, not only for the success of the Inca's military campaign, but for the continued expansion and reproduction of the entire empire. Camelid fleece, and its transformation into cloth, was a crucial element in Inca imperial metabolism, as it was a means by which the Incas effectively appropriated ecological space and human labor time. The main aim here is to arrive at a quantitative estimate of *how much* space and time the Incas were able to appropriate in this manner.

Prehistoric camelid footprints and ecologically unequal exchange

Many scholars of Andean society have written about the importance of cloth and remarked upon the "incalculable" (Murra 1962: 713) hours of work that must have gone into textile production. Some have even specifically warned that our knowledge is too limited, and variation so great, that any attempt at estimating prehistoric production rates would, at best, be fruitless (Gayton 1967: 279; Franquemont 1986: 322). Taking all this into account, an attempt shall be made nevertheless. The Incas themselves used the so-called *khipus*[4] to keep accurate records of all property and economic affairs in their empire, including that related to textile production (Murra 1962: 717), but unfortunately most of the *khipus*, together with the knowledge of how to read them, were lost in the aftermath of the European invasion. Therefore, the data have to be recreated from historical and archaeological evidence, and from ethno-archaeological studies. It almost goes without saying that, in gathering bits and pieces of relevant information in this way from a multitude of sources, uncertainties and inaccuracies are inherent and unavoidable.

The main aim of this analysis is not, however, to arrive at an exact figure of space and time appropriation involved in Inca textile production; it is rather to illuminate, in a very concrete manner, the ecological, or biophysical, aspects of particular cultural strategies of domination in the Andes. The example will also illustrate that even if the asymmetry of specific exchange relations is obvious, measurable, and arguably unjust, the relations of exchange and the resultant inequalities often appear natural and inevitable to the people who are themselves enmeshed in the cultural weave of their own societies. At least this seems to be the case in our modern contemporary society, where asymmetric exchange relations that result in environmental degradation and economic inequalities between different sections of the world population are easily veiled in a persuasive language of unlimited growth and market prices as the medium of fair exchange and distribution.

To uncover the social and ecological consequences of unequal exchange relations, methods such as ecological footprint analysis (Wackernagel and Rees 1996), material flow analysis (Fischer-Kowalski 1998), and analytical frameworks of ecologically unequal exchange have been developed, which seek to find alternatives to the conventional monetary measures (e.g. Hornborg 2001; Martinez-Alier 2002). Although these methods and analyses have mostly been aimed at uncovering asymmetric exchange relations in the modern world-system and the exploitative nature of industrial capitalism, there is no reason why they could not be applied to pre-modern societies and archaeological landscapes. In fact, precisely because of the universal character of measures such as space and time, such analyses should be suitable for studies of long-term environmental change and sustainability, across and between different time periods and cultural settings.

Inca imperial metabolism: cultural notions of reciprocity and the ecological reality behind them

The people who have become known as the Incas were, until around AD 1000, only a moderately complex group of maize farmers. By around AD 1400, however, the Inca state had extended its control over most of the Cuzco region, and began its imperial expansion campaigns (Covey 2008). In a matter of only about 100 years, the small Inca state grew into an empire which can be described as a world empire, or a world-system, in the sense that there was labor exploitation and resource extraction of the periphery by a core polity, and a division of labor based on strict ethnic and class distinctions. The production as well as the consumption of textiles played an important role in the organization of these social distinctions. Ethnic identity and social status within society was signaled through dress, and therefore strict dress codes had to be followed; if not, punishments ranging from beating to death could be expected (Costin 1998: 123–124). People of high status wore fine colorful *qompi* cloth made from the soft fleece of alpacas or vicuñas,[5] while commoners wore coarse *awasqa* cloth made from llama fleece (Murra 1962: 720).

The same strict divisions guided the production of textiles. Through the Inca labor tax system, the Inca state involved practically everyone under their rule in textile production – except for ethnic Incas and others of high status, who were exempt from the tax obligation.[6] Fleece was provided to the common people to weave coarse cloth for the state and for themselves; the chroniclers write that the common people in the Inca empire were constantly busy with spinning and weaving (Murra 1962: 716). In addition to the work done in the common households, Inca society comprised also separate social classes of specialist workers, such as the *aqllakuna*[7] and the *qompi kamayuc*,[8] whose sole purpose it was to serve state needs, mainly with fine cloth. The large quantities of woven textiles were then stored and redistributed by the Inca state as gifts; *awasqa* textiles were awarded to common people, and *qompi* to Incas and other nobles. In certain cases, *qompi* was also given to commoners in reward for some special service or loyalty (Boytner 2004: 131, 139).

One might wonder how the Incas, a relatively small ethnic group of less than 40,000 individuals (Moseley 1992: 9), were able to extract this labor so smoothly and efficiently, and how they were able to exercise their authority over such a vast area. The key to understanding the basis of Inca power lies in the Andean notions of reciprocal exchange, which guided exchange relations at all levels of society in the Andean world (McEwan 2006: 137–138). The ancient cultural principles of reciprocity obliged people to do community work and guided socio-economic relations between members of society. These relations were originally organized through extended kin groups to serve local needs, but the Incas successfully transformed the system of reciprocity to serve the needs of the growing Inca state (Rostworowski 1999: 38). This meant, however, that the power of the Incas was, in the beginning at least, based on their ability to continually renew the ties of reciprocity, which in turn meant that the Inca state was in constant need of staple goods and luxury items to distribute to those with whom reciprocity was practiced (Rostworowski 1999: 46). Since cloth was arguably the most valuable item in the Andean world, it was extremely important in exchange and power relations, and therefore, the Inca state needed a constant supply of textiles to be able to initiate new exchange relations and maintain old ones. The Incas met this growing need by expansion and intensification: they expanded their agricultural area through conquest, and they intensified production through improving the landscape, building, for example, terraces and irrigation canals. Meanwhile, they expanded their labor force through incorporating new populations into their tax system, and through demanding more labor from their subjects.

In summary, the Inca king coaxed people to produce textiles, which were then redistributed as value-added goods, making himself appear as the provider and benefactor of the people. A tunic from the Inca was a prestigious and highly valued gift, and because dress was so closely associated with identity and status, by awarding people with textiles, the Inca king was attributing social status and power. Simultaneously, the "gift" obliged its recipients to reciprocate in a certain manner. Tellingly, we learn from the chroniclers that when the Inca king had conquered new territories, his first act was to present the newly conquered people with gifts, often textiles. As Murra (1962: 721) writes, this can either be seen as the benevolent act of the generous conqueror, or as the initial pump-priming step of a new dependency relation.

Calculations and discussion

The conventional view of the Inca tax system is that people contributed solely their labor, or time, to the Inca state (J. Rowe 1946: 265). The figures listed in Table 6.1 are estimates of just how much labor time could be appropriated through the textile tax and other culturally sanctioned forms of exchange involving textiles and camelid fleece. Although not attempted here, this labor time could conceivably be recalculated into space as the ecological footprint of the laborers. The space measured in this study is that required to sustain the camelids that produced the essential raw material for Andean textile production.

Table 6.1 Ecological space (ha) and labor time (hours) embodied in Inca textiles

	Awasqa[a] *per ton (667 tunics)/per tunic*	*Qompi*[a] *per ton (2,667 tunics)/per tunic*
Space[b]	1,282 ha/1.92 ha (*pampa* pasture)	346 ha/0.13 ha (*bofedal* pasture)
Time[c] (total)	155,941 hours/234 hours	6,821,399 hours/2,556 hours
• Herding[d]	35,653 hours/53 hours	16,713 hours/6.3 hours
• Shearing[e]	488 hours/0.7 hours	366 hours/0.1 hours
• Dyeing[f]	0 hours	4,364 hours/1.6 hours
• Spinning[g]	63,267 hours/95 hours	1,074,349 hours/403 hours
• Plying[g]	20,333 hours/31 hours	322,265 hours/121 hours
• Weaving[h]	36,286 hours/54 hours	5,403,342 hours/2,026 hours

Notes
See the appendix for notes and calculations regarding this table.

Looking at the figures in Table 6.1, we can now begin to answer the questions initially posed: How much space and time was embodied in Inca textiles, and from whom was it appropriated? We see that one ton of coarse *awasqa* cloth would embody 1,282 hectares of *pampa* grazing land, and close to 160,000 hours of labor time. One ton of fine *qompi* cloth would embody 346 hectares of *bofedal* area and close to 7,000,000 labor hours. Because of the cultural preference for fine and soft alpaca fleece, the *bofedal* areas were of particular importance. Camelids require nutritive and succulent vegetation to produce soft fleece, and particularly alpacas are vulnerable to drought and other environmental factors. To maintain their health, alpacas need to graze on *bofedal* pastures that maintain adequate vegetation all year round. Llamas, on the other hand, can be sustained on the dryer *pampa* pastures (Kuznar 1991a: 3). *Bofedales* occur naturally but, as has been suggested by Palacios Ríos (1977: 159), only to a limited extent, and the large *bofedales* that are sometimes perceived to be naturally occurring highland habitats are often the result of human manipulation. To increase carrying capacity, and to improve the quality of fleece, irrigation systems were constructed to lead water to the *bofedal* (Palacios Ríos 1977; Bonavia 2008: 53), and turf walls built to retain the water (Dransart 2002: 37). It is likely that many of these improvements (cf. the concept of landesque capital[9]) were already in place before Inca times, but the Incas are known to have invested heavily in the landscape, constructing terraces, irrigation systems, etc., and it is evident that the Inca demand for high-quality fleece and cloth was reflected in land-use strategies, which left an imprint on the Andean landscape. It must also be considered likely that camelids in pre-colonial times occupied a much larger area than is often presumed (e.g. Flores Ochoa 1982; Bonavia 2008).

If we relate the figures in Table 6.1 to pieces of information that can be found in the documentary sources, we may get an idea of how large an area camelid herding and fleece production must have demanded. The chroniclers write, for example, that every household was required to deliver at least one *awasqa* tunic to the Inca state every year (Murra 1962: 716; A. Rowe 1997: 11; D’Altroy 2002: 290). Assuming, on the conservative side, that there were one million households in the Inca empire, this would give a total of one million tunics. Each one of these *awasqa* tunics embodied 1.92 hectares of productive pasture land or almost the equivalent of three soccer fields, while the embodied labor time is estimated at 234 hours. The pasture land embodied in one million tunics would be 1,920,000 hectares or 19,200 km^2; this amounts to almost 10 percent of the total highland pasture area within the borders of modern Peru (INRENA 1996).

We also learn from the chroniclers that the Inca military was a major consumer of textiles; the army on the move needed clothing, blankets, and tent-making equipment (Murra 1962: 717), and with an army of perhaps 100,000 men (D'Altroy 2002: 216–217), this must have amounted to gross quantities of cloth. Moreover, soldiers serving in the Inca army could expect two tunics annually in reward for their military service (Boytner 2004: 130; Murra 1980: 76). Assuming the tunics were all made from llama fleece, the camelid footprints of this particular military expenditure would be around 384,000 hectares.

The documentary sources also hold some useful information on the production and consumption of fine cloth. One common practice which consumed "untold quantities" (D'Altroy 2002: 294) of *qompi* textiles was sacrificial burning; the chroniclers write that almost every important sacrifice included fine cloth, which was burned as an offering to Inca deities (Murra 1962: 714). Although there is not much information on which to base quantitative estimates, we may suppose that there were 25,000[10] Incas entitled to wearing fine cloth. If we further suppose that they all received two garments annually, corresponding in size and quality to the *qompi* tunic used for calculations here, it would require 6,500 hectares of *bofedal* pasture, which is approximately 7 percent of the estimated *bofedal* area in modern Peru (INRENA 1996). The labor time would be more than 125,000,000 hours, implying that close to 35,000 people would have to work ten full hours per day, every day for a full year just to produce these garments. When we consider that men wore not only tunics, but also a breechcloth and a mantle; women wore a long dress, a shawl, and a belt (J. Rowe 1946: 234–235; A. Rowe 1997), and adding general household requirements of blankets, etc., we can begin to fathom just how much productive land and how large a portion of people's time textile production for the Inca state in particular, and textile production in general, must have demanded.

When it comes to the division of labor in the Inca empire the historical sources are somewhat contradictory, but it is likely that commoner women performed most of the tasks listed in Table 6.1; according to Inca census categories, spinning was mainly a female occupation, whereas herding was carried out by young boys and men and young girls. Plants for dyeing were collected by young girls, and weaving of *awasqa* and spinning thread for *qompi* were tasks for adult commoner women,[11] while the weaving of *qompi* was mainly carried out by the *aqllakuna* and the *qompi kamayoc* (Costin 1998). Commoner women thus carried out a large percentage of the labor involved in textile production for the Inca state. The archaeological evidence seems to indicate the same thing, namely that the workload on commoner households, in some areas at least, increased quite dramatically as a result of Inca demand for textiles (Costin 1993).

An interesting note on which to end this discussion is that in spite of the heavy requirements of cloth production and the high socio-economic value of finished textiles, the people who produced it were seemingly not compensated in any way. While other labor duties were typically rewarded by the Inca state – e.g., *mita*[12] laborers as well as agricultural laborers were fed and served *chicha*, i.e. maize beer (Murra 1980: 31) and soldiers received textiles in reward for their military service – there is no indication that textile labor was rewarded.

Conclusion

We have seen that textiles made from camelid fleece – arguably the main source of Inca power – embodied a large portion of the time and daily lives of ordinary Andean people. Also, it embodied a very large portion of the available productive land, thus dominating entire landscapes and their populations. In the aftermath of the Spanish invasion, with the collapse of the Inca empire and power structure, we see also a collapse of the native herding and breeding systems (Flores Ochoa 1977; Wheeler *et al.* 1995). Simultaneously, as the Americas were rapidly being incorporated into the wider world-system, the Inca labor-tax system was replaced by the so-called *encomienda* and then the *hacienda* systems, instituting new forms of exchange.

At another level of analysis, the main point to be drawn is that while the symbolic organization of (unequal) exchange varies between different time periods and cultural settings, the biophysical, or ecological, aspects of these exchange relations remain measurable across time and space. Therefore, by uncovering both the ecological aspects of unequal exchange and the cultural images through which it is obscured, we can gain useful insights on the interrelations between ecology and power, and on long-term environmental change.

Appendix: notes and calculations relating to Table 6.1

a The terms *awasqa* and *qompi* denote two categories of cloth produced in the Andes during Inca times. *Awasqa* is described in the documentary sources as “coarse and thick”, and *qompi* as “very fine and precious” (A. Rowe 1997: 9), but other than that there is some controversy as to how they should be defined (e.g. J. Rowe 1946: 242; Desrosiers 1986: 229; Costin 1998: 124–125, A. Rowe 1997: 9–10). It must be emphasized that the quality and fineness of cloth as well as the production methods varied greatly, and that the figures and criteria I use in my calculations are approximations based on the sources available to me. I have chosen to base my calculations on the so-called *unku*, which was a knee-length tunic worn by Inca men. The reason why the tunic is chosen over some other garment is because it was the most important type of textile for the Incas, and it was also part of their tax and redistribution system (A. Rowe 1992: 5). The criteria I have used to determine size and thread count in my examples of *awasqa* and *qompi* tunics are found in the article by John Howland Rowe on “Standardization in Inca Tapestry Tunics” (1979), and in

Ann Pollard Rowe's articles on "Technical Features of Inca Tapestry Tunics" (1978) and "Inca Costume and Weaving" (1997). The size of fine Inca tunics varies between 168 and 200 cm in the weft direction, and 72–79 cm in the warp direction (J. Rowe 1979: 245), and I therefore use an average measure of 184 cm in the weft direction and 76 cm in the warp direction. I use this same size measure for the *awasqa* and the *qompi* tunic. The weft count of the *qompi* tunic is 80 per centimeter and the warp count is 12 per centimeter, or 92 per square centimeter in total. I have not been able to find much information in the literature on the typical thread count of *awasqa* cloth, but it seems reasonable to suggest that *awasqa* was roughly 3–4 times coarser than *qompi* (e.g. A. Rowe 1978: 5, 25; A. Rowe 1997: 9). Therefore, I have simply defined the *awasqa* tunic as four times coarser than the *qompi* tunic, with a total thread count of 23 per square centimeter (18 warps and 5 wefts). As it happens, this corresponds rather well with a plain-weave poncho described by Franquemont (1986) in his study on production rates of traditional textiles in the Andes. As Inca textiles were almost exclusively woven with two- or three-ply yarns (A. Rowe 1997: 6) – the warp in finer cloth often being three-plied and more tightly twisted to add strength to the yarn (A. Rowe 1978: 7) – I have calculated with two-ply yarn for both weft and warp in the *awasqa* tunic, and with two-ply weft yarn and three-ply warp yarn in the *qompi* tunic. The estimated weight of the *qompi* and *awasqa* tunics is based on figures on thread count and average weight of yarn in the study by Franquemont (1986: 317, Table 3). The approximate weight of the finished *awasqa* tunic would be around 1.5 kg. Assuming that the *qompi* yarn is four times finer, the weight of a finished *qompi* tunic would be 0.375 kg. It follows that 667 *awasqa* tunics would weigh 1 ton, as would 2,667 *qompi* tunics.

b The calculation of land (space) embodied in 1 ton of *awasqa* and *qompi* cloth is based on figures of annual llama and alpaca hectare (ha) requirements for grazing, and annual fleece production. Kuznar (1991b: 337) writes that llamas require 1.75 ha of *pampa* pasture, while alpacas require 0.63 ha of *bofedal* pasture. The estimated annual fleece production is 1.5 kg for llamas and 2 kg for alpacas (Quispe *et al.* 2009). Because of waste in the production process of yarn, which according to Quispe *et al.* (2009: 4) is 9 percent, the amount of fleece needed to produce 1 ton of cloth is 1,099 kg. Taking into account this loss, it takes $1{,}000/1.5/0.91 \approx 733$ llamas to produce fleece for 1 ton of textiles. Likewise it takes $1{,}000/2/0.91 \approx 549$ alpacas to produce fleece for 1 ton of textiles. The area needed to produce fleece for 1 ton of coarse *awasqa* cloth is thus $733 \times 1.75 \approx 1{,}282$ ha of *pampa* pasture, and the area needed to produce fleece for 1 ton of fine *qompi* cloth is $549 \times 0.63 \approx 346$ ha of *bofedal* pasture. The difference between a hectare of *pampa* and a hectare of *bofedal* is one of both quantity and quality, i.e., the net primary production in *bofedales* is larger, and the quality of the forage is higher (Quispe *et al.* 2009; Kuznar 1991a; Kuznar 1991b). Because of this, the production of fleece is also higher in the *bofedal* and the hectare requirements thus lower. The lower hectare requirement should however be considered in its right context – namely that the total *bofedal* area available is much smaller than the total *pampa* grazing area. In modern Peru, for example, only around 0.5 percent of the total highland grazing area is classified as *bofedal* (INRENA 1996).

c The tasks I have included in my estimation of the labor time involved in textile production are: herding, shearing, dyeing, spinning, plying, and weaving, leaving out factors such as washing, skeining, warping, and finishing (sewing, embroidering, etc). These factors are left out because they are difficult to assess, but if included they would add significantly to the production time, which means that my figures must be considered conservative. I am familiar with only two studies on production rates of traditional Andean textiles. The data for the first study were collected by Grace Goddell in the Pisaq area, and analyzed and published by Junius B. Bird (1969). A second study was carried out by Franquemont (1986) in the community of Chinchero in 1977 with the same methodology as the study by Goddell/Bird and with the aim of "filling in the blanks" of that former study (Franquemont 1986: 309). In both communities, traditional methods of weaving and spinning were still in use, and even if the author in his conclusion specifically warns against it (Franquemont 1986: 322), my own calculations of prehistoric production rates are mostly based on these two studies. Where it is possible and more appropriate, I use other sources.

d The figures on herding are derived from studies made in the herding community of Chinchillape. Kuznar (1991b: 377) estimates that 8 minutes per animal per day is needed to herd llamas, and 5 minutes per animal per day is needed to herd alpacas. Herding the llamas necessary for producing enough fleece to produce 1 ton of *awasqa* cloth therefore required $733 \times 8 \times 365 / 60 \approx 35{,}653$ hours of work annually. Herding the alpacas necessary for producing enough fleece to produce 1 ton of *qompi* cloth required $549 \times 5 \times 365 / 60 \approx 16{,}713$ hours of work annually. From this we can deduce that the herding time embodied in one *awasqa* tunic would be $35{,}653 / 667 \approx 53$ hours, and $16{,}713 / 2{,}667 \approx 6.3$ hours in a *qompi* tunic.

e The figures on shearing in Franquemont's (1986: 312) study appear to be rather high; the shearing of around 1 kg of fleece takes approximately 90 minutes. Taking into consideration that herding strategies in late pre-Hispanic times were different from today (Bonavia 2008: 158), and that yarn production was highly standardized, and perhaps even carried out on an industrial scale (A. Rowe 1980: 87), it is likely that also shearing was carried out on a larger scale and probably more efficiently than is the case today in small Andean communities. Assuming that two people can shear a camelid in 20 minutes, a more realistic figure would be 40 minutes per animal. The figures used for shearing are thus 0.67 hours $\times$ 733 llamas $\approx$ 488 hours per ton of *awasqa* cloth and 0.7 hours per tunic. For *qompi* cloth the figures are 0.67×549 alpacas $\approx$ 366 hours per ton and 0.1 hour per tunic.

f Although the archaeological record holds plenty of evidence that Andean people have dyed their garments for thousands of years, the traditional dyeing methods were largely abandoned by the nineteenth century, and little is known of the exact procedures, let alone how time-consuming they were. Since the information on dyeing in more recent studies is therefore not very useful, we may approach the question of production rate from another angle. Catherine Julien (1988) in her work on the Inca decimal administration system has reconstructed the labor obligations imposed by the Inca on the Chupachos. Julien lists the different assignments and how large a percentage of the total population each assignment demanded. The figures show, for example, that 10 percent of the 400 tax-owing households were to work as "Weavers of tapestry (*qompi*) cloth" and 6 percent (240 households) as "Herders of Inca herds", while 1 percent (40 households) were to work off their labor tax as "Dye makers" (Julien 1988: 265). Since we already have a figure on labor time for herding we can deduce that the labour involved in dyeing is six times less than in herding. The average herding time for llamas and alpacas is (35,653 + 16,713) / 2 ≈ 26,183 hours. The dyeing time is therefore calculated as 26,183 / 6 ≈ 4,364 hours per ton of cloth and 4,364 / 2,667 ≈ 1.6 hours per tunic. Since commoners wore undyed clothes (Costin 1998: 128, but see also A. Rowe 1997: 9), I have only added this figure to the production time for *qompi*, not *awasqa*.

g In order to estimate the labor time involved in spinning and plying, I have calculated the yarn length and the length of single thread in a piece of *awasqa* and a *qompi* tunic, respectively, and used Franquemont's figures on production rate. With an average spinning rate of 1.3 meters per minute (Franquemont 1986: 317), an average plying rate of 1.8 meters per minute (Franquemont 1986: 316), and counting in a 10 percent reduction of the warp because of weft insertion (Bird 1969: 14) and an 11 percent reduction in the plying process because of the twisting (and therefore shortening) of the yarn (Franquemont 1986: 318), the labor time can be calculated. The length of single thread in one *awasqa* tunic sized 184 cm × 76 cm, with a thread count of 23 per square centimeter [5 weft yarns and 18 warp yarns and made with two-ply warp and weft yarns] is (184 × 76 × 5 × 2 / 0.89 / 0.9) + (184 × 76 × 18 × 2 / 0.89) ≈ (174,582 + 565,645) cm ≈ 7,402 m. The spinning time for this tunic is 7,402 / 1.3 / 60 ≈ 95 hours. The yarn length is (184 × 76 × 5 / 0.9) + (184 × 76 × 18) ≈ (77,689 + 251,712) cm ≈ 3,294 m. The plying time is 3,294 / 1.8 / 60 ≈ 31 hours. The spinning time involved in the production of 1 ton of *awasqa* cloth is 95 × 667 ≈ 63,267 hours. The plying time is 31 × 667 ≈ 20,333 hours. The length of single thread in one *qompi* tunic sized 184 cm × 76 cm, with a thread count of 92 threads per square centimeter [12 three-ply warp yarns and 80 two-ply weft yarns] is (184 × 76 × 12 × 3 / 0.89 / 0.9) + (184 × 76 × 80 × 2 / 0.89) ≈ (628,494 + 2,513,978) cm ≈ 31,425 m. Spinning time for this cloth is 31,425 / 1.3 / 60 ≈ 403 hours. The yarn length is (184 × 76 × 12 / 0.9) + (184 × 76 × 80) ≈ (186,453 + 1,118,720) cm ≈ 13,052 m. The plying time is 13,052 / 1.8 / 60 ≈ 121 hours. The spinning time involved in the production of one ton of *qompi* cloth is 403 × 2,667 ≈ 1,074,349 hours. The plying time is 121 × 2,667 ≈ 322,265 hours.

h Of all the uncertain production rate factors used in this study, the weaving rates are probably the most problematic. Figures vary dramatically with different weaving methods and techniques, not to mention the complexity of design and pattern and the weaver's familiarity with it. To estimate the weaving time for an *awasqa* tunic, I use the figures arrived at in the study by Franquemont. Franquemont's (1986: 312, Table 2) figures show that yarn preparation (shearing, spinning, dyeing and plying) amounts to around 70 percent of total production time of a plain-weave poncho. Assuming that a plain-weave poncho corresponds roughly to an *awasqa* tunic, we may therefore deduce that the weaving of an *awasqa* tunic demanded $127 \times 0.3/0.7 \approx 54$ hours and 36,286 hours per ton. In the study by Goddell/Bird, weaving is considerably more time-consuming, probably because of the more elaborate pattern and the difference in weaving method. Goddell's data show that one weft insertion in a 140 cm long patterned poncho takes on average 15 minutes (Bird 1969: 14–15). From that we may deduce that one weft insertion in our 184 cm long *qompi* tunic would take an average of 20 minutes. As there would be 80 weft insertions per centimeter this would require $76 \times 80 \times 20$ minutes = 2,026 hours.

Notes

1 There are four camelid species native to South America: the wild vicuña and guanaco, and the domesticated llama and alpaca (Stahl 2008). Although fleece from all four species was used in the Andes, I will focus on the exploitation of llamas and alpacas.
2 Pre-Columbian population estimates vary greatly (e.g. Denevan 1992; Cook 1981).
3 The term Inca originally probably referred to the Inca (king) himself, but has come to denote the whole ethnic group and the empire they created. I use the term interchangeably to refer to the Inca king and to Inca society in general.
4 A *khipu* is a recording device of knotted strings made from camelid fleece or cotton. It was used by the Incas to record everything from census figures to historical events (Urton 2008; Salomon 2004).
5 There is little evidence on the use of vicuña fleece in pre-Columbian times (Bonavia 2008: 410; Boytner 2004: 134), but because of the exceptional fineness of vicuña fiber, it is often associated with the Inca himself. Murra (1962: 720) writes that unauthorized wear of vicuña cloth was a capital offense.
6 Even if high-status women were exempt from the Inca labor-tax, they still contributed to textile production. Since weaving was the "essence of Andean women's skill" (D'Altroy 2002: 288) we must expect that practically all women in the Inca empire produced textiles, but the labor value of their products most likely varied with their status in society. From the chroniclers we learn that even elite households delivered cloth to the Inca every year (J. Rowe 1979: 239).
7 The *aqllakuna* were "Chosen Women" who were taken from their communities and families at a young age and trained by the older *mamakuna* to serve the needs of the Incas in various ways. After about four years of training they were either given as wives to deserving soldiers or nobles, or they were reclassified as *mamakuna* and remained in the convent-like *aqllawasi* (house of the *aqllakuna*) for the rest of their lives (J. Rowe 1946: 269). The main occupations for the *aqllakuna* were to weave fine cloth and to brew *chicha*, i.e. maize beer.
8 The *qompi kamayuc* were a separate occupational class of male specialist weavers who wove fine textiles, perhaps mostly for military use (Costin 1998: 137).
9 See Widgren (2007) for a definition of landesque capital.
10 Gordon F. McEwan (2006: 93) writes that estimates on the size of the Inca caste range from 15,000 to 40,000 individuals.

11 The documentary sources are curiously silent about the production of yarn, even if it was obviously a very time-consuming and important part of textile production. Ann Pollard Rowe (1980: 87) writes that the "extreme uniformity" of archaeologically recovered yarn suggests that it was produced in the highlands on an industrial scale, and that production was centrally controlled. Anna Gayton (1967: 279) similarly has suggested that the "gross needs" of yarn in cloth production and the "standards of excellence" of the thread indicate that spinners formed a separate occupational class in Inca society. There is, however, no term for spinners as there is for the specialist weavers, the *qompi kamayuc* (D'Altroy 2002: 290). Cathy Lynne Costin (1998: 130) finds evidence in the documentary sources to suggest that fine thread for the production of *qompi* was spun by commoner women. Although the evidence appears contradictory, it probably reflects the variation in production in different regions and time periods. The most interesting conclusion that can be drawn from the lack of information about spinning is that although someone necessarily must have carried out this very demanding and time-consuming work, it was apparently not considered worth much mention in Inca society.

12 *Mita* was the term for the rotational labor obligation, upon which the Inca labor-tax system was based. *Mita* labor could be military service, construction work, work in the mines, etc. (Rostworowski 1999: 184; J. Rowe 1946: 267–268).

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7 Slaves

Inequality and sustainable agriculture in pre-colonial West Africa

Mats Widgren

The relation between social and economic inequality and the environment is one of the most central research questions in historical political ecology. This chapter addresses the issue from the perspective of a specific social form (slave societies), with a focus on a specific environmental issue (soil degradation). It discusses the measures that people in the eighteenth and nineteenth centuries took to ensure sustainable yields through investments in landesque capital. The central question is how slavery was related to soil and water conservation in West Africa during the period of the Atlantic slave trade and its aftermath. There are two underlying arguments. First, while we have indisputable examples of how exploitative social and economic systems have led to degraded environments and to environmental load displacement, this relation needs to be examined critically and empirically, rather than taken for granted. Second, in the current urge to highlight "traditional" soil and water conservation practices for development purposes, there is a need for a better understanding of the political economy and social structures in which these practices once developed.

Environment and inequality

Some of the literature on large empires and their environmental impacts helps us to define more closely what caveats there are in studies of inequality and the environment. Donald Hughes demonstrates some of them in an article on the environmental impacts of the Roman economy (Hughes 2007). As examples of environmental deterioration in the Roman empire, Hughes lists extinction of wild animals, deforestation, salinization, erosion, siltation, soil exhaustion, air and water pollution, lead poisoning, vermin and diseases. What all these processes Hughes refers to essentially have in common is that they belong to what in the late twentieth century was perceived as important environmental problems. Hughes finds them all in the Roman empire. An empirical investigation of the causal relation between the Roman economy and its different effects on forests, agricultural soils and wildlife, however, needs to be more precise. The "environment" cannot be categorized according to what was on the political environmentalist agenda in the late twentieth century. These different processes, which we classify as environmental problems, follow different kinds of logic and are related to human and natural causes in different ways. Historical political ecology needs to be aware of this. If the analysis of the relation between economy and ecology shall be able to say something new, empirically and analytically, it needs to be precise about what is meant with the environment and to examine different, specific processes in the physical world. The understanding of how specific social formations and organizations of labour in given geographical areas impact on the resource base, and the extent to which they improve or degrade environmental conditions, must be based on empirical investigations, rather than past or present narratives of environmental degradation (cf. the arguments on critical political ecology in Benjaminsen *et al.* 2010).

Much research in environmental history seems oblivious to the whole debate on environmental degradation narratives. In the past as well as in the present, narratives about the overuse of the environment have served particular interests. Statements referring to environmental degradation can rarely be taken at face value, and the list of environmental problems in the Roman empire that Hughes provides has very much the character of such a narrative. The fact that widely accepted understandings of environmental degradation are not always empirically based, but are produced within a specific social context, was repeatedly highlighted in the 1990s and most clearly expressed in the work of Fairhead and Leach on deforestation in Guinea (Fairhead and Leach 1996). Since then, this understanding has become something of a common point of departure among critical political ecologists. It is only recently, however, that such an understanding has been incorporated in the works of environmental historians and historical geographers. Diana Davis, for example, has shown how degradation narratives served the interests of French colonial expansion in North Africa (Davis 2007, 2009). Furthermore, some of the more established narratives in environmental history have been subject to intensive empirical scrutiny. This is not least the case when it comes to the causes and extent of deforestation and land degradation in the Mediterranean area during Greek and Roman times, which is much in focus in Hughes' work (see Rackham and Moody 1996: 6–11; Grove and Rackham 2001: 8–23; Butzer 2005; see also the response by Hughes 2010).

The Roman empire was indisputably an extractive economy that drew on a large area to feed consumption at the centre. It exploited both humans and natural resources. But it remains an empirical question to show in what respects, to what degree and where the Roman economy led to environmental degradation, or conversely, how and where it led to investments in landesque capital that improved environmental conditions. This has been clearly shown by Graeme Barker in his extensive research in two different desert environments on the fringe of the Roman empire. In the Tripolitanian desert (present Libya) Barker and co-researchers "found no significant evidence for humanly induced environmental degradation, and indeed several indicators of attempts by the Romano-Libyan farmers to practice sustainable systems of land management" (Barker 2002: 503). This was in clear contrast to the conditions in Wadi Faynan (Jordan), where there was abundant evidence of degradation caused by mining as well as by farming. Barker here sees a difference between a bottom-up approach, based on local knowledge, as in the case of the successful floodwater farming in the Tripolitan pre-desert and, on the other hand, the imposed, top-down decision-making in the example of Wadi Faynan.

Landesque capital and slavery

It has long been established that locally developed soil and water conservation techniques can play a crucial role for sustainable agriculture in semi-arid Africa. Numerous examples of communities using terracing, mulching, manuring, rainwater harvesting and irrigation have been documented (Reij *et al.* 1996; Brookfield 2001; Brookfield *et al.* 2003). Broadly speaking, all of these agricultural techniques are labour-intensive and result in the creation of landesque capital, be it in the form of anthropogenic soils, agricultural terraces or irrigation furrows. In many parts of semi-arid Africa such investments are not a prerequisite for farming, but serve to increase production, reduce risk and prevent soil exhaustion. Much recent literature on traditional soil and water conservation in Africa has been focused on local knowledge and on the "process of learning, experiment and innovation" among small-holders (Brookfield *et al.* 2003: 1). Less emphasis has been put on questions regarding the social context in which such innovative and sustainable farming practices evolved and how they can be sustained today in a different social context.

The causal factors that connect social inequality and land degradation were explored by Blaikie and Brookfield (1987), especially their discussion of marginality (ibid.: 19ff.). Along a similar line of argument, Franke (1987) showed that successful food production systems in the Sahel built on herder–farmer integration and traditional knowledge were positively linked to the relative absence of exploitative social formations. In the search for the social contexts of investments in soil and water conservation, Håkansson and Widgren (2007) also found partial support for such a view. Based on a comparison of four different farming communities in present-day Tanzania, we argued that social stratification was one of several factors that could explain the lack of investments.

In my review of several cases of intensive agriculture in West Africa, I found that during the most intensive era of slave-raiding, investments in soil and water conservation took place at both ends of the political scale. The decentralized, stateless farming communities, which were the potential victims of the slave trade, intensified their agricultural production through terracing in the highlands. The predatory, hierarchical states, based mainly on the plains, which took part in the slave-raiding and used slave labour in their own agriculture, also intensified their agriculture, primarily by investing in anthropogenic soils and in wells for irrigation (Widgren 2010).

We must thus consider in more detail the relation between slave labour and investments in landesque capital. Two contrasting positions can be identified in previous literature. Slavery has for example been seen as the most evident example of a labour organization which combines exploitation of humans with exploitation of the environment. Don Hughes writes that a "slave economy cannot as a rule benefit the environment: slave labour enable exploiters to do more damage, and a slave class whose members were liable to be sold anywhere could not establish a relationship of responsibility with the land" (Hughes 2007: 32). On the other hand, it has been argued that the landesque capital of early agricultural societies "was generally accumulated by chiefs and monarchs through the appropriation of labour by means of slavery, *corvée*, kinship, or other obligations" (Hornborg 2008: 67). Similarly, Scott (2009) has recently argued that the history of upland Southeast Asia can be seen as a continuous struggle between, on the one hand, hierarchical states, slavery and investments in intensive paddy rice cultivation and, on the other hand, the "culture and agriculture of escape" practised by groups who wanted to evade the state rather than be ruled. Escape agriculture implies, according to Scott, shifting cultivation of "escape crops" that are difficult to tax and difficult to appropriate in raids (Scott 2009: 178ff.).

I shall now explore in more detail three different cases of what has been termed traditional soil and water conservation in West Africa, in order to see if their relation to the organization of labour can shed some light on the more general questions of inequality and the environment.

Ring cultivation in the semi-arid belt of West Africa

In the semi-arid zone stretching through present-day Guinea, Senegal, Mali, Burkina Faso, Niger and Nigeria, a specific type of historical farming system has been identified that is usually called the *ring-cultivation system* (Prothero 1957; Pélissier 1966; Ruthenberg 1971: 60; Prudencio 1993; Fussel 1992: 496f.). The central part of the fields consists of a small area, nearest the village, that is permanently cultivated and intensively manured. In concentric rings around this manured field are different sectors of semi-permanent or shifting cultivation, with the intensity of cropping decreasing with distance from the village. In the history of European farming, similar systems are known as *infield–outfield systems* (Uhlig 1961; Christiansen 1978). The high productivity of the infield is based on a long history of soil management. The methods of managing the infield vary between different types of systems and could, for example, be based on stubble grazing and folding of cattle during night-time, combined with the direct application of ashes, household waste, soil, manure from small and big livestock as well as other organic material (crop residues, compost and peat). With the exception of peat all of these methods are known from West Africa, but the crop residues and compost are mainly known from smaller, more intensively used gardens, rather than the infield generally.

A superficial look at a population map or a recent land-cover map of cropland distribution will show a concentration in the semi-arid zone of West Africa. This distribution cannot be explained from the climate or soils, as the area is marginal for agriculture. The density of settlement and the intensity of agriculture rather reflect the important political and economic role that this area, close to the Saharan trade network, has had in history. The landesque capital in the form of anthropogenic soils, formed by centuries of intentional soil management, and wells for irrigation is an important prerequisite for this population density.

The historical background of this intensive form of agriculture cannot be understood without looking into the relations of production that dominated the savannah zone in West Africa during the eighteenth and nineteenth centuries. African slavery existed long before the Atlantic slave trade. The Islamic expansion played an important part in the development of slavery in the centuries preceding the Atlantic trade. During the period of the Atlantic slave trade the system of inland trade routes expanded and a series of predatory states emerged that built their wealth on slave-raiding, agriculture and trade. Meanwhile, the internal use of slaves on plantations increased. After abolition and the end of the Atlantic slave trade, the raiding and trading in slaves continued in Africa. The continued supply, not being matched by external demand, contributed to the peaking of internal African slavery (Lovejoy 2000). It has been estimated that at the end of the pre-colonial period slaves might have been in majority in a number of West African states (Lovejoy 1979: 1273). Lovejoy (2000: 277) argues that, regardless of the share of slaves of the total population, these societies can rightly be characterized by a slave mode of production since “slavery was crucial to the productive process”.

The largest slave society in West Africa in the nineteenth century was the Sokoto Caliphate. It covered large parts of what is now northern Nigeria and was preceded by the federation of Hausa city states. It is estimated that by around 1900 there were 2.5 million slaves in Sokoto, out of a total population of ten million (Hill 1976: 397). This should be compared with the almost four million slaves in the United States in 1860. West Africa during the nineteenth century thus housed the world’s second or third largest slave society (Lovejoy 1989: 392). It is possible that the number of slaves in Brazil was higher than in the Sokoto Caliphate.

Farming in the closely settled zones around the Hausa capitals in the Sokoto Caliphate is well described from the mid-nineteenth century. Barth travelled in the 1850s, outside Kano, through intensively cultivated fields of millet, sorghum, cotton and indigo (Barth 1859). From later evidence we know that manuring, stubble grazing, intercropping, ridging and irrigation were part of the system (Raynaut 1989; Swindell 1986; Swindell and Iliya 1989). Kenneth Swindell has argued that the

> creation of an intensively cultivated area around the town of Sokoto bears a close relationship to the large inputs of labour in the 19th century and its control through a centralized hierarchical political system rooted in the precepts of Islam.
>
> (Swindell 1986: 88)

Swindell recorded farming practices in the area surrounding the town of Sokoto (Sokoto Rima basin) in the 1970s and argued that most of these farming practices were of considerable age. This can be partly confirmed by the accounts of early travellers in the nineteenth century. The combination of ridging with application of manure and ash is an important technique for the improvement of soils in this region.

The manure for the most intensively cultivated area partly came from the cattle of the Fulani pastoralists, who used the area for dry-season grazing. Through arrangements with the Hausa farmers, Fulani cattle were penned on the harvested fields. Later on in the nineteenth century, more Fulani were settled in some of the areas, so a large number of cattle were kept in towns and villages. The nomadic as well as the local herds were important sources of manure for improvement of the farmland (Swindell 1986: 87).

In the historical literature we find evidence of the transportation of manure and household refuse from the towns and villages to the farmland. Polly Hill writes about a slave owner in the village of Dorayi, some kilometres south of Kano city, where farm slavery persisted until the 1920s. One prominent slave owner, controlling about 30 slaves, was remembered as "a cruel master who chained his slave if they refused to fetch manure from the city" (Hill 1976: 417–418). Hamza (2004: 136) writes (also of Dorayi) that the "transport of manure and household sweepings (*daukar taki*) from the city was nearly continuous".

Lovejoy, in his broader discussion of the impact of slavery on the political economy, maintains that there was "relatively little investment in capital or the improvement of land" under slavery (Lovejoy 2000: 277). Such a view evidently underestimates the significant changes in soils as a result of the continuous flow of nutrients and organic matter from the settlements to the fields. It is evident that the slave labour is a crucial factor here. Lovejoy, in another work, shows that only manured land was sellable in the Sokoto Caliphate, a circumstance which underlines the conclusion that the anthropogenic soils were indeed valued as landesque capital at this time (Lovejoy 1979: 1282). Still today, in the ring-cultivation systems of the region, the capacity to control labour and transport is a crucial feature for maintaining soil fertility. This is obvious from recent research in Mali, where the efforts to obtain manure and having the means to transport it were of utmost importance for restoring and maintaining soil fertility. Social inequalities between households, and their capacity to bargain for manure and transport, explain more of the variable pattern of soil fertility than the distance from the settlement (Ramisch 2005).

The *tapades* in Fouta Djallon

In the Fouta Djallon highlands in Guinea, an intensive garden-like agriculture is practised. It is described in recent works on agrobiodiversity by Brookfield (2001: 97–99) and Boiro *et al.* (2003). The *tapades* are intensively cultivated infield areas, which are continually improved by manuring and mulching. The farming practices in these gardens are also described by Richard-Molard (1944) and Derman (1973: 122–131). The term *tapade* refers to the living fences that enclose them, but they are also called *sunture*. Brookfield (2001) and Boiro *et al.* (2003) only vaguely touch upon questions of labour mobilization, mainly in highlighting the role of women's labour.

The close integration of cattle and permanent agriculture that the *tapades* represent could hardly have developed before the immigration and sedentarization of Fulbe cattle herders in a territory that was previously mainly agricultural. This interdependence between the pastoralists and the existing Djallonke farmers developed over the thirteenth and sixteenth centuries until the subsequent takeover by the Fulbe and their establishment of a theocratic state in 1725. The Fouta Djallon state was an active participant in the Atlantic slave trade and its own economy was also based on slave labour, partly drawing on the former inhabitants and partly increased through slave-raiding (Boiro *et al.* 2003; Rodney 1966). According to Lovejoy, following the establishment of the Fouta Djallon state, "tens of thousands of slaves were settled on plantations to supply the army and facilitate caravan traffic" (Lovejoy 2000: 118). The unfree labourers of Fouta Djallon have sometimes been classified as serfs, rather than slaves, because of their partial independence. Lovejoy argues that they should indeed be seen as slaves and that the so-called serf villages can be compared to slave plantations elsewhere in West Africa (Lovejoy 1979: 1273–1274). According to European travellers in the early nineteenth century, they lived in separate villages, where they cultivated their masters' fields but also had their own gardens, where they were allowed to work two days per week (Lovejoy 2000: 198). The history of the intensively cultivated gardens known as *tapades* or *sunture* cannot be clearly traced from existing literature, but all evidence points to a close connection to these former slave gardens.

The works of Richard-Molard (1944) and Derman (1973) provide detailed accounts of how the two different types of cultivation areas were managed. On the one hand were fields which were formerly cultivated by slaves, with fonio, rice and millet as the main crops, and on the other the intensively cultivated women's gardens with cassava, taro, maize, sweet potato, yam, peanut, cotton, hot pepper, and different leaves used for sauces (Derman 1973: 124). The gardens were established on all types of soil and their fertility thus totally dependent on human labour. Richard-Molard (1944: 205–206) argues that the gardens are the result of a later development, compared to the more extensively used fields. Their strong emphasis on crops introduced by the Columbian exchange clearly suggests that they were coeval with the Atlantic trade. According to Derman (1973), the importance of the intensively cultivated gardens further increased from the time of Richard-Molard's fieldwork in 1942 to that of his own fieldwork. It is thus possible that the vast areas of *tapades* indicated by the maps in Boiro *et al.* (2003) represent a substantial expansion of the intensively cultivated gardens, compared to the figures of 400 m^2 up to a hectare for each garden that were mentioned by Richard-Molard. Derman's investigations were in a former slave village, so there may be a connection between the women's gardens he documented and the individual slave gardens documented in early traveller's reports. During the twentieth century such gardens existed both in former slave villages and in villages that were formerly free. It is clear, however, that the division into extensively cultivated fields and intensively cultivated gardens was based on a social organization of labour dominated by slavery.

Terraced agriculture in the highlands, rice paddies on the coast

The many examples of terraced agriculture in the highlands of West Africa have in much previous literature been viewed as the result of a siege-like situation and a response to slave-raiding and the establishment of Islamic states in the medieval period. The intensive farming system can, according to such a view, be seen as the other side of the coin of slave-raiding and predatory states in West Africa. Contrary to the situation in the two cases referred to above, the farming communities in the highlands which practised terracing, stall-feeding, mulching and other intensive farming methods were decentralized societies and the potential victims of slave-raiding.

It is, however, a gross simplification to interpret the settlement and farming of these hills as primarily the outcome of a refuge situation. The hills often had higher precipitation than the lowlands and good volcanic soils. Already before the most intensive period of slave-raiding they offered good possibilities for agriculture. It is nevertheless probable that slave-raiding accentuated an already existing division of labour between groups in the hills and groups in the surrounding savannahs. I have previously developed these thoughts in a separate paper, on which the following three paragraphs are based (Widgren 2010).

The understanding of the social context of the farming system of such decentralized societies in West Africa has advanced from seeing them as mere victims of slave-raiding into a more dialectical view, recognizing both cooperation and conflict with the slave-raiding states as playing a role in their survival strategies. Scott MacEachern (1993) has argued for such a dialectical view of the emergence of intensive agriculture in the Mandara Mountains. He shows how relations between the Wandala state and the decentralized Mandara hill farmers were based on interdependence, since both groups controlled vital resources: "Each group had to be able to exploit the other in order to exist, but too much exploitation would cause conflict and might end the relationship" (ibid.: 258).

The most clear-cut example of this dialectic, however, is illustrated in Walter Hawthorne's study *Planting Rice and Harvesting Slaves* (2003). The Balanta along the Guinea (Bissau) coast were a decentralized population, who totally changed their settlement pattern and agricultural system in the sixteenth century, when it turned to intensive paddy rice farming. This farming system had existed further north along the Senegambia coast well before the arrival of Europeans. Rice cultivation in mangroves could only be undertaken with iron-edged tools, and the people cultivating rice in Senegambia obtained their iron from the Mandinka further inland. This had not been an option for the Balanta. Only when iron could be obtained from the Portuguese did they turn to paddy rice farming.

According to Hawthorne, in the face of slave-raiding, decentralized societies had three alternative ways of coping. One was to retreat to easily defended areas (such as forests or hills) and to amalgamate and fortify previously scattered settlements. A second coping strategy was to "engage with the broad markets and to gain access to valuable Atlantic imports" (Hawthorne 2003: 206). This is the context in which the establishment of labour-intensive rice cultivation among the Balanta should be seen. The Balanta also followed a third alternative by engaging themselves to a certain extent in the slave trade, albeit not as intensively as the slave-trading states.

Slavery and farming practices

I have shown how three different soil management systems, resulting in a build-up of landesque capital, had their background in a time period when slave plantations and slave-raiding were a dominant factor in society. In relation to slavery, the examples differ in an important way. In the first case, in the Islamic slave states of West Africa the build-up of manured infields in the intensively cultivated central parts of the ring-cultivations systems in the savannah were directly related to plantation slavery and to the hierarchical control of labour to secure the flow of nutrients and labour to improve the soils. These anthropogenic soils have been of great importance for present population density in the dry savannahs on the fringe of the Sahara.

In the second case, the Fouta Djallon gardens, there seems similarly to be a close connection with the slave plantations. By granting land and time to the slaves to establish their own gardens and assume responsibility for the reproduction of the labour force, the slave system enabled the development of what later became the intensively cultivated women's gardens. This can be compared with the small but intensively cultivated fields developed by crofters in Scandinavia during the nineteenth century.

In the third case, the heavy investments in landesque capital that occurred in the terraced "islands of intensive agriculture" all over West Africa *and* in the rice paddies along the coast represent a third aspect of labour mobilization. It was based on age-sets and work parties in basically egalitarian societies, but was closely connected to, and driven by, the broader economic and political development of the Atlantic slave trade and its aftermath.

The conclusions of this overview contrast with those of James Scott for upland Southeast Asia, which identify a particular "escape type of agriculture" with decentralized groups turning to swidden as a way of escaping states. While it is perhaps possible to delimit "refuge zones" also in West Africa, as Scott (2009: 25) proposes, there is an important difference between Scott's conclusions and the evidence presented here. It is possible that in other parts of Africa, like in upland Southeast Asia, there were zones of refuge where farmers extensified production as a reaction to slave-raiding, but the zones of refuge in West Africa that Scott refers to all opted for an intensification of agriculture. While there were important differences in the farming practices of hierarchical, slave-raiding states and escaping, decentralized farming communities in West Africa, there seems nevertheless to have been a common direction at both ends of the political spectrum: investments in landesque capital played an important role for raiders and escapers alike.

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8 Steam

Nineteenth-century mechanization and the power of capital

Andreas Malm

A hagiography of James Watt published by *The Times* in May 1859 conveyed a sales argument from his business partner Matthew Boulton, later to become legendary: “I sell here, Sir, what all the world desires to have – POWER.” As the story goes, Boulton exhibited the source of his pride to a visitor at the Soho works, where the steam engines designed by Watt were being manufactured to the clattering noise of hundreds of workmen, in 1776. Power was offered for sale. “A new era had dawned”, the anonymous hagiographer of *The Times* continued, “when *power* could be sold upon this scale, and its creators and vendors might deem themselves princes and kings of *powerless* men.” (*The Times* 1859, emphases in original.) This was no pun: cognizant of the transformations wrought upon the world in the age of steam, the writer of *The Times* clearly knew that the dual meaning of “power” was not a mere semantic coincidence. The mechanical powers mobilized by the steam engine accorded to its proprietors social powers over “powerless men”. Nothing made the machine more attractive.

Today, we know a lot more about the transformations unleashed by steam. A visitor to England, curious to see steam engines, might very well end up at the fine collection of the Science Museum in London, which will inform him or her that these engines “set the Industrial Revolution in motion. They gave access to massive amounts of coal, helping the first factories to flourish. But using fossil fuels such as coal has created a new problem … climate change.” This particular power – to change the climate of planet Earth – certainly did not figure among the advertisements of Boulton and Watt or the calculations of their customers. Not in their wildest imaginations did they believe that their puffs of smoke would set the world on the path towards fundamentally altered living conditions for peasants of Punjab, fishermen of Lake Chad, herders of the Persian steppe and other “powerless men” – and women – not to speak of uncounted species in all ecosystems between the poles. Unexpectedly, one mode of natural-social power has mutated into another.

However, the key to both these forms of power was not, strictly speaking, the still rather primitive steam engines on display at the Soho works in the 1770s, nor the even earlier models utilized in the coal-pits of England. It was the *rotary* steam engine, patented by James Watt in 1784. Up to that point, steam engines had burned coal in order merely to force a piston up and down, performing tasks such as pumping water out of mines. But the use of vertical motion was restricted. Steam engines would not unleash the full potential of coal until they managed to produce continued rotation, keeping wheels in constant motion, so as to propel machines and vehicles. This was the feat accomplished by Watt in 1784, following which the world would never be the same again.

With the conversion of the dense, concentrated energy of coal into mechanical energy – and, in particular, circular motion – the methods for producing and circulating commodities took a quantum leap. Some men gained the power to do almost anything, or so it seemed. They placed their economy in the orbit of perpetual growth, predicated on ever-growing consumption of fossil fuels, generating a sustained rise in carbon emissions and, by laws of biogeochemical necessity, a concomitant increase in the atmospheric concentrations of carbon dioxide. It is this strange kind of economy that we today know as "business-as-usual".

The literally epoch-making role of the rotary steam engine is honoured in the theory of the "Anthropocene". The concept of the "Anthropocene" has recently been recognized by the members of the Stratigraphy Commission of the Geological Society of London and is likely to be the officially recognized successor of the Holocene (Zalasiewicz *et al.* 2008). According to the theory, human beings have disturbed the natural state of the planet by burning prodigious amounts of fossil fuels and belching out CO_2 and other greenhouse gases into the atmosphere, initiating a process of global warming that has pushed living conditions beyond the boundaries characteristic of the Holocene. Thus, the argument goes, we are now living in the Anthropocene. The term was first proposed by Nobel laureate Paul J. Crutzen, in a seminal article in *Nature* in 2002, titled "Geology of mankind". Climate on Earth may depart from natural variability "for millennia to come", Crutzen asserted, and he went on to date the onset of this new epoch, reaching so far into the future, to James Watt's invention of the rotary steam engine in 1784 (Crutzen 2002).

But there are problems with this theory. To begin with, it confuses *invention* with *adoption* and *diffusion*. Some patented machines have never left the drawing-board: frozen fantasies da Vinci-style, they have at most become objects of exhibitions. To transform an economy – not to speak of a planet – an invention has to be widely adopted and diffused. Though the invention of the steam engine was a necessary condition for the creation of business-as-usual, it was not sufficient, and Watt's patent in itself tells us very little about our new epoch. We need to know *why people desired the steam engine.* Why was it applied to the production and circulation of commodities?

This was, to be sure, no automatic or predetermined affair. The breakthrough of the steam engine was contingent upon developments in which neither Watt nor Boulton played a role. To their disappointment, this held in particular for the prime target of their sales efforts: the cotton industry. For no less than four decades after the invention of the rotary steam engine, most owners of the mills where cotton thread was spun – the throbbing new life-blood of the British economy – still stuck to another prime mover. They preferred water wheels. Though steam engines were perfectly capable of powering spinning machinery, few were as powerful, efficient and reliable as the giant water wheels of the time – and, most importantly, the water flowing in the rivers of England and Scotland came for free. The energy propelling the wheels, unlike coal for the engines, did not have to be bought on a market. This made for a continued dominance of water power in the spinning mills up to the mid-1820s, leaving a puzzle for economic historians yet to be fully resolved: why were steam engines adopted so late, in the most advanced industry of their native land? (cf. von Tunzelmann 1978; Kanefsky 1979; Chapman 1971). As for the other major branch of the cotton industry – the weaving of thread into cloth – manufacturers relied on yet another energy source: human bodies. Up to the mid-1820s, almost all weaving took place in cottages and sheds, where men, women and children powered the looms with their own hands. But in 1825, the first ever peace-time depression struck Britain. In the spinning mills, stacks of thread began to collect dust due to extensive overcapacity in the industry, and profit rates plunged to unprecedented lows. To make matters worse for the industrialists, the Combination Laws banning trade union activities had been repealed in 1824, releasing the power of organized labour. No group exploited the new-won freedom more vigorously than the cotton spinners. Since the production of thread remained based on their manual skills in operating spinning mules, they possessed a formidable bargaining power: a turn-out could shut down entire factory districts. Wave after wave of strikes, the next more protracted than the previous, hit the cotton industry after 1824, severely exacerbating commercial problems (Turner 1962).

In the weaving sector, on the other hand, the workers were in a position antithetical to that of the spinners: scattered in their homes, they were unable to organize unions, manufacturers pitting one weaving family against the other. After the outbreak of the 1825 crisis, their wages fell to near or even below subsistence levels. But the weavers possessed one weapon of last resort. Receiving thread from the manufacturers to weave in their own homes, without any overlookers present, they could hide some of it and sell it to other manufacturers, adding to their meagre wages. The equivalent of the strikes in the spinning sector after 1825 was an epidemic of embezzlement in the weaving sector. Manufacturers tried to track down their embezzled threads, furious at the mounting losses, but without much success (Bythell 1969).

The crisis of 1825 did not pass quickly. It assumed the form of a *structural* crisis in the cotton industry, lingering on up to 1848, though punctuated by frenzied booms in which new factories – contributing to even more overcapacity – were established. To a large extent, it was a *structural crisis in the power of capital over labour*. Cotton capital responded by embarking on a full transition to steam. In both spinning and weaving, the insubordination of workers was countered with one mighty weapon: automation. After a spinners strike in 1825, a delegation of mill-owners begged a famous inventor to design a "self-acting mule", a machine capable of spinning thread without the participation of manual labourers. Five years later, a working model was patented, and in the early 1830s the self-acting mule – today regarded as the first truly automatic machine in industrial production – swept through the factories, dispensing with the traditional labour of the spinners and crushing their unions (Catling 1970; Bruland and Smith 1981; Bruland 1982).

A machine for weaving cloth automatically, called the powerloom, had been invented already in 1784, but up to the 1820s it had rarely been adopted, precisely because the handloom weavers were such a weak and inexpensive labour force. After 1825, however, in the climate of fierce competition and rampant embezzlement, manufacturers installed powerlooms in their factories *en masse*, dooming the handloom weavers to ruin. In the place of spinning factories and arrays of small weaving cottages, there arose the combined factories, churning out both thread and cloth from automatic machines tended by a domesticated labour force – chiefly young women.

Over the course of the structural crisis, and contributing to its eventual resolution, capital's power over labour in the cotton industry was thus restored. It was obtained by means of extra-human power. Bodily expenditure of energy at the spinning mules and the handlooms was replaced with automatic machines, animated by another kind of energy source. They were propelled by steam engines. The shift to self-acting mules and powerlooms vastly increased the demand for power in the cotton industry, and the manufacturers moved decisively to steam; the automation of thread and cloth production precipitated the transition. In the period between 1825 and 1848, steam engines rose from their long-standing secondary position to virtually complete dominance in the cotton industry. If the self-acting mule and the powerloom were the weapons used to bring labour to its knees, steam was the ammunition.

But why did the manufacturers abandon water? Had it become a scarce resource? Were the reserves of water power exhausted, causing, perhaps, a rise in its price? Could the water wheels no longer keep pace with the steam engines – were they technically incapable of satisfying the rising energy demand of an automated cotton industry? On the contrary, economic historians have long known that water retained its competitive edge over steam beyond 1825. The most Herculean water wheel installations surpassed the most imposing steam engines; no more than fractions of the commercial potential of the main rivers in England and Scotland had as yet been exploited; and – above all – the total costs of a horsepower of energy produced by water wheels remained far lower than that of a coal-fuelled horsepower. In fact, water power is believed to have maintained its superiority in terms of costs all the way up to the 1870s, long after the final transition to steam power within the cotton industry was completed. Steam gained supremacy *in spite of water being cheaper, at least as powerful and still sufficiently abundant* in the second quarter of the nineteenth century (von Tunzelmann 1978; Kanefsky 1979; Chapman 1971; Gordon 1983).

The adoption of steam thus seems shrouded in mystery. Why did it occur at all? If we turn to the contemporary literature – steam engine manuals, tracts on the cotton industry, parliamentary reports and debates – we find one answer repeated again and again. In his *Treatise on the Steam Engine* from 1827, the most influential steam manual in the burgeoning genre in this period, John Farey explained that steam "is often preferred, because a manufactory by steam power may be established in any convenient situation where fuel can be procured". Water power, on the other hand, "can only be obtained in particular situations, which are frequently unfavourable in other respects". Of particular importance, "natural falls of water are mostly found on rivers in the open country; but steam-engines can be placed *in the centres of populous towns*, *where labourers are easily procured*" (Farey 1827: 7, emphasis added). In 1833, a leading political economist of the time, J.R. McCulloch, presented a similar argument in the *Edinburgh Review*, the house organ of cotton capital:

> The real advantage of the application of the power of steam to give motion to the machinery of a spinning mill, or of a number of power-looms, appears to be a good deal misapprehended. It does not consist so much in any direct saving of labour, as in permitting it to be carried on in the most proper situation. The work that is done by the aid of a stream of water, is generally as cheap as that which is done by steam, and sometimes much cheaper. But the invention of the steam-engine has relieved us from the necessity of building factories in inconvenient situations merely for the sake of a waterfall. It has allowed them to be placed *in the centre of a population trained to industrious habits*.
>
> (McCulloch 1833: 323, emphasis added)

In the age before electricity, water power could only be used on the spot, in close physical connection to the rivers of England and Scotland. It was there to harness, inexpensive and plentiful, but it mostly lay outside the towns. A perfect location on a riverside "in the open country" could well be uninhabited. To construct a viable factory, a capitalist would thus have to establish a colony from the ground up. To attract labour, he might have to offer spacious lodgings, allotment gardens and a whole range of other facilities, unless he could get his hands on "apprentices", pauper children taken from the poorhouses and orphanages of the cities, a once significant labour supply for watermills that had all but dried up in the 1830s. To establish a settlement was an expensive and problematic undertaking. It was all the more risky in a time of unruly labour, when unions and strikes reached to the remotest corners of the cotton industry; with a restricted labour supply, the rural watermills were particularly vulnerable to such disturbances.

Steam was the obvious alternative. Cotton factories powered by steam engines could, as Farey and McCulloch argued, be built anywhere, since the fuel was fully mobile in space, once it had been delivered from the coal mines. Instead of carrying the self-acting mules and the powerlooms to a distant valley or gorge, only to expose their operation to the whims and demands of imported labourers, they could be run in towns teeming with proletarians seeking employment: inside Manchester, Glasgow and Oldham manufacturers could pick and choose between workers *in situ*. In other words, the great advantage of steam over water was not that it opened up new stores of badly needed energy after the reserves and technological potential of water power had been exhausted, but that it gave access to “a population trained to industrious habits”. As a prime mover based on a fossil fuel, rather than on water flowing through particular spots determined by the contours of landscapes, it granted capital the *power to search out the cheapest and most disciplined labour.*

Automation built on water would have been a self-defeating enterprise: building it on steam was the congenial option. There was a second advantage as well, pertaining not to the dimension of space, but to time. Over the course of the second quarter of the nineteenth century, under the pressure of popular uprisings that pushed Britain to the brink of social revolution, a series of Factory Acts were introduced: legislation limiting the extent of the working day. Starting with the first Act in 1833, in which the hours were restricted only for children, and culminating with the Ten Hours Act in 1847, factory legislation re-wrote the rules of the cotton industry. It was particularly painful for watermills. Not only did water flow in particular places and not in others, but at some times of the year the flow might recede, freeze or burst its banks. In dry summer weeks, in cold spells or after severe downpours the water wheels would come to a halt and production be suspended. But neither the immutable spatiality of water nor its intermittency in time was unmanageable per se. Up to 1833, cotton manufacturers had a convenient method for dealing with interruptions in water supply: if production had to be cut short, say to six or eight hours per day during one week of bad weather, the following weeks, when the flow returned, the workers would be requested to stay on the premises for 13 or 14 hours, or even longer. Free to command their workers to unlimited overtime, mill-owners could even out the irregularities of water flow and make up for all the lost time.

The Factory Acts, promulgated as concessions to alleviate popular rage over conditions in the industry, first restricted the latitude of this practice, and then, step by step, put an end to it. Cotton factories were gradually forced to conform to a normal working day. For capitalists reliant on water power, this entailed a risky exposure to the fluctuations of water power, while those opting for steam could always count on extracting the same daily amount of labour from their workers. Moreover, the latter could make up for the loss in working time incurred by the Acts by speeding up the machinery, mobilizing more extra-human power to intensify human labour, increasing the output for a given unit of time. On the rivers, the precarious power supplies inhibited such compensation. The problems were anticipated from the beginning. Already in 1833, when Parliament sent a commission to the industrial districts to investigate the consequences of a limit to the working day, the water mill industrialists were uneasy. The brothers Henry and Edmund Ashworth, leading cotton capitalists in the Bolton area, stated in their testimonies to the commission that

> There are many mills in the country where the water-power is insufficient in dry seasons, and the owners or renters of them are not in a condition to expend large sums of money to provide steam-power [because steam engines required heavy capital investments]. There are other places where

> the expense of fuel is a serious obstacle to the using of steam-engines. *Such mills would be rendered almost worthless*, if the workpeople were prevented by law from working up any portion of the time they may have lost.
>
> (Parliamentary Papers 1834: D1.279, emphasis added)

Another water power industrialist, Samuel Greg, whose company was ranked as the single largest in all of the cotton industry, was similarly apprehensive: "Any legislation, bearing hard on water mills, will entirely ruin an immense property" (ibid.: D1.302). A Manchester manufacturer spinning by steam, Charles Hindley of Manchester, stated the problem candidly: "It is obvious that *the more you diminish the number of hours the more you decrease the value of a water-wheel*, *in proportion to that of a steam engine*" (Parliamentary Papers 1833: D2.49; emphasis added). But such restriction came to be considered a political necessity, lest Britain be thrust into the chaos of revolution. Cotton capital dealt with it – particularly after the Ten Hours Act of 1847 – by new rounds of automation and acceleration through the erection of more powerful steam engines. Under conditions of capitalist production, the factory legislation became the death knell for water power – or, to put it the other way around: only with steam could capital maintain its *power over the working time extracted from labour*.

Armed with steam, industrial capital survived its first structural crisis and weathered the storm of working-class insurgency. When the cotton factories were converted to steam engines, the force of the automatic machines became indomitable. This was widely recognized at an early date. Wondering at the marvels of steam-powered industry, Andrew Ure, the renowned apologetic of the factory system, wrote in *The Philosophy of Manufactures*:

> In those spacious halls the benignant power of steam summons around him his myriads of willing menials, and assigns to each the regulated task, substituting for painful muscular effort on their part, the energies of his own gigantic arm, and demanding in turn only attention and dexterity to correct such little aberrations as casually occur in workmanship.
>
> (Ure 1835: 18)

Ure concluded that "the steam-engine is, in fact, *the controller-general and main-spring of British industry*, which urges it onwards at a steady rate, and never suffers it to lag or loiter, till its appointed task be done" (ibid.: 339, emphasis added). Not only adherents of the factory system adopted this view. Peter Gaskell, known as one of its fiercest critics in the 1830s, made a similar assessment:

> In looking back at the history of the cotton manufacture, and in examining the rise and growth of combinations amongst workmen, it may be asserted, that but for the application of steam, it must either have been destroyed by those who should most have fostered it, or that it would have been so

> restricted in its operations, and so burdened with expensive details, that it would never have progressed so as to become the staple trade of the country.
>
> (Gaskell 1836: 278–279)

Steam saved the cotton industry from the ruination of class struggle. But exactly what properties made its tremendous power possible? Ultimately, they were derived from the fossil fuel itself: from coal, the full potency of which was now realized. Coal was not, like water, an integral part of the landscape impossible to move from one place to another, and neither did it follow the rhythm of the seasons. In principle, its energy could be deployed in any place at any time. Another steam engine manual, written by Hugo Reid in 1838, expounded the latent forces of coal in evocative language:

> *For ages a hidden treasure, it has at last been brought to light*; and has placed within the reach of mankind a force so enormous, that it is limited only by the strength of the materials which must be employed to give it effect; a power unremitting in its labours and universal in its applications; so versatile, that it may be transferred from place to place, worked at any time, and suspended or set in action again at a moment's warning; – and withal, so steady and regular, so manageable, *so completely under our control*, and possessed of a self-regulating property to such an extraordinary extent, that it almost realises the fable of Prometheus, and may fitly be compared to an intelligent being devoted to our services.
>
> (Reid 1838: 4)

These were the powers appropriated by capital. But they proved their worth not only in relation to labour. As Daniel R. Headrick has recently emphasized in his *Power over Peoples: Technology, Environments, and Western Imperialism, 1400 to the Present*, the British empire, along with its European rivals, suffered another form of structural crisis before the 1830s. Most of Africa, Asia, even America, lay beyond European control. Four centuries after the Portuguese had first sailed along the west coast of Africa, the European powers still only had superficial hold over the area, through a string of coastal trading posts. The interior of the continent remained impenetrable. Attempts to foray into the inland regularly foundered, as the rivers could not be travelled with sailing ships. Navigating upstream in shallow waters, with wind and human bodies as the sole available energy sources, turned out to be a recipe for disaster. One expedition after another ended in mass death, sailors and soldiers falling prey to sudden attacks from riverbanks and galleys, exacerbated by the risk of succumbing to unfamiliar diseases (Headrick 2009: chapter 4).

The British empire was confronted by the same fundamental limits, though with local variations in environments and politics, along the frontiers of the Middle East, North Africa, and the Indian subcontinent. This was all the more frustrating for Britain in the early nineteenth century, as the rapidly advancing cotton industry demanded expanding volumes of raw materials, e.g. Nigerian palm oil to lubricate machines, cotton wool from suitable plantation districts and basic foodstuffs to sustain the workers. Sailing ships were not dependable enough to establish control over the required territories, nor to bring home supplies in sufficient quantities, on time, to reasonable costs. Consequently, the terms of trade of the British economy deteriorated: the relative prices of imported primary commodities rose, as the factories churned out ever-cheaper manufactured goods from their improved machines, glutting the world markets. Manufacturers were yearning for new lands as sources of raw materials and markets for their surpluses. With the structural crisis of overproduction, the deficiencies of wind-based imperialism threatened to become unbearable.

Luckily for capital, however, a radically different prime mover was waiting in the wings, or, as Headrick put it: "Starting in the 1830s, the old barriers began to crumble. Motives that had been dormant found a new energy" (Headrick 2009: 177). Britain was slower than the United States in adopting the steamboat as a means of transport within the national territory; instead, fleets of steamboats were sent to the frontlines of the empire. In 1832, a pioneering expedition departed from Britain for the mouth of the Niger River. The *Manchester Guardian* hailed it as "the most interesting armament ever dispatched from the shores of Britain", for "the mighty waters of the Niger", winding through the land of palm oil, had "occasioned the loss of more ink, and of more lives" than any other river in the world. Now the steamboats equipped by Liverpool merchants held out the promise, at long last, of opening the continent: "What a field is here displayed for mercantile adventure! What an opening for extending the trade of Great Britain! What a market for our languishing manufacturers!" the *Manchester Guardian* exclaimed (*Manchester Guardian* 1832).

After three years of navigation up and down the Niger, only nine of the 48 original members of the expedition returned to Britain alive. But the Niger had indeed been explored for the first time. The road to West Africa lay open, and British merchants were scrambling to equip new steamboats and lay their hands on the treasures suddenly made accessible. One officer of the 1832 expedition wrote a lengthy narrative of the journey upon his return, concluding with a proposal for filling the interior of the African continent with British steamboats and stations, for

> we have the power in our own hands … bequeathed to us by the immortal Watt. By his invention every river is laid open to us, time and distance are shortened. If his spirit is allowed to witness the success of his inventions here on earth, I can conceive no application of it that would meet his approbation more than seeing the mighty streams of the Mississippi and the Amazon, the Niger and the Nile, the Indus and the Ganges, stemmed by hundreds of steam-vessels, carrying the glad things of "peace and good will towards men" into the dark places of the earth which are now filled with cruelty. This power, which has only been in existence for a quarter of a century, has rendered rivers truly "the highway of nations", and made easy

> what it would have been difficult, if not impossible, to accomplish without it. *We are the chief repository of it: our mineral wealth*, and the mechanical habits of our people, give us a superiority over all others in the application of it. Can there be a nobler or more profitable application of it, than employing it to open up Central Africa? [...] By it the coast of Africa may be brought within a fortnight's sail from this country; by it her rivers may be explored and navigated in safety; by it may the mighty Niger be guided in a straight course to the sea, instead of spreading itself into countless and intricate channels; *by this Proteus-like power, will the oil from her palms, the sugar from her canes, the timber from her forests, be rendered more valuable and marketable.*
>
> (Laird and Oldfield 1837: 398–399, emphases added)

This was the dawn of another new epoch: that of direct European rule over the major populations of sub-Saharan Africa. In the coming decades, these populations were subjected to the free trade imperialism of the Victorian golden age. They shared this destiny with the peoples of Asia: in India, the arrival of steamboats marked a turning point in the consolidation of colonial control and the expansion of the cotton trade; in China, it provided the heavy artillery for battering down age-old walls. The Opium Wars were *tours de force* of steam power. After centuries of successfully resisting Europe's attempts to impose its trade, China succumbed to the irresistible force of steam-powered gunboats and finally signed the humiliating Treaty of Nanking in 1842. In a parallel campaign, British steamers dislodged the Egyptian forces from the Levant, shelling a string of coastal cities including Acre, Sidon and Beirut. After these two marvellous victories, *The Observer* could barely contain its excitement:

> The most striking fact in the whole history of the collision with China is the employment of steam; and the services performed by that mighty, though comparatively novel, agent in war, have been such as to cause much speculation as to the future amongst all thinking men. This is the second time that steam has been brought into action on a large scale in wartime operations, and it is the second time it has been successful. In the Chinese waters, as well as on the coast of Syria, its employment has produced results which astonished mankind; in the extreme west of Asia as well as in the extreme east – in China and in Palestine – it has finished wars which, under former circumstances, might have been protracted to infinity. But even these achievements, great and important as they are, do not seem to bear any proportion to those which are still possible to that wondrous power. *Steam, even now, almost realizes the idea of military omnipotence and military omnipresence; it is everywhere, and there is no withstanding it*. [...] With a steam navy, complete in all its appointments, England may be mistress of the world any hour she likes. No nation, nor any union of nations, could resist her. *She may be omnipotent*.
>
> (*The Observer* 1842, emphasis added)

The Mechanic's Magazine was even more explicit:

> Let war come to a conflict of steam-engines, and all the barbarian rabble of the world, Turks and Tartars, Arabs, Indians, Africans and Chinese, must obviously be out of question at once. They may massacre each other, but they must fly from the master of mechanics.
>
> (*Mechanic's Magazine* 1837)

These visions did, to a significant extent, come true. By the middle of the nineteenth century, Britain had wrapped the globe in a network of steam routes, carrying its influence into the recesses of the continents; the hearts of darkness were indeed reachable only by steam. With the concentrated energy of coal employed in the propulsion of boats, imperial power could transcend the obstacles of the preceding half-millennium, turn the tables on the natives, and conquer populations and ecosystems previously beyond reach (Headrick 2009: chapter 5).

Unprecedented quantities of natural resources were now shipped off to the factory districts at home. This particular capability of steamboats – to transport vast stretches of foreign nature into Britain – was extolled by the philosophers of steam, such as Michel Angelo Garvey, author of *The Silent Revolution, or, the Future Effects of Steam and Electricity upon the Condition of Mankind*, a utopia published in 1852. Thanks to steam, Garvey wrote, "the raw materials have been fetched from all parts of our own land, and from the forests and mines of regions the most distant". In the near future, "the animal, vegetable and mineral resources peculiar to different parts of the world will no longer remain profitless in the hands of their inhabitants [as] the unlimited power of transport will offer itself for their conveyance to the destined market" (Garvey 1852: 169–170). Again, this dream of steam was grounded in reality, for steamboats turned the negative trend in British terms of trade into its opposite: for the first time, huge volumes of low-value bulk commodities could be imported on time, and at reasonable cost. Relative prices of raw materials began to fall in the middle of the century, allowing the British core to appropriate ever-growing quantities of nature from the peripheries of the world-system. In other words, steamboats, first to mobilize fossil energy on seas and rivers, were the *sine qua non* of modern ecologically unequal exchange (Bunker and Ciccantell 2005: 158–166, 183–187; Hobsbawm 1999: 117–122; Sieferle 2001: 97–98; Huber 2008: 112).

On the waters, as in the factories, steam drew its supremacy from the properties of coal: independent of landscape and weather, under the command of its owners at any place at any time, it was an unparalleled source of power. In an 1824 public meeting in London, where the industrial and political elite congregated to call for the erection of a national monument in honour of James Watt, the Earl of Liverpool told the audience:

> Gentlemen, we have now no delay in our communications with any part of the world. Whatever it may be necessary to communicate, and to whatever

> quarter, be the winds friendly or be they contrary, the power of the Steam Engine overcomes all difficulties. Gentlemen, I have known in time of war when the fate of a campaign, and possibly the fate of a war, might depend upon getting a fleet out of port – contrary winds have prevailed for months, and the whole objects of government have been thereby defeated. Such difficulties can now no longer exist. Let the wind blow from whatever quarter it may, let the destination of our force be to whatever part of the world it may, you have the power and the means, by the Steam Engine, of applying that force at the proper time and in the proper manner.
>
> (Turner 1824: 3–4)

The analogy to the situation in the cotton factories is obvious. As a fuel for the generation of mechanical energy, coal furnished core capital with the power to overrun its adversaries – be they spinners or savages – in space and time. Applied to the production and circulation of commodities, steam thus pulled the British economy out of its first structural crisis, solving problems with a rebellious working class as well as expensive raw materials and a dearth of export markets. Propelling machines and vehicles, it drove the Victorian boom after 1848 and founded the first truly fossil-based economy in the world (Lloyd-Jones and Lewis 1998: chapter 4).

This was the original transition to a system of perpetual economic growth based on the ever-growing consumption of fossil fuels. But it also established a pattern that would be repeated again and again in the history of industrial capitalism. Later waves of working-class unrest have been countered with new rounds of automation, relocation and intensification of production, up to the most recent decades of global restructuring and industrial migration to China; every time, increased withdrawal of fossil energy has provided the requisite power. The threat of increases in prices of raw materials – including oil – have likewise been neutralized by massive expansion of their production across the globe, while export markets have been enlarged through the dismantling of remaining obstacles to free trade. Subsequent to the original transition to fossil fuels, every such phase of renewed capital accumulation has surged forward by tapping into these fuels, simultaneously adding to the growth of the economy *and* the atmospheric concentration of CO_2. Thus if steam engines have now been tucked away in scientific museums, they retain their great historical role as launching pads of what we now know as business-as-usual.

Surely, then, the "Anthropocene" must be a misnomer. The new geological epoch was not inaugurated by neutral representatives of "mankind". Steam was imbued with power relations from the start; it was applied because it augmented *the power of some people over others*. Stocks of coal marshalled as mechanical energy only appeared *in the hands of the owners of steam engines*, who realized their potentials in relation to targeted non-owners: "*We* are the chief repository of it: *our* mineral wealth…" There is no way of assessing the power of steam outside of this context. Being owned – that is, being monopolized by some people, to the exclusion of others – was as fundamental a property of the steam engine as were its emissions of CO_2 – indeed, the latter was only an epiphenomenon of the services it offered its proprietors. The steam engine could not have had any ontological existence or ecological significance prior to property relations, except as an idea in the head of an inventor; its influence on planet Earth was measured by its attractiveness for the prospective customers among capitalists and colonialists. The same basic ontology holds for all later instruments for harnessing fossil energy. Their stunning power to change the climate of the Earth has depended on their value for their owners, as distinct from non-owners.

The notion of the "Anthropocene" glosses over these essential social facts of our epoch. It elevates the actions of a comparatively small subcategory of humanity to the *species level*. But business-as-usual has always involved intra-species polarizations. Owners of steam engines and similar machines are of course human beings, but that is not enough to justify the proposition that this epoch is the product of humanity. The concept of the "Anthropocene" is a scientifically inaccurate product of the separation between natural and social sciences in the study of climate change. It is one of many ideas about global warming that obfuscates and mystifies its character as a social and historical process, thus obstructing requisite political action. The alternative is, of course, to accord proper analytical place to the insight intuitively professed already by *The Times'* hagiographer of James Watt: natural powers summoned by human beings have generally in history been social powers exerted by some human beings over others, and never more so than in the age of fossil energy (cf. Headrick 2009: 4).

Exactly what sort of "power" did steam constitute? In some sociological literature of the 1970s and 1980s, a distinction was made between "power" and "meta-power" (Baumgartner *et al.* 1975a, 1975b; Burns *et al.* 1985). We normally think of "power" as the ability to influence the behaviour of others, or in some similar common sense terms: A has power over B if A can bring B to act according to his/her wishes. Such power is exercised within a given matrix of human relations. But there is something above this ground level: some people possess the power to "change the rules of the game, the matrix of action", the very field where humans interact (Burns *et al.* 1985: 33). They exercise "power over power", or *meta-power* (ibid.: 112). Thus, while A possesses power over B within a given game, he or she might have had no role in *constructing* the rules of the game, from which his or her practical, immediate power derives (ibid.: 42).

We may flesh out this theory by means of examples from the British empire of the 1830s. An overseer urging his powerloom weavers to work faster by following the speed of the machines clearly possessed power, as did an officer steaming up the river Niger to collect palm oil from the natives. But neither of them engineered meta-power. At a causal level above their daily operations, meta-power resided in a constellation of coalmines, colliers, canals, railways, workshops, mechanics, steam engines and all the other links connecting "our mineral wealth" to the loom and the boat; we may call this vast structure "the steam power complex". Through its establishment, new rules of the game of human interaction were written, and new sources of power were delegated to the overseer and the officer. This is what Andrew Ure referred to when he called the steam engine "the controller-general and main-spring of British industry", and what *The Observer* understood when it praised steam as realizing "military omnipotence and military omnipresence; it is everywhere, and there is no withstanding it". The great promise of the steam engine was that it afforded its owners a derivative of meta-power – or, to use a more modern metaphor: the power of the British capitalist and colonialist was downloaded from the meta-power of the steam power complex.

We may thus propose that fossil energy, from the early nineteenth century onwards, has been the primary source of meta-power in the capitalist world-system. As such, it has had profoundly ecological implications. Extracted from the reserves of coal – "for ages a hidden treasure" – it has returned ton after ton of ancient carbon to the atmosphere, generating global warming. The first victims of climate change are latter-day representatives of the same categories of people against which the meta-power of steam was first utilized: people without property, people in the periphery. This is, of course, no coincidence, for today's owners of fossil meta-power can just as well use it to protect themselves, for the time being, against the effects of climate change (e.g. by filling up their car and driving out of New Orleans as a hurricane approaches).

In sources as well as effects, the greatest world-ecological transformation witnessed by humanity is a function of power relations. That is not to say that the suffering now imposed on powerless men and women from Peru to Pakistan has been deliberately crafted by devious actors. Much power is unintentional, and even more of its consequences. The Israeli army may exercise intentional power over the impoverished people of the Gaza strip, reducing them to clinically defined malnutrition, but speculators driving up the prices on staples likewise exercise power over people who go hungry as a consequence of their actions, even though their only intention was to make a profit. Some theorists have referred to the latter form of power as "fate control" (Burns *et al.* 1985: 116–117).

The meta-power of fossil energy, through the interfusion of the cycles of capital and carbon, has been converted into the *meta-power of global warming.* The surplus of carbon in the biosphere – a thoroughly social artefact – afflicts the Earth through the dreadful new powers of extreme weather. Put differently, the overaccumulation of CO_2 in the atmosphere – the aggregated legacy of two centuries of capital accumulation – capriciously hovers over defenceless people, ready to strike them at any place and any moment with a tropical cyclone, a season of torrential rains, rising sea levels or a never-ending drought. This is "fate control" on a truly global scale. Reminiscent of the Foucauldian shift from biopolitics to thanatopolitics, the meta-power of fossil energy that has been propelling the exploitation of the lives and resources of the proletariat and the periphery has transmuted into a meta-power of death and destruction, spiralling into the distant future.

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9 Ivory

Socio-ecological consequences of the East African ivory trade

N. Thomas Håkansson

Pastoralist populations in East Africa appear in the archaeological record 4,000–4,500 years ago, and specialized pastoralism has occurred and disappeared at different times and places over the last two or three millennia (Gifford-Gonzales 1998). While these geographically widespread pastoral societies have received much scholarly attention from a variety of disciplines, the prevailing interpretation of the long history of this socio-ecological specialization focuses on local and/or regional economic and ecological conditions. Yet, the emergence, maintenance, and spread of this form of livelihood as a productive specialization must be explained and not taken for granted. In the literature on East Africa, authors often view pastoralism as an unproblematic consequence of favorable environmental conditions and herd growth (e.g., Spencer 1998: 2–3; Marshall 1990; Schneider 1979). I argue here, like Henrichsen (2000), that pastoralism must be analyzed not as a given natural condition but as a result of wealth accumulation, which is historically constructed in contexts of social and economic world-system linkages. Furthermore, I argue that while instances of pastoralism may have occurred as local developments in time and space, the periods of widespread geographical and demographic expansions and contractions of pastoralist societies during the last millennium are linked to the global trade in ivory, and thus to the world-system.[1]

Theoretical problems in linking the analysis of long-term change in East Africa to world-systems emerge because approaches to the latter are often founded on the assumptions of capitalist relations of production. Extraction and exploitation in terms of labor time and natural resources are not structural properties of world-system relationships based on what Wallerstein called "preciosities," i.e., low-weight goods with high value. Such items became useful because they were incorporated as currencies and prestige goods into the value systems already existing in African political economies and had indirect effects that usually involved regional, rather than global, processes of labor and resource exploitation. That does not mean that currency-related changes in the political economy did not have real effects on human environmental relationships, only that it is difficult to establish a priori from theoretical principles what these could be. Although this is a problem of utmost importance, rather than trying to investigate the structural characteristics of exchange, I am here mostly concerned with establishing that there existed, historically, strong links between world-system processes and pastoralism. In the concluding paragraphs of this chapter I return to the theme of unequal exchange and environmental exploitation.

In the nineteenth century, pastoralists, foragers, and cultivators in many parts of East Africa bartered coastal goods or ivory for cattle. Thus, the ivory trade contributed to the spread and maintenance of pastoralism. In this chapter, I first demonstrate that the expansion of the ivory trade contributed strongly to the spread and maintenance of pastoralism in the eighteenth and nineteenth centuries. The ivory trade and the currencies used in exchange (e.g., cloth, glass beads, and livestock) both stimulated the spread of pastoralism and, through regional exchange, other productive specializations. Next, I explore the possibilities that processes of pastoralization such as those that occurred in East African prehistory were actually not localized phenomena but part of world-system processes that linked the region to Europe and Asia. Thus, I argue that the analysis of long-term changes in land-use and human ecology in the interior of East Africa must be related systemically to global economic and social interactions.

The keeping of cattle, sheep, and goats is ubiquitous outside the rainforest regions of Africa. Livestock is the primary investment capital, providing security and potential for wealth accumulation. In much of East Africa cattle, and other livestock, were (and to a great extent are) essential to social reproduction (Schneider 1979; Håkansson 1994). Before proceeding, let me add the caveat that the ubiquitous role of cattle notwithstanding, other forms of wealth also circulated as social payments in parts of the region, such as pieces of iron, imported cloth, and on the coast even coinage. However, the basic social institutions of families, households, and kin-groups could not, and cannot, be formed without cattle. Every family had to obtain cattle in order to build new households and to establish vital networks of kinship and affinity. Hence, cattle were constantly sought after and were the objects of control and allocation by male and female elders (Håkansson 1994; Talle 1988). Most economic activities were ultimately connected through cattle as the primary prestige good and investment. All agricultural production and land use may therefore be traced to political and economic strategies, which were, in turn, also directed toward access to, and control of, cattle (or sometimes other types of livestock). This pattern has been part of African economies for millennia and forms a continuum from farmers keeping livestock to specialized pastoralists such as the Fulani along the Sahel, Maasai in East Africa, and the Herero in southern Africa. Livestock keeping has a definite impact on the natural environment and large-scale herds of cattle entail the construction of a particular landscape shaped by burning and grazing (Gichohi *et al.* 1996; Homewood 2008: 59; Reid and Ellis 1995; Lane 2011). Fires remove scrub and trees, kill ticks and other parasites that carry infectious cattle diseases, and remove the habitat for tsetse flies, which are the vectors of bovine sleeping sickness (Kjekshus 1977). Thus, the savannah and steppe areas in Africa were partly formed by humans in their endeavors to keep cattle.

In contrast to the treatment of East African cases, historical and archaeological analyses of nomadic pastoralism in other parts of the world view these societies as part of trade systems and states. For example, in the circum-Mediterranean region and Eurasia such societies are understood as part of trade systems and states (Bonte 1981; Barfield 1993; Khazanov and Wink 2001). In West Africa during the last 1,000 years, the Fulani and Tuareg pastoralists controlled and partook in long-distance trade and in political conquests (Homewood 2008: 23, 27). Indeed, according to Bonte (1981: 46), "The formation of pastoral communities in the Western Sahara cannot be understood without reference to … trade." While some recent scholarship does recognize the importance of pastoralists as parts of wider systems of exchange and specialization (Waller 1985; Sobania 1991; Kusimba and Kusimba 2005) it focuses on local or regional adaptation rather than on their world-system relationships (e.g. Dyson-Hudson and Dyson-Hudson 1980; Marshall 1990; Spencer 1998). However, as in the case of pastoralists in other areas of Africa, and the world, it is clear that such a productive specialization does not expand and thrive without connections to wider economic and political networks. Thus, the waves of pastoralist expansion in East Africa were not the product of local and regional processes alone, but were directly linked to the dynamics of the Indian Ocean commercial system.

The ivory trade

Although there is very little detailed information about the amount of ivory extracted from East Africa until the nineteenth century, we have enough archeological and historical information to establish that it was traded already 4,000 years ago from Nubia to Egypt (Alpers 1992). The earliest confirmed trade from East Africa was during the time of the Roman empire (Chami 1999).[2] After the fall of the Roman empire came a period of decline in trade, which was reversed at the end of the first millennium when Arab and Persian ships began to trade on the coast (Kusimba 1999: 95). The expansion of overseas trade then exploded, and between AD 1000 and AD 1500 increasing amounts of ivory, iron, and other commodities were exported to China, India, the Middle East, and Europe (Alpers 1992; Horton 1987). By the eleventh century, the Swahili-speaking intermediaries in the Indian Ocean trade had established themselves along the East African coast and islands. Their towns and villages extended 3,000 km along the coastal strip from southern Somalia to northern Mozambique, with more than 400 sites occupied before the sixteenth century (Kusimba 1999: 34–35; Sinclair and Håkansson 2000). The expansion in settlement numbers and the size of towns reached their greatest extents in the fifteenth century and represent an increase in trade that was not superseded until the nineteenth century (Freeman Grenville 1963; Kusimba 1999: 35–36). Consequently, the fifteenth and sixteenth centuries must have been periods of widespread trade and hunting of elephants in the interior of East Africa. From 1550 to 1700 there was a drastic decline in trade from the interior of East Africa, followed by abandonment of a majority of the Swahili stone-built settlements.[3] In the seventeenth century, Oman had become both a powerful trading nation and sea power, and ousted the Portuguese from their territories in an attempt to gain control over the Indian Ocean commerce. Their domination as intermediaries began at the end of the eighteenth century with the establishment of Zanzibar as the main commercial depot and political center on the coast (Sheriff 1987).

Between the 1830s and 1850s economic interactions with the coast experienced fundamental and unprecedented transformations. Beginning at the end of the eighteenth century, markets for ivory expanded in Western Europe and the United States, where it was used for a variety of consumer goods including combs, piano keys, and billiard balls. Two interrelated factors were probably responsible for the development of the large-scale caravan trade: The increase in demand for ivory could increasingly not be satisfied through the established indigenous trading organizations in the hinterland alone (Lamphear 1970; Håkansson, forthcoming) and the increased demand and world market prices provided a reason for outside capital and merchants to wrest the trade from the trading organizations in the interior (Sheriff 1987: 169). From having been largely an enterprise controlled by interior communities, there was a shift to coastal control that led to the expansion of markets and trading settlements in the interior of East Africa. The increased demand and prospect for profits resulted in a burst of growth in ivory exports from Zanzibar during the 1840s that was primarily a result of the new caravan trade controlled from the Tanzanian coast.

The vast and steady accumulation of cattle in the region between northwestern Kenya, east to southern Somalia, and then south and west to northern Tanzania and the Rift Valley was based on exchange advantages that emerged from the network of trade.[4] The trade activities presented several opportunities through which people could obtain livestock. Ivory, and in some areas slaves, were paid for in cloth and beads, which in turn were exchanged for cattle further inland by people engaged as intermediaries, or as hunters selling their ivory. In the later nineteenth century, caravans obtained cattle from the coast, which were directly exchanged for ivory. Many communities sold supplies to caravans in exchange for cloth and beads, which in turn could be bartered for livestock in other areas outside the caravan routes (Volkens 1897: 240; Reichard 1892: 259; Fischer 1882–1883: 68, 75; Farler 1882). Finally, those members of inland communities who had access to beads and cloth could use these to exchange for food instead of using livestock in such transactions, thereby avoiding dispensing of livestock and preserving their herds.

The trade created an economic field in which people with large cattle herds in the periphery of the trade system exchanged cattle for coastal goods, resulting in a flow of cattle from such areas as what is now Rwanda and southern Uganda (Wissman 1891: 235–240), northern Kenya and Somalia (Fischer 1878–1879), and northwestern Tanzania (Sissons 1984), and including the vast Maasai territories around the central Rift Valley and the Orma in eastern Kenya, but also smaller groups such as Kamba and Giriama.

The economic dynamics of pastoralism

In an article addressing the long-term dynamics of pastoralism in prehistoric East Africa, Marshall (1990) focuses on environmental factors as determinant and seems to view economic and social processes as unproblematic. However, recent historical and ethnographic studies stress that pastoralist societies were part of changing and fluid regional economies and social networks, not a spontaneous result of an environment suitable for livestock. Productive specializations were not exclusive occupations for members of different communities but represented the ends of a continuum along which individuals move back and forth between full-time farming, pastoralism, and foraging (Waller 1985; Wright 2005). Specialized pastoralism is by necessity a regionally dependent productive social and economic mode of production. The specialized pastoralists had to exchange more livestock for crops than did agro-pastoralists, who practiced a mixed economy because a purely pastoral economy cannot produce enough food to feed the population (Brantley 1997; Galvin *et al.* 1994).

Pastoralist societies exhibit cyclical demographic characteristics of human and livestock populations that move up and down in a saw-tooth profile of steady growth offset at irregular intervals by a sharp and devastating loss (Spencer 1998: 41; Waller 1999). Repetitive pre-colonial disasters are documented in oral traditions (Spencer 1998: 208). For example, an earlier, historically known, widespread destruction of Maasai herds took place in the 1830s (Waller 1999). Droughts and stock disease periodically decimated cattle herds (Taylor *et al.* 2000). Human epidemics also reduced labor, which in turn affected herd managements. Those who suffered losses would migrate to agricultural areas where they took up cultivation in order to survive and to build up new cattle herds through the exchange of foodstuffs for livestock with the remaining stock owners (Spear 1997; Waller 1985). Once they had enough cattle for a pastoral existence they would once again move onto the plains and a new cycle of herd growth would ensue until environmental and social factors precipitated new declines in their herds. Such periodic and frequent herd reductions have also been documented in contemporary northern, semi-arid Kenya, where droughts are frequent (Fratkin 1997).

Recent examples must, however, be used with caution because of the presence of conditions that were not extant prior to the twentieth century. For example, in northern Kenya, pastoralists are affected by factors that restrain mobility and access to grazing such as land losses and armed bandits (McPeak and Barrett 2001). Both these historical and contemporary cases demonstrate that a specialization in pastoralism is a cyclical phenomenon that must be seen in dynamic interrelationship with neighboring societies (Spencer 1998: 41; Waller 1985; Mace 1993; Håkansson 2007).

Given the cyclical nature of specialized pastoralism as a system of production, it is difficult to explain the sustained periods of explosive growth in cattle herds and pastoralist communities that occurred during the second millennium. The Maa territorial expansion lasted for 400 years, punctuated by periods of stalled growth and large-scale reductions of cattle populations. Without taking into account external relationships, one would expect localized regional pastoralist communities to wax and wane over time. This seems to have been the case with the Maasai during the twentieth century. After the 1890s, the Maasai experienced large-scale herd losses in 1933–1934, and several times between 1948 and 1962.[5] Although the Maasai were able to rebuild their herds, the cattle population remained the same at the beginning of the 1960s as it was at the end of World War I (Waller 1999: 32). The reason for this long-term stability in cattle numbers was the changed economic and social situation of the Maasai communities, imposed by colonialism. They were placed in reservations and removed from their older integrated contact surfaces and their networks with the agricultural economies in the region (e.g., Hughes 2006). In addition, the restrictions on mobility and livestock trade further forced them to rely primarily on natural growth to increase herd sizes.

Trade and pastoralization in the nineteenth century

Although archaeological data from the East African hinterland for the last millennium is sparse, examples from the nineteenth century illustrate the dynamic relationship between the ivory trade, environmental risk, and pastoral specialization (for locations, ethnic units, pastoral areas, and caravan routes, see Figure 9.1). In Kenya, the agropastoral Kitui Kamba utilized the ivory trade to increase their cattle wealth. Big men and women developed influence and fame through trade. Many of these notables, as well as other more ordinary people, invested the proceeds from the trade in cattle to build large families, establish marriage alliances, and thereby gain political influence (Ambler 1988: 68–69). Coastal goods were used to obtain cattle from areas farther inland than Kitui and the building of cattle herds enriched whole lineages and communities that became completely pastoral, eschewing cultivation. Already in the beginning of the nineteenth century, trade had enabled their colonies along the immediate coastal hinterland to become completely pastoral, subsisting on milk, blood, and meat (CMS: Krapf 01–30–1845, 11–30–1849) and plant food obtained through exchange.

In the region between the Juba River in Somalia and the Tana River in Kenya, the pastoralist Orma involvement in the ivory trade can be traced back at least to the seventeenth century, when they were political allies of Pate, a relationship that was to continue through the nineteenth century (Cassanelli 1982: 152). Their trading partners were the towns of the Lamu archipelago, the coastal Swahili in Takaungu and Mombasa and inland peoples such as Taita, Mijikenda, and Kamba in Kenya (Brenner 1868). On the northern Kenyan coast, the Orma pastoralists undoubtedly undertook the largest volume of coastal trade. Their demand for cloth was so great that they exported not only ivory but cattle as well. Considering the volume and the fact that clothing made from textiles was only used by men, it is difficult to imagine that the desire for clothing by itself fuelled the voluminous export trade (for a detailed discussion, see Håkansson 2004). Although I have not yet been able to find detailed evidence, I hypothesize that the Orma pastoralists used the cloth to obtain both cattle and ivory further inland at favorable exchange rates. Indeed, Fischer (1878–1879) reports that they obtained cattle from 'Samburu' pastoralists at the upper reaches of the Tana River, but does not specify what they offered in return. In the 1860s the Orma also exploited price differences for cattle between the coast and hinterland, using

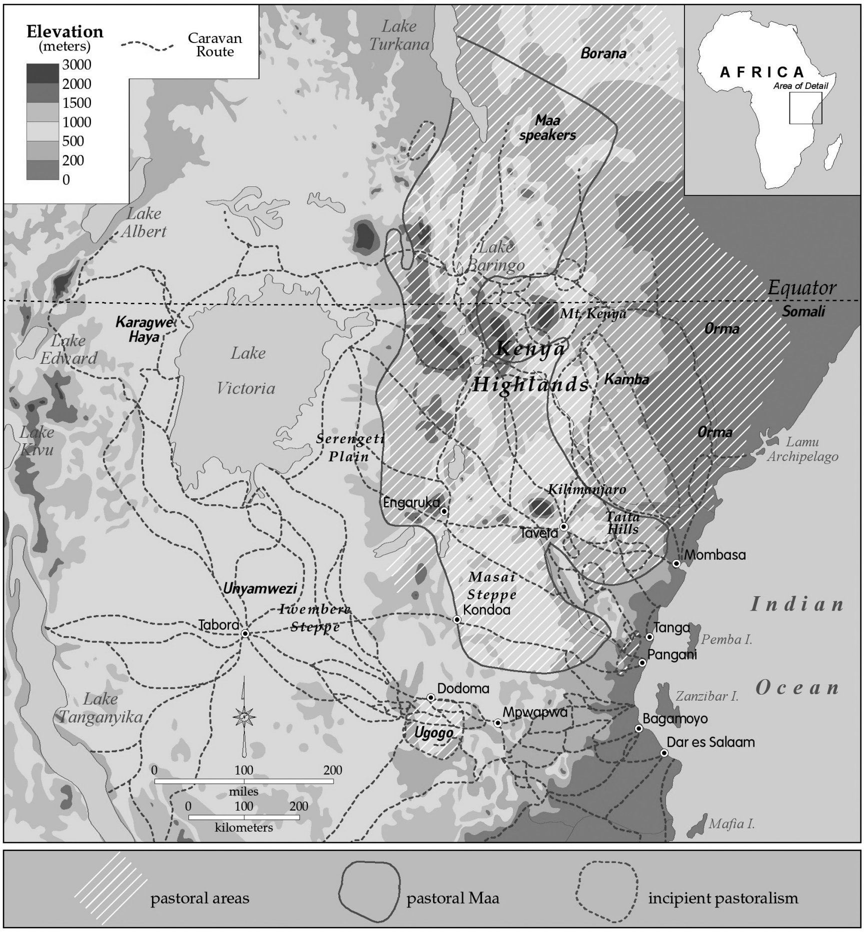

Figure 9.1 Pastoral areas in Eastern Africa, *c.*1850 (sources: Ehret 1971, 1984; Farler 1882; Fischer 1878–1879; Schmidt 1892; Sutton 1990; Wakefield 1882; Waller 1985).

Maria Theresa dollars obtained from the sale of cattle on the coast to buy new cattle from the Somali for a lower price (Fischer 1878–1879).

In the arid and semi-arid lands of northern Kenya, destitute pastoralists at this time traded ivory for cattle in order to rebuild their herds. In Kenya, Laikipiak Maasai and Samburu exchanged cattle for ivory with Dorobo foragers who were building up herds and becoming pastoralists themselves (Spencer 1973: 201; Fadiman 1976), and in northern Tanzania similar transformations in production strategies took place (Berntsen 1976; Waller 1985). The Il-Chamus by Lake Baringo in Kenya is a well-known example of an enclave community that used the ivory trade to accumulate cattle and become pastoralists. Pastoralists in northern Kenya had been integrated into coastal trade networks prior to the nineteenth century, including southern Ethiopia, the Benadir coast, and central Kenya (Robinson 1985: 300). Somali caravans obtained ivory through shorter trade networks in northern Kenya. The Samburu, the Borana, and the Gabbra were especially active traders whenever their herds had been reduced by disease or raiding. Then ivory became a means to generate currency to barter for livestock (Robinson 1985: 310).

The Great Rinderpest epidemic in the early 1890s, which killed up to 95 percent of all cattle in many areas of East Africa (Kjekshus 1977: 130), impelled pastoralists to engage in ivory trade at a larger scale than before. The impact of this catastrophe on the ivory trade in its waning years has not been investigated, but scattered references show that selling ivory was one of several strategies employed by pastoralists to rebuild their herds (see e.g., Berntsen 1976; Barber 1968: 101; Baumann 1891: 294). This increased engagement in the ivory trade by pastoralists may have led to the temporary increase in the volume of ivory exported from Zanzibar in the first years of the 1890s (see Figure 9.2 and Håkansson 2004).

The coastal goods entered complex regional networks that provided a variety of opportunities for exchange that included livestock. This trading system enabled agropastoralists and pastoralists between Lake Turkana and Konso to obtain grain by acting as intermediaries carrying highland products to the lowland (Sobania 1991). The same pattern of exchange was found in nineteenth-century northern Tanzania and central Kenya. In order to avoid expenditure of livestock, Maa speakers such as Maasai and Parakuyu used coastal goods as an alternative medium of exchange. The Maasai around Mt. Kenya exchanged cloth for agricultural products with the Gikuyu communities (Muriuki 1974: 86).

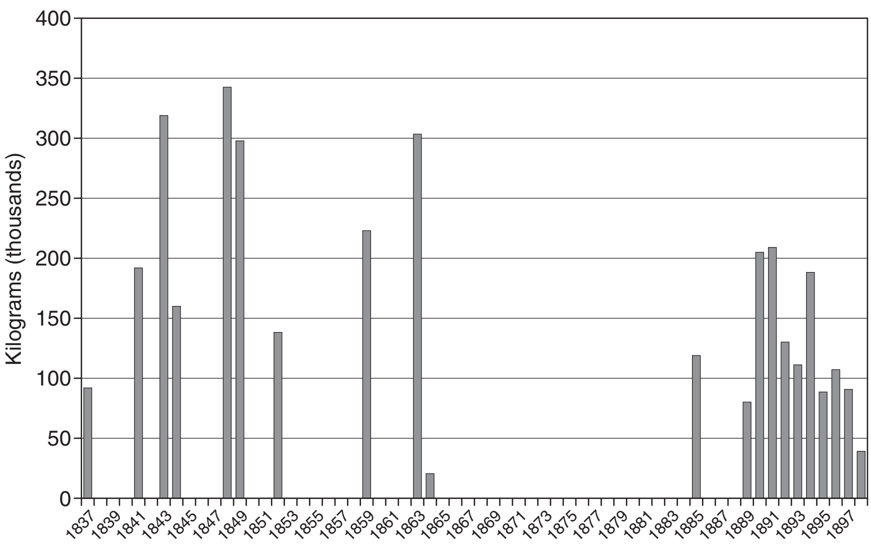

Figure 9.2 Exports of ivory from Zanzibar in kilograms (source: Håkansson 2004).

Also outside the main areas of pastoral development, many agricultural communities on the coast converted their gains from the coastal trade into cattle. During the first half of the nineteenth century, the Giriama north of Mombasa, and the Digo to the south were trading ivory and grain to the coastal towns. While little is known of the ecological effects of this expansion of cattle herds among the Digo, the Giriama were practically an agropastoral group in the middle of the nineteenth century (Parkin 1991: 22). South of Digo, the Zigua communities accumulated cattle through ivory trade and the sale of grain to the coast and expanded their villages westwards toward the Pangani (Giblin 1992: 26, 33). In central Tanzania, Ugogo was an important provisioning area for caravans. The Gogo used a part of the coastal goods to barter for cattle from such neighboring agropastoral groups as the Nyaturu and Segura. This trade may have accounted for 1 percent of the yearly growth of cattle herds (Sissons 1984: 201, 243) and was responsible for the enormous herds of cattle reported by nineteenth-century travelers (Sissons 1984: 156, 167). Thus the dynamics of the coastal trade as a condition for the development of pastoralism on a grand scale with attendant land use designed to optimize cattle production is evident during the second half of the nineteenth century.

A parallel case to the East African process of pastoralization through entanglement in the world economy is found in Namibia. The re-established and wealthy pastoralist Herero society in central Namibia was at the middle of the nineteenth century "firmly integrated into the system of mercantile capitalism which expanded from the Cape Colony into southwestern Africa during the nineteenth century" (Henrichsen 2000: 152). In the early nineteenth century, the Herero lost much of their livestock to raiding by groups with firearms from the Cape Colony. A few decades into the century, mission stations were established and attracted destitute Herero who, under the protection of the missions, began to grow tobacco in order to accumulate small stock and cattle. Agriculture and the increased availability of wage work for European enterprises allowed the Herero to begin accumulating anew. They mobilized themselves along clan lines, and acquired guns and ammunition with which they were able to raid their neighbors, push out the foreign chieftains, and re-establish their herding economy. As the century drew to a close, the Herero continued to accumulate cattle through engaging in the trade of guns, ammunition, and horses, and participated in the commercial hunting system, selling ostrich feathers and ivory (Henrichsen 2000).

Pastoralization and prehistory

The investigation of pastoralization during the last millennium is hampered by the dearth of archaeological and documentary evidence. Some detail can be ascertained through the findings of historical linguistics that give a rough picture of territorial spread and contraction of communities that engaged in specialized pastoralism. Research in historical linguistics suggests that during the last 1,000 years there have been two periods of build up and spread of specialized pastoralist populations. The first was undertaken by people speaking Southern Nilotic languages, and is mainly documented through the historical linguistics research by Ehret (1984), but also through the work of archaeologists such as Sutton (1990) and Lane (2011, in press) in western and central Kenya, respectively. The second, which extends into the late nineteenth century, was dominated by the emergence of Eastern Nilotic speaking Maa groups, the forebears of the modern Maasai, Parakuyu, and Samburu (see also Lane 2011).[6]

Before continuing the discussion, let me emphasize here that a period of expansion of specialized pastoralism and its concomitant socio-cultural attributes should not, as Sutton (1990: 54; see also Ehret 2002: 394; Homewood 2008: 38) points out, be construed as a large-scale population movement of bounded ethnic groups, but rather as the assimilation of successful cattle accumulators into a cultural package of language, social organization, and ritual such as occurred during the growth of Maasai communities. Examples of this process are well documented during the nineteenth century, in which the foothills of the highlands of Kenya and northeastern Tanzania became transition zones for families moving into herding (Håkansson 2008). For example, along the Maasai–Gikuyu borderland, semi-pastoral populations developed through the movement of successful cattle accumulators into the areas where cultivation and forest merged into pastures (Waller 1985).

As a way to make plausible my contention that there is a connection between pastoralization and world-systems linkages in the Indian Ocean trade before the eighteenth century, I relate fluctuations in the territorial expansion of specialized pastoralism to fluctuations in the volume of ivory and other goods traded from the interior. To accomplish this, I rely heavily on a combination of research in historical linguistics and archaeological investigations of the coastal Swahili towns. However, before I elucidate this material, I need to discuss the little data that exists on actual trade volumes and the occurrence of coastal goods in the interior of East Africa. One could argue that the great increase in the volumes of ivory exported in the nineteenth century was an unprecedented occurrence and that earlier ivory trade would have been at a smaller scale and thus had less ramifying effects on the societies in the interior. However, two estimates exist by outside observers from Pate in the Lamu archipelago, off the northern Kenyan coast, that suggest the occurrence of substantial extraction of ivory in earlier periods. The export from Pate was 294,545 kg in 1680 (Bardense 2002: 372). That this figure was not unique is supported by an American trader who, in 1653, observed that the ivory export from Pate was more than *c.*130,000 kg, a figure that we know accounted for more than the export from Mombasa and Mozambique taken together (Ylvisaker 1982). These figures are comparable to the exports from Zanzibar (Figure 9.3) during the heydays of the ivory trade in the nineteenth century – e.g., 159,091 kg in 1844 and 350,000 kg in 1848 (Håkansson 2004). These numbers do not in themselves tell us about the volume of trade south of Pate or during earlier centuries. What they indicate is that even before the expansion of the capitalist world-system, the interior communities were capable of exporting, at least intermittently, volumes that required a wide reach of trade networks in the interior.

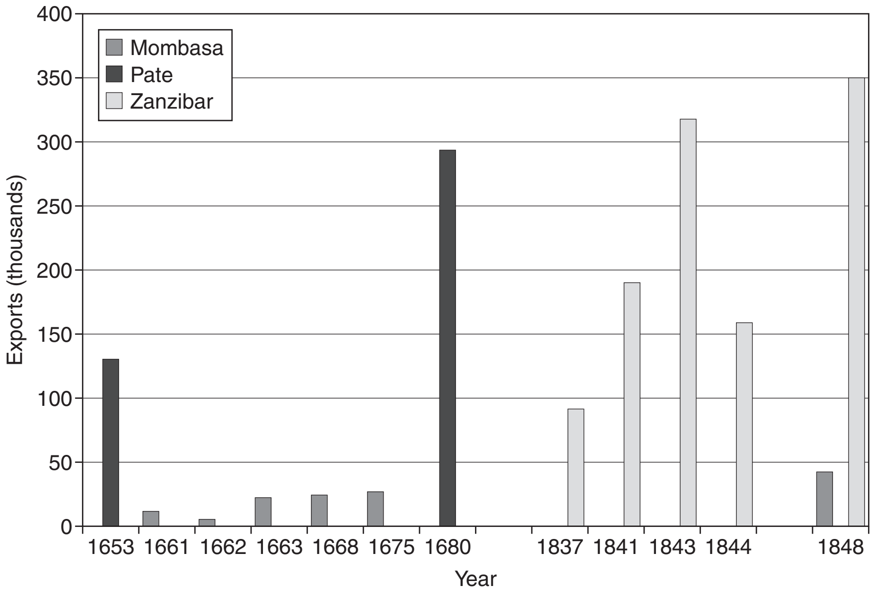

Figure 9.3 Seventeenth-century ivory exports compared to the peak exports from Zanzibar in the nineteenth century. (sources: Bardensee 2002; Håkansson 2004; Sheriff 1987).

The archaeological evidence for coastal connections in the interior of East Africa is still fragmentary due to a lack of excavations on second-millennium sites. However, a few glimpses can be seen in the form of glass and shell beads and some other artifacts of coastal origin. Beads, shells, and copper dating to the fifteenth century have been found in the ruined irrigation community of Engaruka near Ngorongoro in north central Tanzania (Sutton 1986; Westerberg *et al.* 2010). Recently, glass beads, cowrie shells, and worked ivory from the thirteenth and fourteenth centuries were excavated in Bunyoro in eastern Uganda (Robertshaw 1999), indicating an early, wide extension of the ivory trade. Closer to the coast in the Pangani Valley in northeastern Tanzania, glass and shell beads from the thirteenth and fourteenth centuries occur near South Pare Mountain (Walz and Håkansson 2008; Soper 1967) and to the north of this area in Kenya, in the Taita Hills and west thereof, glass beads from the sixteenth century have been found (Dussubieux *et al.* 2008).

The available evidence from historical linguistics suggests that very few communities practiced specialized pastoralism at the end of the first millennium AD (for locations, linguistic units, and pastoral areas, see Figure 9.4). Archaeological research in western Kenya and the central Rift Valley and adjacent areas also supports this view (Lane, in press).[7] The work of Christopher Ehret (1971, 1984, 2002) shows a prevalence of mixed economies where cattle-keeping groups practiced cultivation and foraging as well. The re-emergence of specialized pastoralism seems to be associated with speakers of Southern Nilotic languages who, during the twelfth and thirteenth centuries, spread south from northern Tanzania along the Rift Valley (Ehret 1971: 60–62; Sutton 1990: 41). This new wave of pastoralization took place during a period of sustained growth in the coastal trade. The trade began in the tenth century, when Europe was flooded with magnificent examples of carvings in elephant ivory (Horton 1987: 86), and reached its first high plateau around 1100–1250. Substantial masonry houses were built, and many communities were founded or expanded greatly in size. The population increased during this period and there was a near four-fold increase in known settlement area on the coast (Wright 1993).[8]

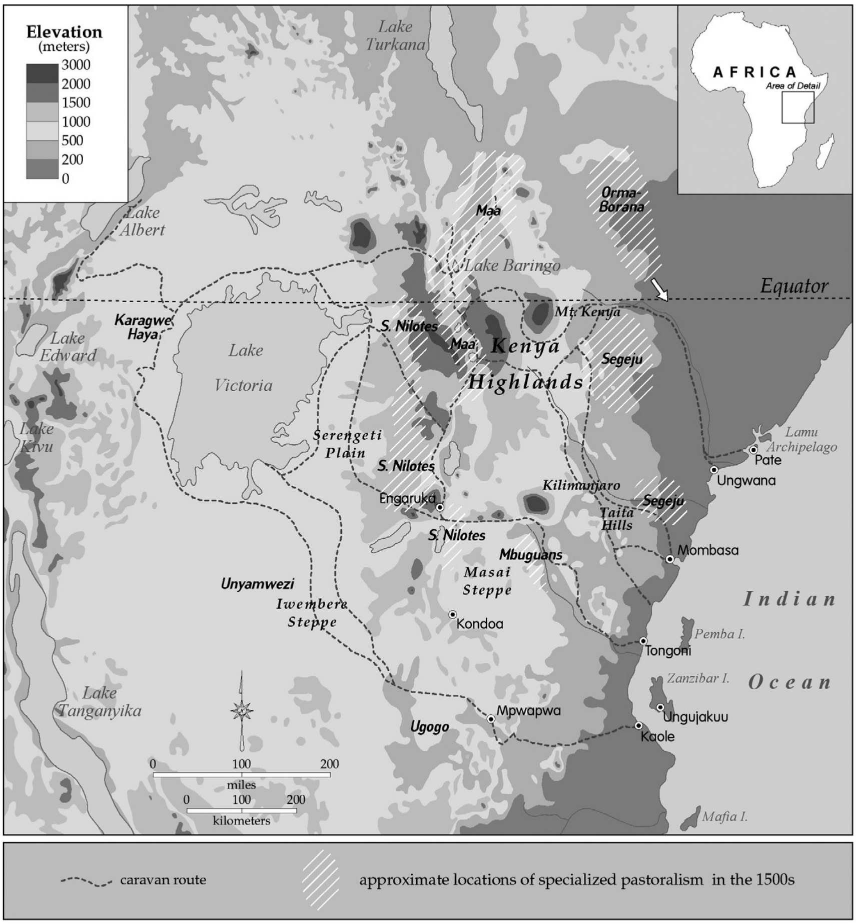

Figure 9.4 Pastoral areas in Eastern Africa, *c.*1550. Hypothetical caravan routes (sources: Ehret 1972, 1984; Galaty 1993; Sutton 1990; Walsh forthcoming).

After the spread of the Southern Nilotes, the next phase of pastoral expansion derives from the Maa cluster northwest of Mount Kenya. The proto-Maasai began to make inroads in the lands of the Kalenjin along the Rift Valley in central Kenya as early as the early sixteenth century.[9] In Kenya, Maa-speaking pastoralists dominated from north of Baringo southwards to the Rift Valley and surrounding plateaus (Galaty 1993). By the year 1600 they had expanded as far as the northern edges of Tanzania (Ehret 1984; Galaty 1993). Indeed, archaeological investigations on the Laikipia Plateau, east of the Rift Valley, indicate a transition from foraging to specialized pastoralism during the first half of the second millennium (Lane, in press). In addition, changes in vegetation toward grassland, marked increase in dung-colonizing fungi, and the emergence of erosion patches in Laikipia around the middle of the second millennium also provide indirect evidence of the spread of pastoralism (Lane 2011). Although currently there is no empirical evidence to directly support the hypothesis outlined here, it is suggestive that the Maa expansion, which is believed to have commenced in the sixteenth century (Summer and Vossen 1993), took place after two centuries of immense growth in the coastal trade. In addition, the Maa specialized pastoralism evolved in an area with the largest herds of elephants in East Africa (Håkansson 2004). These successive waves of pastoralization indicated by the linguistic evidence[10] are associated in time with developments on the coast. In the fifteenth century, after a hiatus of 100 years, there was a marked increase in building and the size of towns, as well as the establishment of new settlements along the coast (Mathew 1963; Pouwels 2002).

Around 1550–1700, an era that can either be characterized as one of stability or stagnation in pastoral economies, seems to be associated with the period of economic decline on the central East African coast.[11] The arrival of the Portuguese on the coast in 1498 was followed by war, looting, and periods of colonial rule. The effect of the Portuguese on the Indian Ocean trade and East African commerce has been much discussed, but was probably minor (Frank 1998: 178–179; Bardense 2002: 340).[12] From 1550 to 1700 there was a drastic decline in trade from the interior of East Africa, followed by abandonment of a majority of the Swahili settlements. During the seventeenth century the building of stone mosques apparently ceased, and a large number of mosques were abandoned and fell into ruin (Freeman-Grenville 1963). The economic depression and depopulation of the coast lasted until the beginning of the eighteenth century, after which a commercial renaissance on the Swahili coast began, including a revival in building activities (Sheriff 1987: 18). Sometime around the middle of the eighteenth century, the trade in ivory started to increase to unprecedented levels, culminating in the mid-nineteenth century (Håkansson 2004).

Conclusion

Scholarship in archaeology and on recent East African history, i.e., the history beginning in the late nineteenth century, is still rooted in a dichotomy that separates pre-colonial isolation from a later time when the capitalist world-system impacted this part of the continent. My argument here is that Africa has been part of successive world-systems for millennia and that an understanding of political and economic processes must be seen as continuous over long periods. At the same time, I propose that these global interrelationships have varied with respect to their mechanisms and structural logic.

Exchange of prestige goods and valuables are more likely to have had indirect effects on regional, rather than on global processes of labor and resource exploitation. If we measure exploitation in terms of differences of labor time and effort invested in items exchanged on the East African savannah, we can say that exploitation by pastoralists of cultivators existed because the amount of grain obtained for a goat or a head of cattle represented many times the labor invested in raising the animal. The flow of coastal trade goods exacerbated the tendencies of unequal accumulation. In the farming areas, female and male dependents produced increased amounts of crops that were exchanged for cloth and beads,[13] which further supported the accumulation of wealth by household heads, usually male, in the form of cattle. Regionally, the indirect effects were seen in the flow of cattle from some areas and their accumulation in others, which in turn led to conflicts and processes of political centralization with ecological consequences. Other forms of exploitative dependencies existed between pastoralists and foragers. For example, the Maasai and other pastoralists maintained foragers as low-caste dependents that had to give up ivory tusks to the dominators for free.

However, sometimes world-system processes based on valuables can entail unequal exchanges in terms of large-scale reduction in the productive capacity at one end of the system. I have suggested elsewhere that the ivory trade indeed did have measurable effects on the productivity of East African environments by removing elephants from the ecosystem where large areas were transformed into unusable scrub (Håkansson 2004; Håkansson *et al.* 2008). Clear international exploitation of labor in terms of time spent on production did not begin until the second half of the nineteenth century through the large coastal caravans traveling into the interior. The ratcheting up of the trade in the second half of the nineteenth century encouraged slave raiding and slave labor used for agricultural production.

Acknowledgments

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Notes

1 Obviously climate change must also be taken into account in a long-term perspective, but its role is still poorly understood (Westerberg *et al.* 2010).
2 Based on Felix Chami's find of Roman beads in the Rufiji Delta.
3 While the abandonment of the stone-built towns does not exclude a continuation of settlements made of less durable material, it indicates that the elites could no longer obtain the wealth necessary to maintain their urban centers. The reasons for this decline in trade are much debated, but this discussion cannot be reviewed here. For an overview see Kusimba (1999) and Håkansson, (forthcoming).

4 Evidence for the impact of spatial differentials in exchange rates on the flow of livestock in the region are scattered in numerous sources. Some of this material is analyzed by Schneider (1979), Koponen (1988), and Håkansson (2004, 2007).
5 The colonial numbers cannot ultimately be taken at face value for clues about herd growth in pre-colonial times. For example, removal of the Maasai to less than optimal grazing areas must have affected herd growth. On the other hand, improved control of cattle diseases through dips and vaccinations may have contributed to increased survival.
6 This situation is currently changing through the work of archaeologists and other scholars at several universities, e.g., University of York and University of Helsinki.
7 Archaeological evidence indicates that there existed earlier communities of specialized pastoralists, but a treatment of these is beyond the scope of this chapter.
8 The evidence for an extensive trade with the interior prior to the sixteenth century is still indirect. No other satisfactory explanation of the wealth of the coastal towns exists, and the time of their efflorescence coincides with an increase in imports of ivory to southern Europe (Alpers 1992). This ivory has unfortunately not been sourced. In addition, the recent increase in archaeological investigations of second-millennium sites in the interior has led to the discovery of coastal goods as far east as Uganda (Robertshaw 1999).
9 There was an earlier expansion of Maa speakers in the first part of the second millennium, resulting in settlements as far south as Kilimanjaro. However, linguistic studies suggest that they were not specialized pastoralists (Ehret 1984).
10 Historical linguists reconstruct economic specializations through the analysis of reconstructed vocabularies. While this method may not be perfect, it is accepted and used by several scholars working in East Africa (Ehret 1998).
11 The causes of the latter continue to be debated, but a discussion is beyond the scope of this chapter.
12 The reasons for the coastal economic decline are only partly clear. One dominant view blames aggressive Portuguese policies (Kusimba 1999). However, there is circumstantial evidence for a decline in the supply of ivory and other goods from the interior during the 1600s. During their attempt to exclude the Swahili from the formerly lucrative ivory trade, the Portuguese do not seem to have been able to derive much profit from their trading monopoly (Strandes 1961 [1899]: 212).
13 The evidence for an increase in the production of crops for sale to caravans is mostly indirect. If the farmers did not increase production, they must have redirected the surplus from exchanging with pastoralists to supplying the caravans. There does, however, exist a couple of well-documented cases of increased production for this purpose from Ugogo and Kondoa in north-central Tanzania (Sissons 1984; Mung'ong'o 1995).

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10 Lawns

Botanical garden design as colonial domination

Mats Mogren

Apart from the environmental hazards they entail, there are few landscape features in our time as ideologically innocent as lawns. The presence of lawns in every suburban garden has rendered them invisible. Lawns are nowadays kept to keep up norms of conformity. This practice has not always been the case. Lawns were once explicit status markers signifying the societal position of the owner. The change from status marker to conformity marker is relatively recent and it came with the mechanical lawn mower.

Edwin Budding invented the lawn mower in 1830, and in 1832 it was put on the market. It was an awkward, heavy and very expensive machine, which did not revolutionize gardening at first. Many lawn owners still relied on scythesmen. By the end of the nineteenth century the invention was improved, but it was still hard to use. In 1893 a steam-powered lawn mower was introduced, weighing 1.5 tons and quite unmanoeuvrable. In 1902 the first gasoline-powered mower was put on the market (Elliott 1993). In general, the entire nineteenth century can thus be said to fall within an old lawn-mowing mode. Every person mowing his or her own lawn is a twentieth-century phenomenon.

Before the mechanical lawn mower, lawns were kept trim with scythes. Using a scythe required certain expertise and the mode was of course labour intensive. Lawn establishment and maintenance was extra difficult in the tropics. Hugh Fraser Macmillan, in his once popular and repeatedly reprinted *Tropical Planting and Gardening with Special Reference to Ceylon*, underlines the difficulty in sowing lawns in the tropics. The better option is to cut turves from close-grazed pasture land and put them in the intended place. In the dry season they must be richly watered and in the rainy season they must be mowed two or three times per week (Macmillan 1935: 66f.). These requirements not only affected local animal husbandry and agriculture in a dramatic way, they also implicate the need for a substantial labour force. Yet, in colonial society, lawns were considered indispensable (Roberts 1998: 122). The lawns were the stage for various social activities in the upper strata of the colonial hierarchy, and were in that way charged with the local dominance pattern. It could even be said that colonial society was to some extent constituted by these green spaces.

This chapter addresses the socio-political charge that lawns and tree-lined avenues (both of which are human-made landscapes) had in colonial society, and especially in one type of landscape where they were not necessary from a utilitarian point of view – the botanical garden. The creation of these tropical landscapes was part of a very ambiguous concept, colonial modernity.

On the one hand, colonial modernity was scientifically oriented; the overseas possessions were to be studied, understood and exploited according to the new knowledge obtained. Infrastructure was developed to facilitate the exploitation and to knit the far-flung territories together with the metropole. Railways were constructed on a grand scale not much later than in Western Europe, and steamship lines spun a net to the remotest spots of the empires. During the third quarter of the nineteenth century, telegraph cables tightened the net further.

On the other hand, colonial modernity was often aiming for its own opposite; it was traditionalizing, de-industrializing and de-modernizing (Adas 1995; Misra 2008).

Imperialism, the scientific ideals of the age and the commercial exploitation of nature all found a nexus point in the colonial botanical gardens. Brockway (1979) and McCracken (1997) provide rich historical accounts of the growth of the extensive network of botanical gardens in the British empire of the late eighteenth and the nineteenth century, as instruments for the exploitation of tropical nature. This imperial project involved a discourse about Man's dominance over Nature, about the plants being created for Man to use (based on Genesis), about botanical science as serving economy, and about economy being made to serve empire. But it was also about the manifestation of empire via the transformation of landscapes, which included a discourse of Man's dominance over fellow Man, over the colonial Other. This aspect of an implicit discourse of domination has not been addressed to the same extent as the exploitative one, but will tentatively be the focus of this chapter.

Bernard S. Cohn's essays on the knowledge systems of colonialism serve as a natural starting point for this study (Cohn 1987, 1996). Among the sub-types of his investigative modalities, the aspects studied by Brockway, McCracken and others represent a survey modality (Cohn 1996: 7f.), while the aspect briefly presented here fits his concept of a surveillance modality (Cohn 1996: 10f).

The Botanic Gardens of colonial Ceylon

European colonial powers established botanical gardens in their tropical possessions from the mid-eighteenth century into the early years of the twentieth century. In the British empire botanical gardens constituted a network linked to Kew Gardens in England, facilitating the exchange of plants, seeds and knowledge. The garden at Howrah outside Calcutta (Kolkata) was considered the finest one outside of the British Isles. Peradeniya Botanic Gardens in Ceylon (Sri Lanka), 6 km southwest of the last indigenous capital city, Kandy, ranked in the top tier, and serves as an important case for this discussion.

The garden in Ceylon was established in 1821, only six years after the British annexed the area and three years after establishing full control of the region after putting down the 1817–1818 rebellion. The highlands of Ceylon were not a crown colony at that time; the former Kandyan kingdom was administered independently from the crown colony on the coast, under a resident, until 1832. It is also noteworthy that the gardens were established two years before the first primitive cart road between Kandy and the coast was built.

The grounds used for the Botanic Gardens was a former royal garden, established in 1780 on land that had been a royal demesne since 1371 (Pethiyagoda 2007: 63). In the grounds the kings had built a palace and a monastic *vihara* with a stupa. Ruins were still visible when the Botanic Gardens were established. A ditch had been dug along the banks of the Mahaweli River, which made a loop around the gardens. Thus, gardening had long been practised here. The name Peradeniya, meaning "guava cultivation land", is indicative of this fact.

In the native gardens of the area, coffee was planted as single bushes, and the British understood that the ecological conditions for coffee were excellent in the region. The governor, Sir Edward Barnes, took a lot of interest in the matter and in 1824 established an experimental plantation just across the river in Gannoruwa and encouraged the establishment of the first commercial coffee plantation, Sinhapitiya in Gampola.

This interest in coffee gave the Botanic Gardens its *raison d'etre*. Part of the area was planted with jak, coconut and vegetables, which were consumed by the Government Agent, but most of it was planted with coffee and cinnamon, and plants were distributed among the newly established commercial plantations of the area.

The golden age of the gardens was from 1844 to 1911. The superintendents, from 1857 called directors, of this period, George Gardner (1844–1849), George Henry Kendrick Thwaites (1849–1879), Henry Trimen (1879–1896) and John Christopher Willis (1896–1911), were all eminent botanical researchers. George Gardner, a Scot, had become famous for his five years of botanical work in Brazil. He is especially noteworthy, given that he shaped the general layout of the gardens. He had numerous links to the nobility of Scotland and England. His father was the gardener of the Earl of Dunmore and subsequently the Earl of Eglinton. In Britain the Duke of Bedford was his patron. He was also shown a lot of friendship by the Earl of Derby, and in Ceylon he was a close friend of the governor Lord Torrington. He died at the age of 39. These directors were also efficient instigators of the plantations and their needs, especially Thwaites and Trimen, who founded the Museum of Economic Botany. Willis founded the botanical bulletin at Peradeniya. He later became director of Rio de Janeiro Botanical Gardens.

During this period the Botanic Gardens received the layout that we can still see today. This landscaping, however, does not correspond well to what we might expect from such a utilitarian institution. The gardens were laid out as an English park, with tree-lined avenues and enormous lawns. The roads and "walks" of the gardens were wide enough to enable visits in horse-drawn carts. The central walk was straightened out into an axis, and during 1855–1905 this and four other roads were planted as palm-lined avenues: a Royal palm avenue, a Palmyrah avenue, a Cabbage palm avenue, a Talipot palm avenue and a

Seychelles palm avenue. The two largest lawns, the Great Circle from 1844 and the Great Lawn from 1885, covered 1.8 ha and 3 ha, respectively (Palipana 2006). In both design and size they can be called monumental. The grandeur seems to have been implicitly understood – there is no mention of it in the ordinary visitors guide to the gardens authored by Henry Trimen (1883), which concentrates entirely on the botanical marvels.

There were four branch gardens established in Ceylon. In the upper montane region Hakgala Gardens was established by Thwaites in 1860 as a cinchona nursery. During the 1880s a garden at Anuradhapura was under development especially for dry-zone flora, and later a garden was established at Badulla.

In 1876, a smaller auxiliary branch garden, Heneratgoda Botanic Garden, was established in the western humid lowlands of Ceylon, near Gampaha. Its sole objective was to acclimatize the rubber seedlings that Kew had sent to Ceylon, after Henry Wickham's successful smuggling operation of seeds from the Amazon. The very first rubber tree planted in Asia stood here until 1988, when it was felled by a cyclone, but the roots are still preserved as a kind of monument to the history of the rubber industry. Also in this smaller garden, with its clear utilitarian focus on one type of plant, it was considered necessary to plant two axial tree-lined avenues and a "Great Lawn".

Kirstenbosch Botanical Garden, South Africa

The botanical gardens at the Cape of Good Hope display totally different features to the Sri Lankan ones. In Kaapstad, the Dutch East India Company, under Jan van Riesbeek, established a garden in 1652 as one of the first two measures in establishing a Dutch presence at the Cape – the other was to build a fort, the first Cape Town Castle. This garden was declared a botanical garden in 1848, but the locality close to the city centre was unsuitable, water was scarce, the soil was poor and space was too limited. As a result, it never developed according to intentions and in 1891 it was taken over by the municipality as a public park. Also, before that date, the designation as a botanical garden was mainly nominal. Most of the gardens in Cape and Natal that were established during the nineteenth century also fall into this category. The Durban Botanic Gardens in Natal, established in 1851, albeit small in size (50 acres), aimed at filling the requirements of a botanical garden proper. The funding was inadequate, however, and the curators had to supplement the income with the selling of plants to the public. In the late nineteenth century the gardens had become, in reality, a state-subsidized nursery (McCracken 1987: 61).

Within the botanical research community in South Africa the need for a botanical garden proper was articulated repeatedly over the years. In 1910 Professor H.H.W. Pearson at South African College, Cape Town, who was originally a Cambridge man, addressing the South African Association for the Advancement of Science, proposed the establishment of such a garden (*Bulletin of Miscellaneous Information* 1910). This proposal led to the formation of a National Botanical Society in 1912 and ultimately to a unanimous agreement to a proposal in the House of Assembly about the establishment of a National Botanical Garden the following year (*Bulletin of Miscellaneous Information* 1913).

In 1913 the Kirstenbosch area, in the large Groote Schuur estates on the eastern slopes of Table Mountain, was set aside as a national botanical garden. The area had a prehistory as colonial cultivated land going back all the way to van Riesbeek himself, who undertook the planting of a hedge of wild almond trees in 1670 to protect the cultivated area from the cattle herds of the Khoi-Khoi pastoralists. The hedge is still partly preserved inside the garden. However, it was not until none other than Cecil Rhodes acquired the estate in 1895, with a view to preserve the area as a national heritage, that we can start discerning what would become of the estate. Rhodes planted a tree-lined avenue in 1898, with camphor trees from Hong Kong, Moreton Bay figs from Australia and cork oaks from Gibraltar, with pretensions of creating an imperial avenue fit for the queen herself to travel along. The avenue is still there within the garden and is known as Camphor Avenue.

Rhodes died in 1902 and the estate reverted to government land. When Pearson managed to convince the government to set aside the estate as a botanical garden, it was overgrown and neglected. Pearson, the first director, died young in 1916, and was succeeded by another Cambridge botanist, R.H. Compton, who took up the directorship in 1919. These two men, the curator J.W. Mathews and their staff transformed the estate in just a few years into a botanical garden, with a cycad collection, a Protea garden, an Erica garden and a Great Lawn (Paterson-Jones and Winter 2004: 4–5, 14, 21–22). The developed botanical garden covers only a part of the large estate. Most of the remaining part is a natural reserve.

The Great Lawn in Kirstenbosch, which was established from the start in 1913, is large, and it certainly displays a few echoes of the garden design of Lancelot “Capability” Brown,[1] but it can hardly be called monumental. It is more of a calm centre point of the garden, spreading around a constructed pond. In general, the lawns in Kirstenbosch have the function of connecting the various flower beds and special gardens for the indigenous Cape flora and enhancing the beauty of the area. In fact, the present extent of lawns in Kirstenbosch is a recent phenomenon. Up to the 1970s there were many more pathways in the garden, but after the introduction of a water reticulation system, several of them were removed and made into lawns. In any case, the difference between the Kirstenbosch lawns and those in the Sri Lankan gardens is evident and striking. The same goes for the tree-lined avenues. How are these differences to be understood?

A comparative discussion

Professor Pearson’s proposal for a national botanical garden coincided in time with the formation of the Union of South Africa, which was given dominion status within the British empire. In his speech in 1910 he repeatedly argued that such an institution is a requirement for any nation that calls itself civilized (*Bulletin of Miscellaneous Information* 1910).

Forging a new nation is the theme that Pearson refers to over and over again. The South African War was just eight years distant. Memories of burned homesteads and thousands of dead children in the concentration camps were still very vivid. Establishing a union out of the four separate colonies, and making the former Transvaal president Paul Krüger its first leader, must be understood as a policy of reconciliation. Power was shared by placing the parliament in Cape Town and the ministries in Pretoria. Animosity between Boers and Anglo-Saxon settlers, and thus the need for a display of dominance by one party, was ruled out. Any potential black opposition could be disregarded in the Western Cape Colony, where the Khoi-Khoi and San groups had been almost exterminated during the eighteenth century, and the Xhosa migration from the Transkei was still in the unknown future.

The situation in Ceylon some decades earlier, when the garden designs were laid out, was entirely different. If the Western Cape was a society where whites were undisputedly dominant, Ceylon was a society where they had to be made dominant. It was also a society left to itself by the "tyranny of distance", where the attitudes of the governing elite had a strong impact. Especially in the period before the telegraph cables, i.e. pre-1870, the position of the governors and their nearest staff was one of enormous autocratic influence. Their backgrounds and attitudes shaped much of colonial society, not just in Ceylon, but in all of the far-flung crown colonies of the Victorian age. They came from "polite society", and the ruling classes in Britain were more and more estranged from the rest of society around the turn of the century. Their education at public schools in combination with the Classics or History at Oxford or Cambridge socialized them to have an attitude of superiority over indigenous society, culture and forms of knowledge. At the same time, it provided almost no formal education of use for administering a foreign territory (cf. Mendis 1984: 18). Previous colonial experience, if any, of the governors of Ceylon had been obtained in Africa or the Caribbean, never in neighbouring India, but "they were all steeped in the affairs of empire" (Mendis 1984: 24).

That much said, it must also be emphasized (at least for the Ceylonese case) that even if the indigenous groups were regarded as inferior, they were seen as rapidly progressing under British rule and would ultimately reach the level of European civilization, if given the proper role models (Wickremaratne 1996: 262–264).

The gentlemen of the polite society were often raised in the setting of a manor surrounded by the typically English parkland designed perhaps by Capability Brown himself. As Tom Williamson (1999) and others have described, this park landscape of rolling lawns and picturesque groves of trees imitated nature, but was pure culture, a landscape for consumption only. It was taken for granted that its consumers, the peers of the owners, understood its meanings with references to the paintings of Poussin and Lorrain and to what they had seen in the Italian campagna during the Grand Tour of their youth. The parks were designed as three-dimensional postcards, as Williamson so elegantly phrases it. The most important aspect of the park landscape was perhaps that it totally excluded any elements of a landscape of production – factory chimneys, labourer's quarters, even the manor's own vegetable garden, had to be hidden from view. The landscape thus obtained a very evident class mark.

In addition to these general attitudes, the political and social history of Ceylon is important to consider. The formidable rebellion of 1817–1818 was only one generation in the past. The leader of the rebellion against the last king, the first dissawe Ehelepola, died in Mauritius in 1829, and the last king of Kandy died in India in 1832, but there were still many members of the leading chieftain families to reckon with. The policy of resuscitation of indigenous aristocratic influence in local administration did not come about until during the governorship of Sir Arthur Hamilton Gordon in the 1880s (de Silva 2005: 401). Furthermore, in 1848 incidents of unrest in the highlands, to which the young and totally inexperienced governor Lord Torrington and his staff overreacted, were labelled as another rebellion and quenched with military force. The European population grew wary. There were never more than around 8,000 Europeans at any time in Ceylon during the colonial period, while the native population was approximately 1.5 million people towards the second half of the nineteenth century. In this context, the whites were in a marked minority.

The strong European dichotomy between nature and culture also shaped these colonial gardens. When Europeans came to the tropics, administrators, planters and scientists saw "nature" in a particular way. They were blind to the managed ecology of agro-forestry and swidden cultivation practised in tropical countries. The "wild state" of the tropics had to be civilized in the name of progress and the role models were taken from home. Plantations were ordered according to industrial plants, gardens according to the English parks. Much of the existing cultural landscape was poorly understood, disregarded or altered.

It is possible therefore, to interpret the layouts of the Peradeniya and Heneratgoda gardens in terms of a display of dominance. They both appear to have been semiotic reminders of the hierarchical society of Britain and its extension into the colony, and a setting of examples for the "civilizing" project in Ceylon. In any case, botanical garden design was not due to the needs of botany itself.

The white population at the Cape of Good Hope was not feeling threatened. It was eager to join the civilized world as a new nation, and had no strong incentive to establish an imperial power display at the time of garden establishment at Kirstenbosch. Cecil Rhodes' imperial Camphor Avenue was incorporated as a remnant of the old in what was otherwise a garden looking towards the future.

In colonial Ceylon of the nineteenth century, lawns and tree-lined avenues were established as implicit expression marks saying that under British rule nature, as well as society, was ordered and controlled, and empire made manifest thereby. They were also used to alter the meanings of the existing landscape. The fact that Peradeniya Botanic Gardens was established in the grounds of an ancient royal demesne, including some monastic remains, effectively re-coded the place. The landscape of the Kandyan kingdom was already heavily laden with meaning (Duncan 1990). The symbolic townscape around the palace and the Dalada Maligawa in central Kandy was de-charged by building the British administration building, the kachcheri (later the High Courts building), in 1880 just a few metres upslope from the royal assembly hall on the site where the King's Treasury (Maha Gabadawa) had been. In a similar manner the remains of the old hierarchies in Peradeniya were effectively eclipsed by Western aristocratic turf and tree-lined avenues. Such was the impact of lawns in the days before they obtained their innocence.

Note

1 Lancelot "Capability" Brown (1716–1783) was an English landscape architect who designed around 170 estate parks in England. He was the main proponent of the new "English" style of gardening that swept away the older, formal or geometric garden designs of the Renaissance and the French Baroque. Williamson (1999) and others have elucidated the strong class aspect of these gardens.

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Part II

Struggles over material resources in the modern world

11 Footprints

The division of nations and nature

Andrew K. Jorgenson and Brett Clark

Introduction

For the first time, in January 2007 the *Bulletin of Atomic Scientists* included the emerging ecological crisis as part of the planetary catastrophe that threatens humanity, prompting them to move the symbolic "doomsday clock" two minutes closer to midnight. Both natural and social scientists are increasingly demonstrating that human activities are the primary forces responsible for the observed warming of the earth's atmosphere, the pollution and overexploitation of the world's ecosystems (including the oceans), and the loss of biodiversity (Halpern *et al.* 2008; Intergovernmental Panel on Climate Change 2007; Millennium Ecosystem Assessment 2005). Given the scale of ecological degradation, scientists are questioning the "business-as-usual" operation of the global economy and the overall organization of the social world (Hansen *et al.* 2008).

A cadre of environmental technocrats – such as Thomas Friedman (2009), Fred Krupp of the Environmental Defense Fund and Miriam Horn (2009), and Ted Nordhaus and Michael Shellenberger (2007) from the Breakthrough Institute – have called for a green industrial revolution, which would enhance economic growth through technological innovation and the creation of new global markets for green products. Friedman (2009), following the work of Amory Lovins of the Rocky Mountain Institute, proposes that this ecological transformation will facilitate the greening of the military, as fuel efficiency and renewable energy concerns become more pervasive throughout the social world. There is a danger here that the environment itself is disappearing in the activity surrounding the green economy and military. Thus, we consider it necessary to establish a deeper understanding of the anthropogenic drivers of environmental change and potential ecological crises.

Both the economy and the military influence socio-ecological relationships, as well as the hierarchy of nations within the stratified interstate system. In what follows, we present cross-national panel analyses that engage the treadmill of production and treadmill of destruction traditions within environmental sociology, as well as the emergent ecologically unequal exchange orientation in the comparative social sciences (see also Jorgenson and Clark 2009). We utilize these structural frameworks to illuminate the environmental consequences of the contemporary world's interstate system, with a particular focus on the consumption-based environmental impacts of nations, measured as per capita ecological footprints. Furthermore, we assess the extent to which the impacts of ecologically unequal exchange relationships vary between developed countries and less-developed countries.

The treadmill of production

The treadmill of production argument stresses that an economic system driven by endless growth, on an ever-larger scale, generates widespread ecological degradation (Schnaiberg and Gould 1994). More specifically, the "subjective goal and the motor force of the economic system" is the rapacious quest to accumulate more capital, intensified by the competition and the creation of new markets (Sweezy 2004: 91–92; Schnaiberg 1980: 230). New technologies are employed to expand production and to reduce labor costs. Such growth requires raw materials and energy to operate, given that nature is used to fuel industry and to produce the commodities for the market. As a result, economic growth and the environment are caught in an "enduring conflict" (Schnaiberg and Gould 1994). An economy that is constantly increasing the scale and intensity of production to expand profits runs up against the natural limits of a finite world. It creates ecological problems associated with the ancillary production of pollution (Pellow 2007). The degradation of the environment increases as its bounty is consumed at a faster rate, potentially undermining the reproductive capacities of ecosystems (Clark and York 2005a, 2005b).

Attempts to dematerialize society and decouple the economy from energy and material consumption have been caught in the "Jevons paradox" – as greater efficiency in resource use often leads to *increased* consumption of resources (Jevons 1906). In other words, gains made in improving the efficiency of energy use tend to be outstripped by the expansion of production – and the actual use of a raw material tends to expand (Clark and Foster 2001; Jorgenson 2009a; Polimeni *et al.* 2008; York 2006). Thus, the treadmill of production perspective argues that economic growth generates environmental problems, given the ceaseless demands placed upon nature. Resource consumption grows and environmental degradation worsens as development continues, while the scale and intensity of production increases.

The treadmill of destruction

Despite its potential influence on the environment, there has been scarcely, with few exceptions, any theorization regarding the environmental impacts of militarism. Hooks and Smith (2005) are perhaps the most notable exceptions. Drawing upon the treadmill of production argument, they assess relationships between the military and environmental degradation. While recognizing that the military and economy are related, they contend that the former is somewhat independent of the latter. The military has its own expansionary dynamics, which involve significant environmental and ecological costs. Given the logic of militarism and the emphasis on national security, the military produces a treadmill of destruction, which undermines environmental protection.

The treadmill of destruction perspective argues that militaries as social structures generate environmental degradation regardless of whether they are engaged in armed conflicts or not. Even outside of war, military institutions and their activities consume massive amounts of non-renewable energy and other resources to sustain their overall infrastructures and hardware (Dycus 1996). Research and development, including the testing of weapons, and general maintenance of equipment also contribute to the environmental impacts of militaries. What is more, military operations require the use of land for bases, other forms of installations, and training exercises. As part of the treadmill of destruction, the military stockpiles fuels and other materials (Clark *et al.* 2010). Additionally, the armed forces consume large amounts of fossil fuels that directly contribute to carbon dioxide emissions and the emission of other greenhouse gases known to impact global warming and climate change (Jorgenson *et al.* 2010; Renner 1997). Renner (1991) indicates that land vehicles, aircraft, sea vessels, and other forms of machinery burn 75 percent of all energy used by armed forces worldwide.

Although geopolitical competition often drives arms races, as well as technological advances and infrastructural development, military development does not necessarily entail increases in armed forces' personnel. For developed nations, which devote vast amounts of money to building their militaries through high technology, the environmentally damaging capabilities are likely a function of the weaponry and machinery that often requires fewer soldiers for possible use. More capital-intensive militaries are likely to experience increases in their material infrastructure, become more spatially dispersed, or at least remain relatively constant. In a related vein, international political economists (e.g., Chase-Dunn 1998) explain that nations with more capital-intensive and thus technologically advanced militaries often utilize their global military power to gain disproportionate access to natural resources.

Ecologically unequal exchange

The contemporary theory of ecologically unequal exchange asserts that through the "vertical flow of exports" from less-developed countries, more-developed *and* militarily powerful countries partially externalize their consumption-based environmental costs to the former, which in turn increase forms of environmental degradation within their borders while suppressing domestic levels of resource consumption, often well below globally sustainable thresholds (e.g., Hornborg 1998, 2001, 2006; Jorgenson 2006, 2009b; Rice 2007). We posit that the ecologically unequal exchange perspective intersects with both treadmill orientations. The treadmill of production propels the world economy toward constant expansion, demanding more and more resources to meet its insatiable appetite, especially in the articulated consumer markets of developed countries. Similarly, in the interests of national security, technological innovation, political power, and geopolitical influence, the treadmill of destruction facilitates the increased appropriation of resources by the nations' militaries and their supporting sectors. What is more, increased military strength enhances access to the natural resources and sink capacity of less-powerful, underdeveloped nations.

Generally speaking, more-developed *and* militarily powerful countries are positioned advantageously in the contemporary world economy, and thus are more likely to secure and maintain favorable terms of trade allowing for greater access to the natural resources and sink capacity of bioproductive areas within less-developed countries. These advantageous positions facilitate the externalization of environmental costs of resource extraction and consumption to less-developed countries, and help create conditions where more-developed countries and those with more powerful militaries are able to over-utilize global "environmental space" (Rice 2007) as well as the global commons. The misappropriation of environmental space suppresses resource consumption opportunities for many less-developed countries, which also impacts the health and well-being of their domestic populations. Furthermore, given the structure and acceleration of both the treadmill of destruction and treadmill of production, it is quite likely that the consequences of these processes for less-developed countries are more pronounced than for developed countries.

The analyses

The dataset

We analyze a panel dataset consisting of measurements for 53 developed and less-developed countries from 1975 to 2000. These are the countries in which data are available for the dependent variable and key independent variables. Data are point estimates at five-year intervals (1975, 1980, 1985, 1990, 1995, 2000). To maximize the use of available data, we allow sample sizes to vary among the models. Overall sample sizes range from 297 observations to 318 observations, with a minimum of three and a maximum of six observations per country. The appendix lists all countries included in the study.

Random effects models

For methodological and substantive reasons, we estimate generalized least squares (GLS) random effects (RE) models with robust standard errors for all reported analyses. Additional details on the characteristics and appropriateness of these methods for the current study are provided in Jorgenson and Clark (2009).

Dependent variable

The dependent variable for the analyses is the updated estimates for the *per capita ecological footprint.* These data, which are converted to logarithmic form (i.e., logged) to minimize skewness, were obtained directly from the Global

Footprint Network. All other variables in the study that are logged (denoted as "ln") are done so for analogous reasons. The ecological footprint quantifies the amount of biologically productive land (global hectares) required to support the consumption of renewable natural resources and assimilation of carbon dioxide waste products of a given population (Wackernagel *et al.* 1999). It measures the consumption-based demand upon both domestic and global natural resources. For a detailed description of the calculations used for the updated footprint estimates, see the *2006 Living Planet Report* (Loh and Goldfinger 2006).

Independent variables of particular interest

We include gross domestic product per capita (*GDP per capita*) as a measure of a nation's level of economic development, affluence, and capital intensity. These data, which are logged (ln), are measured in 2000 constant US dollars and obtained from the World Bank (2007). Treadmill of production theory would propose a positive association between the per capita footprints of nations and level of economic development.

Military expenditures per soldier (ln) are included as a measure of the capital intensity of militaries, as well as a nation's relative military strength. This variable is calculated by dividing total military expenditures by total military personnel. Total military personnel estimates are gathered from the World Bank (2007) and total military expenditures are obtained from the Stockholm International Peace Research Institute (SIPRI) (1977, 1984, 1987, 1991, 2000). Military expenditure data include all current capital expenditures on the armed forces, including: peacekeeping forces; defense ministries and other government agencies engaged in defense projects; paramilitary forces, if these are judged to be trained and equipped for military operations; and military space activities. To minimize collinearity, we regress these data on GDP per capita, and use the residuals in many of the reported models to assess the effects of military expenditures per soldier on the per capita footprints of nations. Treadmill of destruction theory would propose a positive association between the latter two measures.

We calculate and use two weighted indices to evaluate key assertions of ecologically unequal exchange theory. The first quantifies the relative extent to which a country's exports are sent to more-developed countries (measured as per capita GDP). The second measures the relative extent to which a country's exports are sent to nations with more powerful militaries (measured as military expenditures per soldier). We refer to these indices as *export flows weighted by GDP per capita* and *export flows weighted by military expenditures per soldier*. Both indices are logged (ln). Data required for the construction of the indices include relational measures in the form of exports between sending and receiving countries, and attributional measures of economic development and military expenditures for receiving countries in the form of per capita GDP and military expenditures per soldier (MXPS). The exports data are taken from the International Monetary Fund's *2003 Direction of Trade Statistics* CD-ROM database and are reported in US dollars. The per capita GDP and MXPS data are derived from the same sources as discussed above. To minimize collinearity, we regress the export flows weighted by MXPS on the export flows weighted by GDP per capita and include the residuals as measures of the former in models that include both weighted indices. For additional details concerning the weighted indices, see Jorgenson and Clark (2009).

In order to assess the theoretically derived notion that the impacts of different forms of ecologically unequal exchange are more pronounced for less-developed countries than for developed countries, we calculate and use interactions between the weighted export flows measures and a dummy-coded variable for less-developed countries. The estimated coefficient for either weighted export flows measure is the unit change in per capita footprints for developed countries (the reference category) for each unit increase in the former for the same year. The effect of export flows (weighted by GDP per capita or MXPS) for less-developed countries equals the sum of the coefficients for developed countries and the appropriate interaction term, labeled as "*export flows weighted by GDP pc (ln) X LDCs*" or "*export flows weighted by MXPS (ln) X LDCs*." The test of statistical significance for the slope-dummy coefficients determines whether the slope for the particular interaction and the reference category – in this case developed countries – differ significantly.

Additional independent variables included in the reported analyses

We include measures of *urban population*, which quantifies the percentage of a country's population residing in urban areas. These data are gathered from the World Bank (2007). To minimize collinearity, we residualize urban population by regressing these data on GDP per capita. We use the residuals in the reported models to assess the effects of urban population on the per capita footprints of nations, entirely independent of economic development. Urban political-economy perspectives commonly argue that due to the scale and intensity of their built infrastructure, as well as the productive activities and embedded articulated consumer markets, more urban areas exhibit higher consumption-based environmental demands (e.g., Dickens 2004).

We include a dummy-coded latitude measure – "*Tropical*" – to control for climate conditions. Countries where the predominant latitude is less than 30° from the equator are coded as tropical. Temperate and Arctic countries, meaning those where the predominant latitude is greater than 30° from the equator, are the reference category. Conventional wisdom suggests that more resources are consumed to sustain societies in colder climates.

All models include unreported period-specific intercepts (period effects).

Results

Table 11.1 reports the findings for the panel analyses. Nine tested models are reported. Model 1 consists of GDP per capita, urban population, and the tropical dummy variable, while Model 2 consists of military expenditures per soldier as well as the tropical and urban population controls. Model 3 includes both GDP per capita and military expenditures per soldier, as well as urban population and the tropical dummy predictor. All remaining models include the four predictors in Model 3 as well as 1–4 additional independent variables. Export flows weighted by GDP per capita is the additional predictor in Model 4, while export flows weighted by military expenditures per soldier is the additional predictor in Model 5. Model 6 consists of both weighted export flows measures. In Model 7 we include export flows weighted by GDP per capita as well as its interaction with less-developed countries. Model 8 does the same as Model 7, but for the export flows measures weighted by military expenditures per soldier. Model 9 consists of all predictors included in any of the preceding models. We remind readers that unreported period-specific intercepts are included in each tested model as well, and Models 7–9 also include an unreported dummy variable for less-developed countries, which controls for the possibility of differing intercepts (and their potential impacts on the differing slopes of interest) for this group of countries relative to the developed countries.

We begin with a brief summary of the associations between the outcome and the two statistical controls. The effect of urban population on the per capita footprints of nations is positive in all models. This finding, which supports urban political-economy assertions, is also consistent with prior comparative research on society–nature relationships (e.g., Jorgenson 2003, 2005). The effect of the tropical dummy variable on the outcome is also statistically significant in all reported models, but the association between them is negative. Thus, and all else being equal, consumption-based environmental impacts do indeed increase with distance from the equator. These results underscore the importance of considering the extent to which ecological milieu condition the human dimensions of environmental change. We now turn to the results of interest for the current study.

The level of economic development, measured as GDP per capita, is found to positively affect the per capita footprints of nations, and the positive association is statistically significant in all relevant models. The positive effect of per capita GDP on the per capita ecological footprints of nations provides support for the treadmill of production perspective. Economic development remains tied to growing demands on the environment, increasing resource consumption and concomitant ecological degradation. Similarly, the consumption-based environmental impacts of nations are positively associated with military expenditures per soldier. The positive effects here support the treadmill of destruction argument: as militaries become more capital intensive, additional consumption-based demands are placed on the environment. Thus, economic development *and* military technological power in the context of expenditures per soldier *both* condition the consumption-based environmental harms of nations. Whether it is the economic treadmill of production *or* the military treadmill of destruction, the expansion of either requires vast amounts of resources, taxing ecological conditions.

Models 5 through 7 indicate that both forms of ecologically unequal exchange relationships under investigation are of relevance when considering levels of resource consumption in comparative perspective. More specifically, the effects

Table 11.1 Unstandardized coefficients for the regression of per capita ecological footprints on selected independent variables: random effects model estimates for 3–6 observations on 53 developed and less-developed countries, 1975–2000

	Model 1	*Model 2*	*Model 3*	*Model 4*	*Model 5*	*Model 6*	*Model 7*	*Model 8*	*Model 9*
GDP per capita (ln)	0.138**		0.135**	0.175**	0.181**	0.181**	0.142**	0.147**	0.152**
	(0.013)		(0.013)	(0.015)	(0.016)	(0.015)	(0.016)	(0.015)	(0.016)
	[0.455]		[0.388]	[0.470]	[0.488]	[0.489]	[0.366]	[0.373]	[0.384]
Military expenditures		0.037**	0.151**	0.184**	0.190**	0.191**	0.140**	0.145**	0.149**
Per soldier (ln)		(0.008)	(0.014)	(0.014)	(0.015)	(0.016)	(0.015)	(0.016)	(0.015)
		[0.094]	[0.260]	[0.336]	[0.349]	[0.350]	[0.273]	[0.284]	[0.293]
Urban population	0.003**	0.005**	0.003**	0.004**	0.005**	0.005**	0.003**	0.004**	0.005**
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
	[0.072]	[0.240]	[0.079]	[0.102]	[0.122]	[0.123]	[0.084]	[0.110]	[0.121]
Tropical	–0.387**	–0.506**	–0.382**	–0.301**	–0.284**	–0.283**	–0.171**	–0.148*	–0.155*
	(0.065)	(0.071)	(0.065)	(0.063)	(0.064)	(0.063)	(0.062)	(0.062)	(0.063)
	[–0.380]	[–0.497]	[–0.375]	[–0.295]	[–0.279]	[–0.278]	[–0.168]	[–0.145]	[–0.153]
Export flows				–0.060**		–0.057**	–0.016		–0.034
Weighted by GDP pc (ln)				(0.021)		(0.021)	(0.022)		(0.023)
				[–0.037]		[–0.035]	[–0.010]		[–0.020]
Export flows							–0.047**		–0.046**
Weighted by GDP pc (ln)							(0.008)		(0.008)
X LDCs							[–0.395]		[–0.386]

Export flows					–0.036**	–0.040*		–0.002	0.055
Weighted by MXPS (ln)					(0.010)	(0.019)		(0.012)	(0.036)
					[–0.041]	[–0.078]		[–0.001]	[0.031]
Export flows								–0.043**	–0.120**
Weighted by MXPS (ln)								(0.007)	(0.041)
X LDCs								[–0.417]	[–0.060]
Constant	0.221	0.724	–0.161	0.062	–0.185	–0.046	0.302	0.147	0.393
R^2 within	0.157	0.023	0.157	0.185	0.191	0.191	0.208	0.244	0.241
R^2 between	0.787	0.696	0.757	0.830	0.831	0.830	0.872	0.873	0.876
R^2 overall	0.774	0.681	0.744	0.818	0.819	0.819	0.861	0.862	0.865
N	318	318	318	297	297	297	297	297	297
Min/max number of observations	6/6	6/6	6/6	3/6	3/6	3/6	3/6	3/6	3/6

Notes
All models include unreported period-specific intercepts; *$p<0.05$; **$p<0.01$ (two-tailed tests); unstandardized coefficients flagged for statistical significance; robust standard errors are in parentheses; standardized coefficients are in brackets; MXPS refers to military expenditures per soldier; pc refers to per capita; military expenditures per soldier are residualized on GDP per capita (except in Model 2); urban population are residualized on GDP per capita (except in Model 2); export flows weighted by MXPS are residualized on export flows weighted by GDP pc in Models 6 and 9; models 7–9 include unreported LDCs dummy variables.

of the two weighted export flows measures on the per capita footprints of nations are negative. What is more, Model 7 suggests that structural relationships between relatively more and less militarily powerful nations have unique impacts on resource consumption, independent of structural relationships between more and less economically developed nations. The results of Models 8 through 10 indicate that the effects of ecologically unequal exchange relationships in the context of economic and military power are much more pronounced for less-developed countries than developed countries. In particular, the interactions between both weighted export flows measures and less-developed countries are negative in the individual models (Models 8 and 9) as well as Model 10, which includes both interactions as well as the main effects. These findings suggest that there is a division between nations, as far as the appropriation and consumption of nature are concerned, primarily to the benefit of the global North. Considering that the per capita ecological footprints of many less-developed countries are below globally sustainable thresholds, and that resource use is fundamentally tied to basic needs and human quality of life, the negative effects of the interactions underscore the ecologically unequal and underdevelopmental consequences of such interrelationships for many less-developed countries.

Conclusion

Assessing the consumption-based environmental impacts of economic development, the military, and ecologically unequal exchange relationships is critical when considering the consequences of "business as usual" within the complex global society. Results of the panel regression analyses indicate that the per capita ecological footprints of nations are tied to both economic development, measured as per capita GDP, and military growth in the context of expenditures per soldier. These results lend support to the treadmill of production and treadmill of destruction theories in environmental sociology, but more importantly, they underscore the importance for considering *both* theories when investigating how human activities and our social institutions impact the environment. There is a longstanding tradition in the environmental social sciences to focus on the environmental harms or benefits of economic development. While this is a critically important line of inquiry, our findings indicate that other institutions – particularly the military – are crucial to consider as well. Further, the analyses indicate that more economically developed and militarily powerful nations are able to secure and maintain favorable terms of trade, allowing them to over-utilize global environmental space, which suppresses the domestic consumption levels of many less-developed countries, often well below globally sustainable levels. Findings also suggest that the consequences of both forms of ecologically unequal exchange relationships are indeed much more pronounced for less-developed countries than developed countries. Overall, these results highlight the divisions that exist between nations concerning their demands placed on nature. From this comparative perspective, environmental sustainability necessitates addressing global inequalities, especially those that are sustained through international economic and military relationships.

Appendix: countries included in the analysis

Algeria
Angola
Argentina
Austria*
Belgium*
Brazil
Bulgaria
Cameroon
Canada*
Central African Republic
Chad
China
Colombia
Congo, Democratic Republic of
Cote d'Ivoire
Egypt
Finland*
France*
Gambia
Germany*
Haiti
Hungary
India
Indonesia
Iran
Italy*
Japan*
Kenya
Laos
Lebanon
Mali
Mexico
Nepal
Netherlands*
Pakistan
Panama
Poland
Portugal*
Romania
Rwanda
Senegal
Sweden*
Switzerland*
Syria
Tanzania
Thailand
Tunisia
Turkey
Uganda
United Kingdom*
United States*
Venezuela
Vietnam

* denotes developed countries

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12 Water

Irrigation and resilience in the Tanzanian highlands

Michael J. Sheridan

The people who now grow coffee, beans, and maize in Tanzania's North Pare Mountains have relied on irrigation to make intensive agriculture possible despite generally low soil fertility and long dry seasons for at least several centuries (Sheridan 2002). Indigenous irrigation and intensive agricultural systems were somewhat of a rarity in pre-colonial sub-Saharan Africa (Adams and Anderson 1988; Widgren and Sutton 2004), so understanding how and why these systems worked is a top priority for farmers and development administrators in East Africa. Population density in North Pare is now roughly 12 times higher than it was in the pre-colonial period, and irrigated agriculture would enhance food security and likely spark economic diversification. In the pre-colonial period (before *c.*1890), North Pare irrigation had been a robust network of more than 400 water intake structures and canals that formed a web of water from the mountain peaks to the plains 5,000 feet below. The system was remarkably resilient throughout the economic, political, and cultural changes wrought by two colonial regimes (German 1885–1915 and British 1918–1961), but independent Tanzania left the system a shambles of broken intakes and dry canals. This chapter reviews resilience theory and evaluates how well this functionalist approach from systems ecology can account for the course of change in North Pare. Power and political history, rather than function, explain the area's dynamics better than resilience, which suggests that resilience theory may be poorly adapted to the task of building new social-ecological systems.

Adaptive cycles: a theory of hope

Now that ecology has firmly shifted away from a focus on stable states (such as climax forests and carrying capacity), efforts to integrate non-equilibrium ecology into social science have centered on social-ecological systems and indeterminate complexity (Scoones 1999; Cliggett 2001; Perry 2002). These shifts have produced ethnographic case studies of the politics of environmental management, such as the work of Dan Brockington (2002), Christian Kull (2004), and Paige West (2006) on conservation and politics in (respectively) Tanzania, Madagascar, and Papua New Guinea. The theme that runs through all of this scholarship is that global discourses such as "sustainability" and "development" interact with local politics and land use in ways that often produce both ecological and social problems. The tone within these case studies is agonistic; environmental management appears a messy struggle about ideas, claims, money, access, and resources. While not entirely pessimistic, these researchers see the potential for participatory local environmental stewardship in the tropics as fairly bleak.

It is striking, then, that one of the more influential contributions to the merger of new ecology and social science also relies on these themes of dynamism and complexity – yet in a wholly optimistic way. A remarkably influential group of scholars, based partly in Stockholm and partly online, has presented a robust theory of social and ecological change. The Resilience Alliance, which has been organizing a synthesis of natural and social sciences since 1999, recently took material form as the Stockholm Resilience Centre (founded in 2007), and has become a leading network for sustainability research. The core concept of resilience, defined as "the capacity of a system to absorb disturbance, undergo change and still retain essentially the same function, structure, identity, and feedbacks" (Resilience Alliance 2010), comprises a meeting point for ecologists, social scientists, and policy-makers. Given the scale and breadth of the ecological changes anticipated in the twenty-first century, understanding the ability of both social and natural systems to avoid degradation and collapse has never been more important.

The framework of resilience theory has been laid out in a series of books and articles exploring methods for analyzing social and natural systems (e.g., Berkes and Folke 1998; Berkes *et al.* 2003; Walker and Salt 2006). Of these texts, the most influential, and the cornerstone of Resilience Alliance scholarship, is the distillation of ecologist C.S. "Buzz" Holling's work into the book *Panarchy* (Gunderson and Holling 2002). The basic premise is that policies based on static and equilibrium-based models of ecosystemic climax, market supply and demand, and fixed social groups often become obsolete as things change. Resilience scholars insist that dynamics and instability are inherent in all things, which therefore demands models that anticipate the messiness and unpredictability of both society and ecology. The ultimate goal of this work is not to theorize a static state of planetary sustainability, but rather to develop concepts for identifying the flexible ability of systems to adapt to change.

At the core of the panarchy model is the concept of "adaptive cycles." Generally speaking, species tend to pursue one of two reproductive strategies, represented by r and K: r-strategy creatures such as mosquitoes and frogs tend to reproduce rapidly and invest little care in their young in the scramble for survival; K-strategy creatures invest greater resources in fewer young, have slower growth rates, and have more specialization – which is the case for whales and humans. Holling and Gunderson have applied this ecological insight to human–environmental relations by postulating that resource use tends to shift from phases of rapid exploitation to increasingly stable, structured, and "conservative" relationships. From this perspective, then, slash-and-burn horticulture on a sparsely settled frontier is an r-phase system, whereas a highly structured agricultural society (such as colonial North Pare) is a K-phase system.

This model does capture the general trend toward increasing institutionalization and specialization over the ten millennia since much of humanity shifted away from foraging, but it cannot account for revolution, collapse, and systemic change. The resilience theorists therefore introduced two additional phases to complete the model. A mature K-system is somewhat fragile precisely because it is so highly structured. Eventually exogenous change moves the rigid system into an omega phase (hereafter Ω phase) characterized by the "rapid creative destruction" of a forest fire or the downfall of a civilization. Holling and his colleagues refer to this Ω phase as a period of "release," after the "exploitation" of r and the "conservation" of K. The disorder of Ω cannot, however, last, and organisms and societies alike quickly pick up the pieces to recombine in new ways. Like an ecosystem after a fire or a social system after an earthquake, this alpha (α) phase of reorganization is a period of general experimentation and innovation, and soon a new cycle of exploitation begins, albeit with different characteristics. A graphic representation of this model appears here as Figure 12.1. Note that the "potential" described in the model can refer to the total productivity of a system in terms of biomass, wealth, or social capital. "Connectedness" shows how tightly the relationships that constitute a system are woven together. A third dimension (not pictured in Figure 12.1, but see Holling and Gunderson 2002: 41), "resilience," describes how the K-phase is brittle compared to the adaptive flexibility of α and r. Finally, the model's "front loop" of r to K is relatively slow compared to the quick "back loop" of release and reorganization. Thus it took

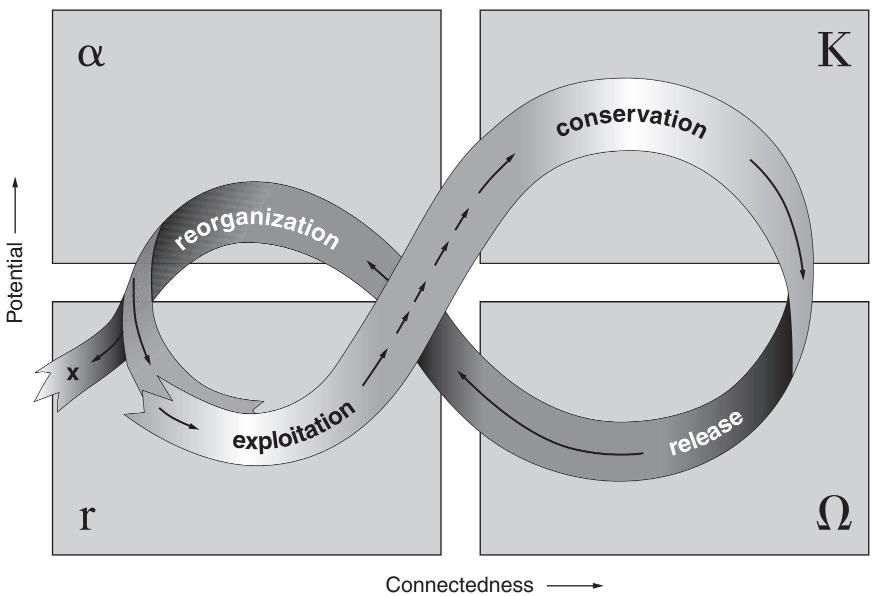

Figure 12.1 The adaptive cycle (source: Walker and Salt 2006 (adapted from Gunderson and Holling, *Panarchy* © 2002). Copyright © 2006 Brian Walker and David Salt. Reproduced by permission of Island Press, Washington, DC).

centuries to build North Pare's irrigation network, but only a few years to thoroughly transform it.

This model of human–environmental relationships has some strengths and some notable weaknesses. It allows us to talk about ecological and social change in the same terms, and may be an opportunity for "hybridization" between the natural and social sciences (Zimmerer and Bassett 2003). It is about process and change, not typologies and continuity. It also theorizes hope, which has thus far been a particularly scarce resource in the twenty-first century. Resilience theory insists that successful human–environmental relations are open-ended learning processes that can, given the right institutional arrangements, self-organize to achieve both ecological and social stability (Resilience Alliance 2010). It is probably no coincidence that this theoretical assertion is also a good summary of the general goals of Western liberal environmentalism.

The weaknesses of resilience theory lie in how its assumptions limit its applicability. The origin of the adaptive cycle model was Holling's seminal (1988) study of spruce budworms in North American boreal forests. The strong seasonality of temperate latitudes appears as an annual cycle of release and reorganization, which prompts the question of whether the model may be less suitable for tropical ecosystems. For example, most African farmers cannot rely on winter to kill crop pests, which suggests that the thresholds of resilience will be different from those in the North American corn belt.

A second flaw is that the model may be most suitable for democratic, industrial societies. The theorists suggest that resilient social-ecological systems will occur when environmental knowledge is widely available, when the power of socially differentiated actors is limited, and when social networks bridge the gaps between interest groups and administrative hierarchies (Scheffer *et al.* 2002: 239). Nation-states with such levels of transparency, equity, and justice are unfortunately rare, and billions of people live under authoritarian or incompetent governments that resist adaptive policy-making.

The third problematic assumption is that many aspects of resilience theory dovetail with the tenets of neoliberal capitalism. The theorists explicitly equate corporations with species (Holling *et al.* 2002: 406), and often assume that organisms, people, and social institutions can and should interact in self-correcting markets of resources, knowledge, ideas, and actions. This neoliberal bias may explain why the main agent of change to a K-phase system is always an external force, not the internal contradictions that Marxist theory would posit.

Finally, the model flattens cultural and social differences by stripping power, politics, and ecology of their social and historical contexts. Resilience theory is generally silent on the often violent and oppressive ways that social elites maintain themselves (Gotts 2007). It is generally functionalist, normative, and relentlessly optimistic. Where oppression, conflict, domination, and exploitation *do* appear, they are either short-term phases of longer adaptive cycles that even things out eventually, or maladaptive dead ends that will be outcompeted by more innovative species or firms in ecosystems and markets.

The language of adaptive cycles is a useful way to think in terms of processes in ecological and social systems – yet it seems to require a very narrow understanding of human nature, cultural difference, and socio-cultural evolution. Understanding irrigation in North Pare requires us to ask both "*How* did it function?" and "*Who* did it function for?"

Pre-colonial irrigation in North Pare

Irrigation in North Pare was (and is) deeply gendered, in both institutional and symbolic terms (Sheridan 2002). The ownership of both intakes and furrows was a male privilege, and women only received access to water through male kin, although they provided the majority of agricultural labor. Most irrigation intakes in the highlands were stone-walled reservoirs that collected water every night from slowly seeping springs – in Pare these are known as *ndiva*. Oral histories suggest that these structures date from the seventeenth and eighteenth centuries, but the archaeological work to confirm these dates is just beginning. The technology and symbolism appear to have remained continuous, and the people of North Pare often cite these physical and ideological structures as "customary" and "traditional." Water pressure held a wooden plank in place against the interior wall of the *ndiva*, and a rope held a plug in place. Releasing the plug was deemed a task that only men could perform, and this division of labor was maintained ideologically with fertility symbolism. As a man controlled his wife's fertility by "plugging" her womb with semen, so did he control agricultural fertility. Accordingly, women who touched irrigation intakes risked infertility, gynecological problems, and birth abnormalities. Elderly men therefore achieved both material and symbolic control through their management of this system, and the most privileged men were the highest-ranking elders who controlled the major intake structures. The network of intakes and canals was, in sum, the physical expression of a patriarchal gerontocracy. The management of the system at the regional level involved men's presentation of beer to men living uphill of them, who would then release a certain amount of water into the system of furrows that connected intakes. Water flowed down because beer flowed up. No central authority governed irrigation in North Pare, and this was key to its resilience. When the rains were good, water managers simply left the *ndiva* open to flow into streams, and the system became dormant. When drought threatened food security, or farmers wished to extend the growing season or add another cropping cycle, the irrigation system became vibrant with female labor and male management. In the pre-colonial period, North Pare was a particularly wealthy node in the East African regional system.

In the language of resilience theory, North Pare irrigation was a K-phase system. It was a highly structured adaptation to an uncertain bimodal rainfall regime, and clearly made the most of water resources by connecting entire watersheds into integrated social-ecological systems. It structured the "potential" of the region's biomass for human consumption. It was, along with initiation rituals and tribute payments to clan chiefs, a critical form of "connectedness" in social terms. Resilience was its key characteristic as a system, and it made an agricultural lifestyle more flexible and productive. Yet it is clear that social control – in this case based on a hierarchy of gender and age – was also its purpose. Identifying this system as a functional and resilient example of a self-organizing adaptive cycle naturalizes the inequality and exploitation inherent in North Pare irrigation. As subsequent events would show, patriarchy and gerontocracy were the keys to both the system's resilience and its fragility.

The decline of irrigation in North Pare

Colonialism stretched the North Pare irrigation system into new institutional formats, but the system's resilience held steady throughout a period of rapid social change (Sheridan 2004). Although pre-colonial chiefs had been more concerned with the economics of livestock and luxury goods, the colonial chiefs became increasingly involved in the mundane details of land management. A series of conservation laws in 1936–1938 shifted authority from networks of male kin and neighbors to the chiefs' bureaucracies, but administrators usually chose to enforce the conservation laws that let them collect fines rather than promote particular management practices. Irrigation networks remained in the hands of kin groups except when the elders called upon the chiefs for dispute settlement and legal sanctions. Although pre-colonial irrigation had been oriented toward food security and crop surpluses, colonial irrigation was about coffee (an exclusively male crop).

Coffee became particularly important in 1922–1928, when the number of coffee growers in North Pare increased from 140 to 8,388 despite the British colonial government's policy of "non-encouragement without prohibition" (Tanzania National Archives (TNA) 1733/8/66; Iliffe 1979: 289). Coffee grows best with partial shade and consistent moisture, so this cash crop entered the highly gendered agricultural system of North Pare without disrupting food security. Coffee, the quintessential "male crop," typically grows within irrigated plots of banana, the emblematic "female crop." The farmers of North Pare devoted much of their coffee profits to building the physical and social infrastructure of their mountain home, mostly by building one of the colonial territory's first middle schools (in 1951) and rectangular homes with "modern" metal roofs. By the end of the colonial period in 1961, North Pare was a well-educated and prosperous area by Tanzanian standards, and much of this was due to the intensification of the indigenous irrigation system in the colonial export market economy.

The colonial state, however, regarded the new uses for indigenous irrigation as small-scale systems without proper engineering. The government officials responsible for agricultural development considered irrigation to be the task of the Water Development Department, which had only been created in 1945 (TNA 517/A3/13/2). This department generally ignored small-scale community-based irrigation, and disparaged it as

> amateur irrigation without adequate appreciation of the need for drainage has resulted in damage to the soil by waterlogging … the design and

> construction of a proper irrigation scheme is a far more complex engineering task than the design and construction of a small earth dam.
>
> (TNA 19/3/28/II/326)

In the margin of the 1954 central government memorandum that I consulted for this passage, the District Commissioner for Pare District had written "then God help us." The colonial state's Malthusian assumption that population growth in the Tanzanian highlands was inevitably leading to deforestation and erosion blinded the administration to the intensification occurring in Pare, which led it to promote unpopular afforestation and terracing programs as the keys to building a sustainable social-ecological system in North Pare. According to the oral histories I collected in 1998 and 2004, this neglect (and high coffee prices) kept irrigation robust until the 1960s.

The decline of irrigation in North Pare began in the months after Tanzania's independence in 1961. Farmers knew that the local administration would soon be replaced by new administrative structures, so the British conservation regimes the chiefs had embodied (and used to build their patronage networks) since the 1930s became irrelevant. The swamps that had been conserved by the chiefs to maintain the area's aquifers and supply reeds for thatching houses were quickly subdivided, drained, and cultivated by land-hungry women soon after independence (Sheridan 2004). Without the swamps to store water, irrigation systems began to fail in the lower part of the North Pare watershed. Floods broke the rock dams that had fed into river intakes, and the rivers scoured deeper channels that were 2–3 meters below the old furrows. The day-to-day management of irrigation also suffered from the ambiguities of political change. In 1967 the government of Tanzania declared an "African socialism" (known in Swahili as *ujamaa*) as its guiding principle, and it became clear that the colonial era hybrid management by kin groups and chiefs was now a political liability. As one man told me,

> after Nyerere [the first president of Tanzania] gave these directives that everything belonged to the village community, then even talking about clan property was seen as being against socialism. So we stopped protecting our clan areas and things became damaged.

The course of this damage followed the social contour that had made irrigation resilient – management by male elders. Since 1967 most of the *ndiva* reservoirs have become broken and neglected mini-swamps where elderly women grow sweet potatoes. There are many stories about *ndiva* bursting because impatient women loosened their plugs, which then triggered the ancestors' wrath for this violation of taboo. But it is the organization of the local political and moral economy that best explains the neglect in the 1960s and 1970s.

Indigenous irrigation was everything that modern Tanzania was not supposed to be, and agricultural modernization ("*Kilimo cha kisasa*" in Swahili) was the political slogan of the day. The goal was to boost domestic production through the use of fertilizers, pesticides, and mechanization, and the methods focused on central planning and bureaucratic rationalization (Scott 1999). The 1975 Village and Ujamaa Village Act, which reformed local government to pursue this modernity, created village committees to coordinate land use and agricultural production. In North Pare, this law replaced kin group elders with local bureaucrats. Because even subcommittees were subject to direct administrative control by party stalwarts, this constituted a radical centralization of irrigation authority. The trust that had underpinned system resilience had no place in the new structure. As one man explained the lack of accountability in the village subcommittees:

> If I have a farm and I go to the committee chairman and ask for water, he's going to make me pay some money. Maybe Tsh 1000/=, 2000/=, or up to 5000/= [about US$1–5], depending on how wealthy he thinks I am. So the payment is just going to be eaten. The difference between clan management of *ndiva* and committees is that with the clan, the tribute is open and gives you rights to water. With committees, the tribute is secret, and because it's for just one person instead of for all of the old men of the neighborhood, it gives you very weak rights. Clan ownership is a thing of the past and the new system doesn't work. There's no profit in irrigation these days.

This administrative shift occurred alongside changes in the ability of male elders to control young men's labor. The local web of reciprocity and obligation had allowed elders to compel young men to cultivate and repair irrigation intakes in the 1950s, but by the 1970s, they say, the youths would just laugh and leave for city jobs. Once irrigation had gone into decline, houses, roads, and fields came to occupy the areas once covered by networks of intakes and furrows. The technical and social connections are therefore quite broken, and today much of the irrigation systems that remain in North Pare are isolated and poorly maintained. Most surviving intakes supply water to the garden plots of a single extended family, not entire hillsides.

Resilience theory would call this systemic collapse the Ω phase of "release," which should have quickly led to the α phase of "reorganization." The self-organizing and resilient irrigation system should have developed into a new stable K-phase in North Pare, perhaps with a different, more gender-inclusive management system. The area instead exports mostly young male labor, and is largely populated by children, retired civil servants, and wives running family farms without the benefit of their husbands' labor. North Pare seems to have entered a long, slow period of ambiguity, in which both social institutions and cultural norms became unpredictable and incomplete (Sheridan 2004). Today, North Pare farmers are deeply skeptical about the ability of government to manage resources, yet are unable or unwilling to manage resources through kin networks. Ambiguity has become resilient, not management. The first law of thermodynamics teaches us that energy cannot be destroyed, only transformed; and resilience theory suggests that the energy of social-ecological systems follows this law. In North Pare, as in much of sub-Saharan Africa, however, the capacity for local land management has remained ambiguous, contradictory, and incompletely transformed for decades (Berry 1993; Sheridan 2009). In the 1980s a European development agency arrived in North Pare to push the area's irrigation system through a new cycle of reorganization toward sustainable K-phase conservation. Once again, power and contradiction explain the course of change better than the language of adaptive cycles.

Reviving traditional irrigation without tradition

The Traditional Irrigation Improvement Programme (hereafter TIP) began in 1986 with an inventory of indigenous irrigation systems throughout the Tanzanian mainland. This two-year investigation documented the colonial government's focus on large-scale irrigation and the effort to replace traditional systems with "properly engineered" modern systems. From 1952 to 1970, only 10 percent of the annual budget of the Department of Water Development and Irrigation went to improving established irrigation systems. Repeated administrative upheavals curtailed the department's efficacy in rural Tanzania, while six different ministries supervised it from 1960 to 1975 (Burra and van den Heuvel 1987: 62). One legacy of the first decades of independent governance in Tanzania was the replacement of cheap and viable indigenous irrigation systems with expensive concrete ruins.

After receiving funding from the Dutch government, TIP started work in 1988. The project worked directly with local governments as a way to sidestep the competing sectoral claims of central government ministries. In North Pare, an area that had been largely ignored by the Japanese-funded regional development programs for the Kilimanjaro Region in the 1980s, TIP provided irrigation officers with office space, vehicles, staff, engineering consultants, and an agenda. During Phase I of the project (1988–1992), TIP supported tree nurseries, promoted terraces, and rehabilitated 11 intakes and furrow systems in the North Pare area. During Phase II (1992–1998), the program systematically integrated soil and water conservation, gender training, and afforestation into its irrigation activities (TIP-Mwanga 1995). In Phase III (1998–2001), TIP gradually handed over its projects and resources to the district government. Today, most of the rehabilitated *ndiva* have rusty sluice gates that drain water from tiny concrete-lined plots of sweet potatoes.

TIP was keenly interested in maximizing the participation of rural farmers in its planning and project design, and therefore relied on Water Users Groups (WUGs) and participatory local institutions to be effective. When someone in North Pare requested TIP assistance, the program sent a technician to evaluate the irrigation intake and furrow to be rehabilitated. If the plan was feasible, TIP instructed the community to form a WUG and elect a chairman, treasurer, secretary, and water manager. TIP was very concerned with women's limited role in irrigation management in the North Pare area, so the program required that half of each WUG be female. Then the WUG members formed a cooperative labor group to build terraces. Once the new WUG members had terraced at least 50 percent of the land to be irrigated, TIP began reconstruction. On the whole, the program was moderately successful in North Pare and enjoyed a good reputation among farmers.

TIP considered the WUGs to be venues for grassroots participation, but the program's demands meant that acquiescence usually took the place of participation. The associations among irrigation management, overlapping rights to resources, and gender symbolism made the WUGs arenas for conflict and negotiation. TIP wanted to ensure gender equity in water rights, so it required that women participate in all WUG activities, including intake construction. The program made videos and distributed calendars to promote women's rights to water, but the more TIP pushed gender equity, the more resistance they encountered from Pare men (and, significantly, some women). During WUG meetings I attended in 1998, men charged that TIP was trying to usher in an era of *utawala wa matiti* ("governance by the breasts"), while some women feared that their participation in intake construction could lead to reproductive problems. In their meetings with prospective project beneficiaries, TIP extensionists commonly confronted these attitudes by telling the people of North Pare that if they wanted program assistance, they had to "abandon traditions that had been passed by the times." The following exchange (which I have edited) comes from a TIP meeting in November 1997, and reveals the continuing salience of gender ideologies in irrigation management:

TIP FACILITATOR: It looks like the indigenous traditions don't allow women to enter intakes or participate in water affairs.

TIP ADMINISTRATOR: If TIP helps you to build [a *ndiva*], will women be involved in leadership?

ELDERLY MAN #1: Long ago, the old men sacrificed before construction, and now the experts just arrive with cement and start work. So if TIP does its work this way, then women must share the work.

TIP ADMINISTRATOR: When you sign a contract with TIP, you have become married to the project, so you must follow our rules.

ELDERLY WOMAN: In the past, women did not go into the *ndiva*. We don't want to go now, either.

TIP FACILITATOR: Well, now it is necessary.

ELDERLY WOMAN (with quiet bitterness): Very well.

ELDERLY MAN #2: I remember when a *ndiva* was rebuilt during the colonial era. The old men sacrificed a goat and surrounded the *ndiva* with its intestines. The mason continued with his work and it was a complete success. But if TIP wants to rebuild our *ndiva* without tradition, we are old and we have no power so we must agree.

Women do, however, have secure water rights in North Pare as long as they participate in seasonal furrow cleaning. Because these rights depend on maintenance, not construction, the requirement that women enter the intakes contradicted the gendered pattern of labor organization that had given rise to irrigation in the first place. The core misunderstanding on the part of the project administrators was that North Pare irrigation was not simply an adaptive cycle by a society seeking food security. It was a matter of a deeply gendered division of labor and power, and these symbolic systems cannot be simply discarded like worn-out clothing. The technical process of reviving irrigation systems renewed cultural expectations about authority and resource rights, and thus sparked political and moral conflicts. Men consistently told me that the hierarchy of age, gender, and kinship relations had made the social relations of water management transparent and reliable:

> The *ndiva* that were managed by clans were easier to manage and maintain because everyone knew, trusted, and respected the old men of the clan. Maybe if you moved to the area, even if you weren't of that clan, you could go to the man in charge and give him some beer as tribute, and he'd drink it together with the other old men. They would unanimously agree to give the newcomer water rights. And it wasn't a problem for them to organize the laborers to clean and maintain the system. There was no doubt.

Women consistently said that although the system had never been fair, at least it had worked.

All TIP participants were well aware that the program would eventually leave the district and return irrigation matters to the district government. Because most Tanzanians understand land rights to stem from the investment of labor in the landscape, not statutory law (Shivji 1994), this meant that all rehabilitated irrigation intakes and canals would eventually become local government matters. Even when TIP and the local government insisted that they were only providing technical and organizational know-how instead of creating new property rights, North Pare irrigators recalled the many examples of broken promises, dispossession, nationalization, and relocation during the heyday of African socialism. Even when government officials promised them property rights in the improved irrigation systems, North Pare farmers had little confidence that future administrators would not seize these areas as state assets. By rehabilitating a clan *ndiva* through TIP, therefore, a kin group "knew" that it would inevitably transfer its management rights to the local government. It is possible for a water manager to solidify his water rights by getting a formal document showing land ownership, but this process is expensive and difficult enough to discourage most irrigators. The *ndiva* manager would have to provide the District Land Development Officer with a complete topographic survey of the land around the *ndiva* and a variety of signed documents showing approval by the village government and Ward Development Committee. Although TIP was aware of these tenurial problems, the program was unwilling to shepherd its participants through this critical process because it would have consumed much of its time and resources.

The irrigators of North Pare were caught between the contradictory demands of two social institutions of resource management. Both TIP and peasant farmers sought food security and sustainable resource use, but their clash generated doubt, conflict, and inequality. The TIP project was based on the notion that planning and engineering could reform a traditional system into a modern one. This assumption of dichotomous steady states prevented the planners from anticipating the way that tenurial ambiguity, gender taboos, and social inequalities combined to ensure that TIP irrigation projects were, although quite popular, socially and morally problematic. The project should have been an increasingly structured and predictable r–K process of "exploitation" and "conservation," but instead it became yet another drawn-out ambiguous Ω–α process of incomplete "release" and "reorganization." This is why most of the rehabilitated irrigation systems in North Pare stand idle today.

Conclusion

Resilience theory has tremendous appeal for environmentalists, humanitarians, and planners alike, because it defines disorder, collapse, and reconstruction as beneficial for long-term social and ecological success. It is a profoundly functionalist perspective in which power lies in the mechanics of the system as it (somehow) seeks self-organization and resilience. What is missing, however, is an appreciation of how the dynamics of power in social-ecological systems are always shaped by both social inequality and shared culture (Hornborg 2009). In the case of North Pare, gender/age hierarchies and the symbolic systems that expressed those inequalities had made irrigation resilient and robust (for different reasons) in the pre-colonial and colonial periods. Those same characteristics made irrigation less resilient in the context of post-colonial Tanzania. Resilience theory is a useful tool to describe functioning isolated systems, but it runs the risk of a moral relativism that naturalizes exploitation and repression. Its utility decreases further when it tries to account for the dynamics of social-ecological systems as parts of the global-scale systems controlled by colonial administrators, post-colonial modernizers, and development agencies. Social-ecological systems are indeed in desperate need of increased resilience, but without attention to the social conflict, cultural contradiction, and moral ambiguities that make up much of human experience, resilience theory is unlikely to steer farming societies in sub-Saharan Africa toward new K-phases of resilient sustainability.

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13 Meat

The new geopolitics of food

Ulf Jonsson

Although global patterns of food consumption still remain highly diverse, there are certain points of convergence. The most significant is the incorporation of expensive, high-quality meat and dairy products in the diet. This trend is reflected in the growing international trade in foods, the global diffusion of fast-food chains and an expansion of US and European eating habits. This process started among the present OECD countries after the Second World War. It coincides with what the agrarian sociologists Harriet Friedmann and Philip McMichael (1989) have characterized as the second international food regime. The striking difference in the present situation is the rapid rise in the consumption of meat and dairy products in the global South, in particular in East and Southeast Asia and in the oil-rich Middle East (Delgado *et al.* 2001). China is by far the most spectacular case. China has moved from a per capita consumption of barely 6 kg to over 50 kg at the beginning of the twenty-first century. The same pattern is visible in countries like South Korea and other rapidly growing Asian economies, whereas Japan went through the same process a couple of decades earlier. There are, however, parts of the world that are entirely left out of this process, most notably sub-Saharan Africa.[1]

Historically, vegetable and animal production have been closely connected. In fact, it was not until after the Second World War that increasing specialization and separation had any significance outside the ranching regions in the United States and Argentina. Furthermore, the raising of grass-fed cattle and sheep in the classical ranching areas had little in common with present-day animal production and did not always entail a complete separation of vegetable and animal production.

Modern animal-rearing began with poultry and pork production. Today, all kinds of livestock production are more or less part of the industrial logic. So-called “confined animal feeding operations” (CAFOs) are spreading also to bovine meat production (through feedlots) and dairy farming (Gurian-Sherman 2008).[2] Even if beef cattle kept in feedlots still constitute an exception outside the United States, the situation is changing rapidly.

From a situation where most of the stages in the livestock production chain were integrated at the farm level, we are moving toward increasingly complex, global livestock commodity chains. Some regions specialize in providing input such as high-value protein fodder, while others concentrate on meat and dairy production. It has often been possible to locate large-scale animal production close to urban centres.

In the global North, people have become increasingly aware of the complications of this food production model as a result of a number of food scandals that have haunted consumers. A scope for alternative production has emerged, usually of either ecological or dietary rationale. Alternative forms of production also exist in the South and are often connected to social development programmes. These alternatives are important, especially as possible solutions to problems of sustainability (Jailette 2000).[3]

Nevertheless, mass production is still dominant in the global North and is expanding rapidly in the South. Thus the problem of sustainable food chains must be addressed at the global level. The livestock chains discussed in this chapter are beef, poultry and pork, which cover the bulk of global meat consumption and production. In these chains, mass production is becoming more and more complex and dependent on long and increasingly global supply chains for strategic inputs – in particular, animal feed. The final goods are also traded over long distances, such as special cuts of meat aimed directly for the supermarket shelves. This constitutes a great challenge for producers as well as consumers in all parts of the world. High-quality animal food used to be the domain of the developed countries, with some exceptions such as beef production in the Southern Cone of Latin America. Under the protective shield of huge subsidies in the post-war era, it became a stronghold of European agriculture and food industry. In the present context of decreasing levels of subsidies and tariffs, the European agro-food sector faces a severe challenge.

The challenge is no less significant in the rapidly expanding middle-income countries in Asia and Latin America that, at first glance, may seem to be winners in this process. Mass production of animal foods and their inputs, such as soybeans, puts a considerable strain on the production systems in these countries. Large, confined animal production sites close to huge urban centres in China and other Asian countries are a striking example of risky practices. Problems of social polarization and ecological sustainability in large-scale soybean cultivation is another troublesome example.

The current situation differs considerably from animal production in the late nineteenth and first half of the twentieth centuries. We shall now discuss the extent to which this means a challenge to fundamental power relations in the global food order.

The rise of industrial animal production

The integrated animal–vegetable and/or more extensive systems of livestock production in the first half of the twentieth century provided the inhabitants of the developed world with increasing quantities of meat and dairy products. Still, for the vast majority, a steak was still very much a luxury rather than a daily occurrence.

In the early 1960s, the separation of significant parts of animal production from vegetable cultivation was quite advanced in the United States and well under way in western Europe. By the beginning of the new millennium industrial animal-rearing had been widely diffused in the industrial world. The so-called wheat–meat complex characteristic of the second international agro-food regime was well established (Friedmann and McMichael 1989). Although some important nutritional and dietary differences remained quite strong, we can see a clear convergence in meat consumption. Greece and Italy, representing the archetype of Mediterranean cuisine and historically associated with a modest share of meats in the diet, moved from a per capita consumption of barely 21 kg of meat in Greece and 30.5 kg in Italy in 1961 to 88.5 kg and 89.8 kg, respectively, in 2000. For high-income countries as an aggregate, the change was from 55.5 kg in 1961 to 92 kg in 2000 (Jonsson 2004).[4]

The significant increase in meat consumption all over the developed world is clearly connected to the expansion of industrial animal-rearing. This development took place within the framework of the highly regulated agro-food system of the Bretton Woods era. The basis of this order was a deal between the United States and Europe, where the United States accepted high levels of European protection of wheat in exchange for an opening of the market for American exports of feed grains, primarily soybeans (Thoyer 1998).[5] The increasing availability of protein-rich concentrated feedstuffs laid the foundation for one of the most significant trends in the post-war food order in developed countries: the industrialization of animal production and the increasing separation of animal and vegetable production. Grain production inclined towards monocultures. Cheap inputs of grains and soybeans were provided at subsidized prices. Genetic research contributed breeds adapted to CAFOs. We saw the shift from a 73- to a 42-day chicken (Weiss 2007: 60–62). Hogs were bred in ever-growing establishments. In the United States this kind of production has advanced at a rapid pace. CAFOs also manage beef cattle and dairy farming, which is still relatively uncommon in Europe (Gurian-Sherman 2008: 334–335).

The rise of CAFOs has had a clearly exclusionary character. Small farmers cannot afford the investments necessary to establish an industrial feeding operation. Increasingly, concentrated food-processing firms were important drivers in the industrialization of animal-rearing. Contract farming, where processors control all important parts of the production chain, is becoming more common (Gouveia 1994). A few companies dominated the national scene even in large countries like the United States (Hendrickson and Hefferman 2007). The same pattern can be seen in western Europe. Towards the end of the Bretton Woods period, the dominance of North-based corporations in the global meat market was uncontested.

The Bretton Woods food order, which constituted the framework under which industrial animal-rearing and meat-processing first flourished, came under heavy attack in the neoliberal offensive from the 1970s onwards. As a highly regulated and protectionist sector, the agro-food sector became a favourite target of neoliberal campaigns. The transnational agro-food companies had strengthened their position considerably during the last phase of the Bretton Woods era and were eager to get rid of national regulations that could block their global expansion strategies. The emerging food regime has been characterized by the liberalization of agricultural markets and the decrease of national (state) influence over the production and distribution of food. The transformation of national agro-food enterprises into transnational companies supplying inputs to agriculture and the food industry has created a shift of power from local and national agents in favour of global agents (McMichael 2005).

However, the post-war, chemical-intensive and highly specialized food order has also met an increasing resistance from worried consumers in the North. In recent decades we have experienced a number of "food scares", e.g. mad cow disease and dioxin-poisoned chickens, which have created headlines in the media and a more general awareness of the problems inherent in highly centralized food systems (Jailette 2000).[6] These worries have been extended to a more general idea that the prevailing agricultural and food production model is approaching an end (Goodman and Redclift 2005). This critique is stronger in Europe than in the United States, and the development of alternative food supply models based on small-scale ecological and/or dietary networks is also stronger (Miele 1999; Fonte 1998; Jonsson 2008). The search for alternatives is thus very much part of the struggle going on in the current global food system. In an international context, for producers facing cutbacks of subsidies that have been strategically important for conventional agriculture, the marketing of quality can appear as an attractive option.

The ambivalence about industrial meat that is mounting in the high-income countries is unheard of in the middle-income countries in Asia, the Middle East and Latin America. These parts of the world have only recently embarked on the road to a meat-based diet. For middle-class consumers in Asia and the Middle East, the thrill of being able to consume meat in quantities unheard of by their parents is still new and exciting. The demographic size of these regions means that huge quantities of meat have to be provided. The middle-income countries consumed almost 140 million tonnes of meat in 2002, and China alone consumed nearly 68 million tonnes compared to the 88 million tonnes eaten in high-income countries. This change has profound implications for the global agro-food system, the international division of labour, power relations and not least for farmers in the South as well as in the North. The most profoundly transformed agro-food sector is found in the Southern Cone of Latin America, which is the subject of the next section.

Meat in the global food order

A significant part of the demand for meat in the new meat-consuming countries in Asia is met by domestic sources. Japan is an exception and has increased its meat imports considerably over the last decades. In the Middle East the possibilities to expand domestic production are very limited and the region has to rely on meat imports.

The Asian, and in particular Chinese, demand has far exceeded what can be produced based on internal sources of animal feed. The region thus has to rely on imported animal feed. Since production and consumption is heavily biased towards pork and poultry, for which protein-rich fodder is especially important, there has been a huge increase in demand in the last 10–15 years. Soybeans and soybean derivates, cakes and meal, are by far the most important source of protein in animal fodder and completely dominate the market for major protein meals, constituting 65 per cent of world consumption in 2007–2008 (*Soya & Oilseed Bluebook* 2010).

China, the place where soybeans were once domesticated, has become the world's largest importer of soybeans and soybean oil.[7] In particular, it has become an important customer for newcomers on the soybean scene in the Southern Cone of Latin America. In just a couple of decades the structure of agro-food exports from Brazil and Argentina has been completely reoriented. The soybean sector (beans, meals and oil) in the mid-2000s constituted almost 57 per cent of Argentinean agro-food exports, whereas meat reached only 7.4 per cent. Cereal exports of wheat and maize constituted 18.9 per cent. Argentina has moved far away from the classical wheat-and-beef export pattern. Soybeans are not quite as dominant in the more varied Brazilian export profile, at 40.3 per cent. It is worth noting that coffee, once the major export item, now only accounts for around 8 per cent of the value of Brazilian agro-food exports. Still, Brazil is the world's largest exporter of green coffee.[8]

The sheer scale of China makes the impact of its consumption tremendous. Most of the soybeans imported to China are destined for the growing livestock industry, primarily pork and poultry. The Chinese state and private actors are actively pursuing a policy of domestic processing, relying on joint ventures with the big oilseed transnationals to get access to state-of-the-art technology (*Chemical Market Reporter* 2005; *Oils, Fats & Waxes* 2000). The enormous size of the Chinese market makes it an attractive location for direct investments in enterprises relying on raw soybeans from Brazil, the United States and, to a lesser extent, Argentina. Similar processes are going on in a number of smaller but rapidly growing Asian countries and in other middle-income countries. Western Europe remains the largest market for soybean meals and cakes, but the Asian share is rising.

The diffusion of Western, meat-based diets has changed the international division of agro-food labour. The South–South flows of agro-food goods, animal feed and meat have reached levels unthinkable only a couple of decades ago.[9] Primarily this is a phenomenon connecting middle-income countries. However, the modest meat consumption (consisting mostly of poultry) in the poorest countries today is to a large extent supplied from Brazil.[10]

To what extent is this new feature of the global division of agro-food labour also reflected in changing power relations in the global food order? What are the consequences for farmers, farm workers and other actors in the animal feed and meat commodity chains? These questions are very complex and need to be explored at various levels. I will here limit my attention to the meat sector in the Southern Cone of Latin America. Since the fate of the meat industry is intimately linked to that of soybean production, this sector particularly needs to be addressed. In Argentina and Brazil, the two largest agro-export economies in the Southern Cone, the global expansion of meat consumption and production has produced quite different outcomes.

Argentina and Brazil in the global division of agro-food labour

Argentina is increasingly becoming a supplier of protein-rich animal feed, including raw soybeans, but more importantly cake of soybeans and soybean oil. Argentina is by far the world leader in exports of cake of soybeans and number three in exports of raw soybeans. The world's largest soybean processing zone is located in the state of Santa Fe in the greater Rosario area. Heavy investments have been accomplished in the last ten years, making Argentina one of the lowest-cost soybean processors in the world. This region also processes a substantial part of the increasing Paraguayan crop. Thus, Argentina has advanced beyond simple commodity exports in the soybean sector. However, so far very little processing of soybean meal and oil into high-value products such as concentrated animal feed has developed. The distinguished Argentinean scholar Graciella Gutman and her co-authors classify Argentina as primarily a commodity exporter (Gutman *et al.* 2006). The soybean processing industry in the Santa Fe region has few linkages to the Argentinean agro-food processing industry outside the soybean sector. Only 3 per cent of the production is consumed in the country. The processed goods made from soybeans have a fairly standardized character. Certainly, more value is added to the products compared to raw soybeans, but the really high-value sections of the global soybean chain are located elsewhere. Although there are powerful domestic actors on the soybean scene in Argentina, processing and trade are firmly in the hands of four transnational companies: Cargill, Bunge, Dreyfyss and Archer and Daniel Midlands (ibid.).

Furthermore, soybean cultivation is increasingly pushing out cattle-rearing and dairy production from the fertile lands of the humid Pampa. Beef production has stagnated. Thus Argentina's agro-food production is becoming less diverse and more dependent on foreign markets. Some observers even fear that the country's capacity to provide the domestic market with high-quality foodstuffs such as beef is put in jeopardy.[11] Even if the country has not yet reached that point, the development of meat production is worrying (see Figure 13.1).

The Brazilian situation is in many respects quite different. If we look a bit closer into the relationship between exports and domestic consumption, we find an increasing domestic use of soybean meal in Brazil. In 2005–2006 almost 44 per cent of the soybean meal production was used on the domestic market. Out of a total production of 22 million tonnes, 10 million were absorbed on the home market.[12] Most of the domestic use of cake of soybeans was consumed in the booming poultry and pork industries. In 2004 Brazilian poultry exports surpassed the previous world leader, the United States. The Brazilian poultry industry is increasingly supplying major markets such as Japan, the largest importer in value terms, with high-value cut and processed products rather than standardized whole chickens, while whole chickens constitute an important item on the Middle Eastern markets.

Thus, in Brazil the soybean chain has served as a foundation for developing high-value agro-food exports for the expanding markets in Asia and the Middle East.[13] The market leaders in the Brazilian poultry and pork industry are currently dominated by domestic enterprises.[14] In recent years we have seen a rapid concentration in the Brazilian meat-packing industry. The two largest actors, the pork and poultry companies Sadia and Perdigão, recently merged to form Brazil Foods, thus creating one of the largest companies in the sector in the world (*Business Latin America* 2009). Recent plans of Brazil Foods to invest almost one billion US dollars in the boom town of Lucas do Rio Verde in the state of Mato Grosso will increase the slaughtering capacity to 145 million chickens and 2.5 million hogs per year. The operation will also include a soybean feed factory with a daily production of 1.2 tonnes. The quantity demanded corresponds to 1.35 million hectares or 20 per cent of Mato Grosso's soybean crop. The contract farmers supplying this factory are often large-scale entrepreneurs like the *Fazenda Mano Julio*, employing 25 permanent workers to produce 146,000 pigs per year.[15]

Brazil is also a global leader of beef exports, mostly from grass-fed cattle. In the beef industry, JBS Friboi has taken over the US company Swift & Co. to create the world's largest beef producer, surpassing in terms of animals slaughtered the former leaders, the US-based company Tyson foods.[16] The company is now

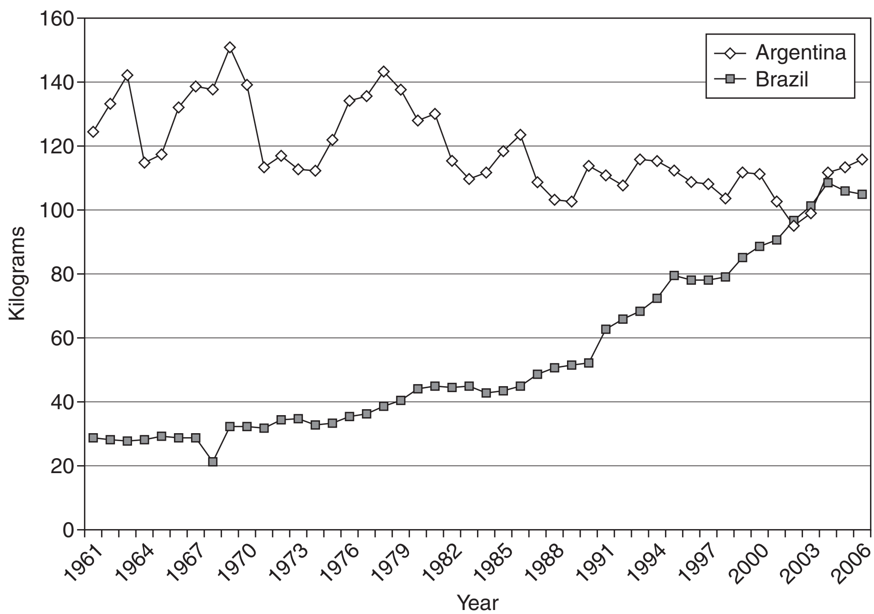

Figure 13.1 Per capita production of meat in Argentina and Brazil 1961–2006 (kg) (source: World Resources Institute, Earth Trends).

diversifying into pork and poultry through the acquisition of the US company Pilgrim's Pride.[17] The announcements of mergers and acquisitions in the Brazilian meat-packing industry have been frequent in recent years. The US-based transnational Cargill has ceded its poultry operations to the Brazilian company Mafrig, already an important actor in the meat industry in the Southern Cone, owning a significant share in the Argentinean and Uruguayan meat-packing industry. Mafrig has recently also taken over a large European pig and poultry producer.[18]

In the meat industry the leading Brazilian-owned companies are becoming transnationals challenging the giants in Europe and the United States. On the so-called emerging markets many business analysts see a strengthening of the Brazilian competitive advantage. A market analyst of GIRA, a leading consultancy company in the agro-food sector, describes the comparative advantage of Brazil in industrialized hog production in the following way:

> Brazil will be able to provide lower feed grain prices because it has the capacity for arable expansion and it has *no problem with manure disposal* [my italics] – a problem that has hindered the growth of the European industry because of environmental concerns.[19]

In other words, the weak position of environmental interests is a significant part of Brazil's competitive advantage.

With all reservations concerning the environmental and social sustainability of the soybean chain – and there are huge problems – the industry has had a much more dynamic impact on the Brazilian agro-food sector than in Argentina. The size of the domestic market is an important factor behind this process. The potential demand and the huge resource base give Brazilian entrepreneurs an advantage when dealing with the big transnational actors. Brazil is not just any sourcing zone that can easily be substituted with another. On the other hand, this is not the only and perhaps not even the most decisive factor. Brazilian policies vis-à-vis the agro-food sector have been more consistent and consciously directed towards strengthening global competitiveness than policies in Argentina (Chaddad and Jank 2006).

The development of a global and competitive agro-food sector in Brazil has resulted in structural changes in all parts of the agro-food chain. The Brazilian rise to eminence in this chain has occurred within the framework of modern high-input agriculture and standardized, capital-intensive food processing. Consequently, a large number of small farmers and landless rural workers have been excluded. The soybean chain is a very obvious example of such processes. Soybean cultivation is highly capital-intensive and does not generate much employment. The same is true for soybean processing. Modern meat-packing is also highly capital-intensive. The investment of more than US$900 million referred to above is expected to generate 6,000 new jobs.[20] In a situation where long-term stable employment in the urban sector does not expand at a rate sufficient to absorb the labour force pushed out of agriculture, the problem of an increasingly unequal division of income becomes acute.

Nevertheless, compared to the Argentinean reliance on commodity exports, the Brazilian development path has a greater potential. Brazil has claimed a more advanced position as a global agro-food power. Certainly, it is a development firmly anchored within the paradigm of the productivist agro-food system, which is under increasing pressure in the developed world. The old familiar story of North–South patterns of dependency needs to be revised. A number of Brazilian agro-food companies are global actors of the same magnitude as core-based transnationals. Brazil's emergence as a global agro-food power is not entirely conditioned by outside forces. Undeniably, there still remain strong elements of the old story of dependence on powerful economic interests in the North, but there are also new features such as the importance of emerging markets. The dependence on markets in Europe and the United States has been significantly weakened. The expanding Asian and Middle Eastern economies will probably fuel the agro-food sector for a considerable time. For example, Asia and the Middle East absorbed more than 70 per cent of the Brazilian poultry export in 2008.[21] In fact, Brazilian agro-food industries are rapidly out-competing US and European rivals on these markets.

Brazilian governments from Cardoso to Lula da Silva have pursued policies intended to strengthen Brazil's geopolitical role. Of course, this ambition involves much more than the agro-food sector. Nevertheless, a competitive agro-food sector remains an important tool for achieving a new geo-political role. Important questions for future research include a critical analysis of the ambitions to use MercoSur and a more general Latin American integration as a tool to strengthen Brazil's (and the region's) position in the global agro-food system.[22]

In the middle and short run, Brazil and the other Southern Cone countries have good chances to extend their influence as suppliers of high-value standardized goods. In Europe, large-scale animal production meets increasing resistance from well-off and well-educated consumers. The environmental concerns around waste disposal from CAFOs is also a brake on further expansion in Europe, as the analysts from GIRA have noted. However, the lobbies for mass production are still strong in Europe and certainly also in the United States. Recently, the European lobby organization for mainstream industrial farmer and agricultural cooperatives, COPA-COGEA, protested against the re-opening of commercial negotiations with MercoSur. European mass producers of meat fear the competition from the efficient, low-cost rivals in Latin America. The argument has a somewhat hypocritical tone, emphasizing environmental aspects (Copa-Cogea 2010). Coming from an organization that has opposed EU environmental regulation for decades, the conversion to environmentalism is not entirely convincing.

In a somewhat unintended and paradoxical way, movements highly critical of the current agro-food order may contribute to the formation of a new division of agro-food labour, where mass production will be concentrated in a few hot spots in the South. The North, meanwhile, can increasingly put the emphasis on niche production with an ecological and/or dietary accent for well-off consumers, while poor people in the South as well as in the North continue to rely on products with dubious environmental and health consequences.

Notes

1 http://earthtrends.wri.org/searchable_db/index.php?theme=8, 10 March 2010.
2 For an overview of the importance of CAFO in contemporary US agriculture, see Gurian-Sherman (2008).
3 For an interesting overview of these alternatives see Jailette (2000).
4 http://earthtrends.wri.org, 14 March 2010. For an overview of the discussion on convergence and maintenance of gastronomic and dietary variation in Europe, see Jonsson (2004).
5 US agriculture was also highly protectionist, using a different set of subsidies. Food policy and food aid in particular became an important instrument in American security policy directed towards the third world. For an interesting comparison of agricultural subsidies in the United States and Europe and its recent transformations, see Thoyer (1998).
6 The critique of mass produced food has developed into a "growth industry" in publishing. For an interesting and particularly colourful example of this type of critique, see Jailette (2000).
7 UN Statistical division, Comtrade, 2000–2008.
8 FAO key statistics of food and agricultural external trade 2004.
9 There are other significant changes in the emerging international division of agro-food labour. The growing counter-seasonal trade in fresh fruit and vegetables is a well-known and much discussed example. The trade in these goods is very much centred on flows from the global South to the North and will not be discussed here.
10 UN Statistical division, Comtrade, 2008.
11 The Beefsite, "Argentina may import beef by 2012", www.thebeefsite.com, 12 October 2008.
12 www.soyatech.com/oilseeds_statistics, 29 August 2007.
13 Brazil is also increasingly supplying the African market, out-competing European producers (*USDA Foreign Agricultural Report* 2007)
14 Among the 11 companies accounting for 85 per cent of the exports in 2005, only two were transnationals: Seara, a subsidiary of Cargill; and Frangosul, owned by the French giant in the global poultry industry, Doux. Together these two companies had an export share of 24 per cent (*USDA Foreign Agricultural Report* 2005).
15 www.manojulio.com.br/conteudo/atividades-suinocultura.asp#call, 3 September 2008.
16 http://reuters.com, 9 June 2008.
17 www.thepigsite.com, 22 February 2009.
18 www.thepigsite.com, 22 February 2009.
19 www.thepigsite.com, 16 September 2008.
20 www.brazilintl.com, 15 August 2008.
21 UN Statistical Division, ComTrade 2008.
22 The Brazilian president Lula da Silva expressed ideas along these lines in an interview in the Argentinean paper *Clarin*, focusing on the geopolitical role that the MercoSur region could play in Africa by reinforcing regional integration; see: www.servicios.clarin.com/notas/jsp/clarin/v8/imprimir.jsp?pagid=1755208, 24 September 2008.

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14 Trees

Conflicts between pastoralists, loggers and conservationists in the Himalayas

Pernille Gooch

The forest is a veil
behind which we live
(Van Gujjar saying)

Down through history India's forests have been an integral part of agrarian landscapes as they were used by local communities, heavily dependent on forests for their subsistence. The links between biodiversity and cultural diversity were strong as diverse ethnic groups evolved in interconnection with specific parts of ecosystems. However, for the last one and a half centuries forests are the property of the state, managed and policed by the officials of the Forest Department. This change has given rise to conflicts over the use of forest resources between the state and local people. The part of the Himalaya that is of special interest here, the state of Uttarakhand, has a long history as an area of contestation and confrontation on forest issues. Environmental historian Ramachandra Guha (1989) has named it "the ecological landscape of resistance". State powers, whether imperial British or Indian, have been seen as intruders by local people and resisted, sometimes violently but mainly by different forms of hidden insurgence and defiance. In forest conflicts, local people have habitually been seen as the main cause of deforestation and the state as a guarantor for scientific and sustainable management.

Traditionally, the rights to forests and forest produce between different users were regulated through local institutions. However, in the second half of the nineteenth century, India's forests were taken over by the British colonial administration as Crown land, and scientific forest management was introduced. Through this colonial conquest and control, the local was drawn into global connections, changing the trees of the Himalayan forests from natural resources for local subsistence needs into produce for commodity chains, supplying material for the growth of the British imperial power, based on one hand on industrialisation at home and on the other on capital accumulation through extraction of raw material from the colonies. It was also the start of a process of deforestation and change of forest ecosystems; indigenous trees, with multiple uses for local people as well as being important sources of fodder for wildlife, were replaced by plantations of trees for commercial use. After independence in 1947, India chose a path of economic development based on modernisation of industry and agriculture advocated by Nehru, rather than the Gandhian way, which favours decentralisation and small-scale rural development. The result was that the degradation of India's natural resources and the disruption of the relationship between nature and local communities accelerated in the decades after independence. Trees of the Himalayas became a cheap commodity for the Indian industrial houses emerging after 1947. After the structural adjustment in the early 1990s, however, forest management in the Himalayas has undergone a new transformation from commercial forestry to the conservation of nature, as more and more forests are now set aside as protected areas.

The environmental history of Uttarakhand is usually seen through the perspective of the settled peasantry (Guha 1989; Gadgil and Guha 1993; Agrawal 2006). However, here we will look at it from the perspective of one of the most marginalised and vulnerable groups in the region, the *Van* (forest) Gujjars. The Van Gujjars are forest pastoralists, subsisting almost entirely on dairy pastoralism, with their herds of buffaloes in state forest. Due to their complete dependence on trees for survival, they were one of the communities hardest hit by colonial forest policies. Throughout history the Van Gujjars have specialised and adjusted pastoral production, based on milk buffaloes, to the mountain ecosystem of the Central and Western Himalayas. One feature of the mountain environment to which they have had to adapt is the seasonal variation in climatic conditions and thereby in the growth of vegetation. As a result, migration is an ecological necessity. The transhumance of the Van Gujjars oscillates between two fixed points in their landscape of pastoral movement: the forests in the foothills, where they stay in winter, feeding their buffaloes on leaves cut from trees – so-called lopping – and the forests in the high range adjacent to the alpine pastures, where they go for grazing during summer. As they lop a wide array of indigenous trees for fodder for their animals during winter they also need a forest where biodiversity is maintained.

Connecting the history of forest utilisation in the region with the history of local people, we see how the lifeworlds of seemingly isolated forest communities, such as the Van Gujjars, over time are dramatically altered through changes in global and national discourses and policies.

As this chapter deals with trees, I have limited my description to the utilisation of trees by the Van Gujjars during winter in the forests of the foothills, and not included the summer season in the alpine meadows where buffaloes mainly feed on grass.

The situated perspective on nature degradation

How people react to environmental problems of pollution and nature degradation depends on the point of view from which such problems are perceived. This is, of course, just as true for the view from a subaltern position, the people at the bottom, as it is from the perspective of the elite. Environmental problems are not merely abstract, generalised and global, but have tangible, localised aspects. Environmental conflicts may also be the manifestations of latent class struggles over resources between elites and disempowered sectors of society denied control over common assets. In the forests of the Himalayas we see the result of such struggles in the nineteenth century, where the powerful – the conquerors – take control over the commons, the resource base of the rural poor through a legal framework that denies the latter their customary rights. In the twentieth century, conservation policies give rise to enclosure policies further estranging local people from their forests. Author and critic Hans Magnus Enzenberger (1995: 290–291) criticised the ecological movement he saw emerging in the West in the early 1970s, pointing towards the strong class bias that may be found in such movements. In the nineteenth century, the English working class lived in an unhealthy environment, heavily polluted by industrialism, which was overcrowded and dangerous. As Enzenberger states, to a "neutral observer" this would have provided "food for ecological reflection". But what happened was:

> It occurred to no one to draw pessimistic conclusions about the future of environmentalism from these facts. The ecological movement has only come into being since the districts which the bourgeoisie inhabit and their living conditions have been exposed to those environmental burdens that industrialisation brings with it. What fills these prophets with terror is not so much ecological decline, which has been present since time immemorial, as its universalization.
>
> (Enzenberger 1995: 291)

Below, we will see how the concept of "conservation" changes in connotation for the forest of the foothills in Uttarakhand during the 105 years between 1878 (the Indian Forest Act) and 1983 (the proposal for Rajaji National Park in the foothills). In the 1870s the expression was used by the Imperial Forest Department for a scientifically managed forest, producing the maximum number of commercially valuable trees for logging. From the 1970s onwards the concept was reintroduced by the Indian Forest Department, together with the international conservation lobby and the local elite for a forest of "natural beauty" where biodiversity and wildlife should be conserved. Neither position saw any place for the rural poor in the forest, nor did they appoint any role for them in the conservation of trees and wildlife.

Transformation of the Uttarakhand forests

With the arrival of the British in the beginning of the nineteenth century, first as traders but later as rulers, the ecological history of Uttarakhand, as of the rest of India, was radically transformed. At that time the British were well into the Industrial Revolution, while in India they met populations, such as peasants, traders, artisans, herders and hunter-gatherers, still relying on pre-industrial modes of production, directly dependent on natural resources. In Uttarakhand they found a region very rich in natural resources used by local communities for subsistence, but to a large degree inaccessible to outsiders. Due to this, the region remained well forested through the first half of the nineteenth century. However, from the middle of the nineteenth century, the forests were opened up for large-scale logging. The Gangetic plains below were at that time to a great extent exhausted of wood, with the result that timber contractors, searching for new areas to exploit, moved to the hills in large numbers (Dangwal 2005).

One important reason for the rush was the rapidly increasing demand for timber for the construction of the Indian railway network. The forests of Uttarakhand thus came to supply raw material for the infrastructures needed for the economic and spatial expansion of the British empire. Dangwal (2005: 119) notes: "The demand for sleepers and fuel by the Imperial railways exerted a constant and relentless pressure on the forests of the region from the middle of the 19th century to the early 20th century." Most important were hardwoods, mainly *sal* (*Shorea robusta*) and *deodar*, for sleepers, while other species of trees were used to satisfy the never-ending need for fuel for the steam engines powering the locomotives. The substantial revenue to the state received from logging was used for making roadways into the interior of the forests, thus further opening up the hitherto inaccessible mountainous region for extraction of its trees. By the end of the 1860s the forests of Uttarakhand were one of the most important suppliers of sleepers for the rapidly expanding Indian railway network. In order to satisfy the demand, logging operations were now conducted all the way from the *sal* forests of the foothills to the *deodar* and pine and spruce forests of the middle and higher ranges.

The demand for timber induced by the expansion of the Indian railways was crucial in changing the position of trees from integrated parts of forest ecosystems, used by local people, into anonymous marketable commodities to be removed and used elsewhere. It was also crucial in the rapid expansion in the 1860s of state power over Indian forests, manifested in the establishment of the Imperial Forest Department in 1864 and the introduction of the first Indian Forest Acts in 1865 and 1878. The forest department was formed on a demand in 1862 from the Governor-General for a department that could, "ensure the sustained availability of the enormous requirements of the different railway companies for sleepers" which made the "subject of forest conservancy an important administrative question" (Gadgil and Guha 1993: 121–122). The administrative question of conservation was thus not to conserve forests and their trees, but to safeguard the transformation of forests into suppliers of raw material for continued growth of the empire.

However, what gave the Imperial Forest Department a full state monopoly on Indian forests, thus denying the customary rights of local communities, was the Forest Act of 1878. The act provided the legal ground for scientific forestry, by which large blocks of forest could be worked commercially without any consideration to claims by local people. While not completely forbidden, the use of trees by native inhabitants became regulated, restricted and taxed. The task of policing the forest was given to the Forest Department. A result of the Act was the forced creation of a dividing line between, on one side, agrarian village lands and, on the other, the "forest land" now belonging to the state. This meant that while people subsisting on the land as agriculturists were provided ownership of what was recognised as private farming land, people subsisting on forest trees were seen as intruders on state-owned land. The Act took little regard of the fact that forests in India had been integrated parts of rural livelihood systems not only for migratory groups, such as hunters and gatherers or nomadic pastoralists, but also for village communities of agriculturalists as well as a wide array of artisans such as wood carvers, basket weavers, rope makers, etc. Such policies led to agro-ecological changes with serious consequences for the maintenance of the natural resource base of the communities. In India there was no industry to absorb the rural poor as labour, as there had been for the English peasants when their common lands were enclosed 100 years earlier. They remained in the rural areas, surviving on primary production, but cut off from control over their natural resource base. Through the loss of livelihood and the system of revenue to the state for the right to use the land and its resources, the transformation also led to the inclusion of rural people in the market.

A couple of records from forest officials during the period illustrate the extent of destruction of the sub-montane forests. In the 1860s, Mr Sibley, Forest Surveyor, surveyed the forests covering the Himalayan foothills. With their lush cover of valuable *sal*, he characterised them as "probably the most extensive forest of one particular tree in the world" (Stebbing, vol. II 1922–1927: 509). As they were within easy reach of the plains, they were seen to constitute a "forester's dream as a source of easily extractable timber" as well as a "sportsman paradise" of rich and bountiful big-game hunting grounds. However, less than 20 years later it was reported in many places that forests of the foothills closest to the plains were "now totally exhausted of timber" (Traill, *Statistical Sketch of Kumaun 1878*, quoted in Dangwal 2005: 122). Recorded was also that the destruction of the sub-Himalayan forests of the region was so massive and relentless that "thousands of trees were felled which were never removed, nor was their removal possible" (Pearson 1869, cited in Stebbing, vol. II 1922–1927: 331–332). Through all this, little consideration was given to communities dependent on local natural resources. Ironically, they were the ones who came to be considered as the "destroyers of trees".

Pearson, a British forester, who in 1869 surveyed the *sal* forests in the foothills, where the Van Gujjars now have their winter camps, wrote: "The *sal* was not pure but mixed, in places plentifully with *sain* (*Terminalia tomentosa*) and other *jungle* woods. These forests required thinning and good revenue would be realised from poles and firewood" (Stebbing, vol. II 1922–1927: 331–332). This statement demonstrates how only those species of trees that had commercial value were taken into account by the newly established Forest Department, while the softwood trees of no economic value, among them indigenous trees such as *sain*, one of the most valuable fodder trees for the people of the hills, were categorised as "jungle woods" and considered as waste.

In the forest of the Van Gujjars

When we move into the forest of the pastoral Van Gujjars in the latter part of the nineteenth century, we see how forest policies wreaked havoc, not only on the trees of the forest, but also on the people gaining their livelihood from them. For centuries the life of the Van Gujjars had been based on the use of forest land in the foothills and the high ranges of the Himalayas, intercepted with seasonal periods of camping on the fallow in the plains, where the dung from the buffaloes helped fertilise the fields. In an account from 1870, at the point of transition to scientific forestry, Wilmot, a British forester, describes the pastoral Van Gujjar as one of numerous forest tribes, roaming far into the Himalayas in summer and in spite of their "uncivilised Eastern habits" it is evident that he was impressed by them:

> The Gujjars (cattlemen) are a tribe apart, who keep herds of buffaloes and make a living by the sale of milk and butter. They dwell in the forest, selecting a place for their huts in the vicinity of grazing and water, moving on, as these become scarce and roaming far into the Himalaya in the summer. Their buffaloes return to the station [camp] twice a day, morning and evening, and after being milked wander off again into the forest, sometimes alone, at others accompanied by a youthful Gujjar, who often reclines upon the broad back of one of the cows. The Gujjars know no fear; they were in the past a martial race and today they show no subservience and present picturesque figures as they stand on the high wooden sandals, robed in black blankets and armed with formidable 6-foot bamboos. They are one of the numerous forest tribes with whom the forest officer comes into frequent contact and from whom he learns the characteristics and habits of an uncivilised Eastern population – habits which he may condemn, but which he must acknowledge to have good reasons for their origins.
>
> (Eardley Wilmot about cattle grazing around 1870, in *Forest Life and Sport in India*, cited in Stebbing, vol. I, 1922–1927: 173)

Through this glance into the world of the Van Gujjars in the *sal* forests of the foothills from 1870 we meet a people who "show no subservience" and whose habits of forest use may be condemned according to this British forest official, but which, none the less, "have good reasons for their origins". However, like the reports on the state of the forest, historical evidence less than 20 years later indicate a completely changed situation as a consequence of the forest laws of 1878.

The British only recognised rightful occupation of land for settled agricultural communities, classifying pastoral nomads below peasants on the evolutionary scale. Through their labour, peasants improve the land on which they subsist, while pastoralists only use the land in its natural state. The former were thus entitled to ownership while the latter needed supervision and, ultimately, settling. This definition contributed to the development of new systems of control that were introduced for the "wandering herdsmen" of the Himalaya during the last decades of the nineteenth century. Grazing passes were introduced in the region in the 1880s, stipulating permitted migration routes as well as the number of animals allowed. In order to ensure that rules were followed, checkposts were established along the migration routes. Any Van Gujjar attempting to traverse the area without a pass or to proceed along a route not stipulated in the passes was liable to severe punishment and would be compelled to return to the plains (Gooch 1998b: 223–224).

As indicated by a letter from a Conservator of Forest with some sympathy for their case, if pastoral Van Gujjars were "condemned" to stay in the plains during summer, it would mean that they and their animals would die:

> The buffaloes would die in the plains if detained there during the hot weather and so would their owners who are Hill people and travel with their wives and family. These men do not believe that government intends to exclude them from the hills and come up every year hoping to work on the good nature of the forest officer in spite of the threats of prohibition. It is not easy for an officer to resist the appeals of a crowd of these simple people and to condemn them to spend the hot weather in the plains.
>
> (*Collector's Record 1888–1901*: letter of 26 July 1887, from W.R. Fisher, Conservator of Forest, School Circle)

While in pre-colonial times agriculturalists and migrating pastoralists shared communal rights over natural resources, the British created antagonism and competition between them through a policy of *divide and rule*. Nomadic pastoralism was considered obsolete, and in 1931, towards the end of the colonial regime, a Conservator of Forest characterised the pastoral Van Gujjars as "a dying race" (Letter to the Superintendent of the Dun, dated 19 May 1931). Gone were the proud forest dwellers, described by Wilmot in the early period of colonial forest policy as having no fear and showing no subservience.

Conflict over conservation

The consequences of colonial policies were still clearly visible in the 1980s, when I started visiting Van Gujjar families in their winter camps in the *sal* forests of the Shiwalik foothills. Although trees from their forests were felled a century earlier for the expansion of industrialism and the world market, the Van Gujjars never used the Indian railways to ride away to "development". They were still living in the forest, subsisting on a pre-industrial mode of production and using their own legs and pack animals for transportation during the seasonal migrations. As stated by Gulam Nabi, the Van Gujjar leader,

> Ever since the beginning of the forest the Van Gujjars have been staying in it, and as the world has progressed other people have gone into lucrative positions, but the Van Gujjars are still where they were *in the jungle*.[1]

What the Van Gujjar lost through the colonial encounter was control over their territory of migration and over the natural resources on which they depend. They were thus left in the forest, but marginalised and with a strong feeling of loss and insecurity. Bibo, an old Van Gujjar woman I met in the hills in the summer of 1992, expressed her hopelessness and despair in these words:

> We have no land [*zamin*] and now they are taking the forest [*jangal*] from us. We have nothing. Even the bear has a better life than we do. It has got somewhere to creep in for the night, but the Gujjars have nowhere. The government might just as well shoot us all, children and everybody, and throw us down over the edge of a cliff.

With the establishment of Rajaji National Park, which covers a large part of their winter camping grounds in the foothills, the menace threatening to alienate the Van Gujjars from the forest was once again state policies for "conservation". However, the meaning of the concept had changed. Today the issue is no longer conservation of a well-managed forest in order to ensure the sustained availability of trees for logging, as in the nineteenth century, but the idea of conservation of a "natural" forest *for* wildlife and *without* people: a forest for the bear but not for Bibo and her family. Only one thing remains the same: it is still the rural poor gaining their livelihood directly from the forest who are considered the most serious threat to the forest. For the Van Gujjars, what was threatened was their lifeworld and the threat was embodied in the forest officials, people who habitually exploited them and who were one of the unpleasant aspects of living in the forest.

Preservation of wild nature and wildlife in India has generally been considered the exclusive domain of middle-class environmentalists representing elitist positions in regard to natural resource use. These views are usually articulated within modern concepts of development, where "nature" on one hand is seen as natural resources to be utilised by humans for economic gains within the capitalist system, but on the other hand reserves are left as icons in their "wild and pristine" state and outside of human use in an otherwise degraded landscape. A unified legislation concerning management and protection of wildlife was passed in India in 1972. The wildlife conservation strategy of "fence and protect" that was applied was borrowed from the United States according to the US ideology for creation of national parks. The idea is to conserve a pristine nature *for* wildlife but *without* (resident) people as a breathing hole far away from the hustle of modern life. As part of the structural adjustment of the Indian economy in 1991, conservation laws for fencing the forest and protecting it from local users were further tightened, and after 1991 increasing areas of forest were brought into the "protected area network".

Once declared a protected area, all human activity inside it is banned (except for a public servant on duty or a person permitted entry by the authorised officer). This means that traditional users lose all their rights. They are no longer allowed to collect anything from the forest and are even barred from entering it.

According to the law, new categories of people may now be granted permission to enter or reside in the sanctuary: apart from forest officials and wildlife wardens, only those engaged in scientific research, photography or tourism. Naturally it is within these categories that the people are found who fuel the movement for wildlife conservation, i.e. city-dwellers (from India or abroad) who enjoy a weekend or a holiday with a sojourn in the "wild", preferably with a camera to catch the exotic, or biologists interested in the preservation of "wilderness" as habitats for non-human species. As expressed by Guha (1997: 14), conservation in India is not only extensive, it is also big business.

The tightening of conservation laws in 1991 had immediate repercussions for the Van Gujjars. When they returned from the summer camps in the alpine pastures in the autumn of 1992, the laws of "fence and protect" were strictly applied to Rajaji National Park, with the result that the Van Gujjars were physically stopped by park officials from re-entering their winter lands within the park borders. For the Van Gujjars it appeared as if the park was just dumped on them by the Forest Department, or perhaps by the *Sarkar* (government). From their perspective, it looked like a case of pure and inexplicable injustice. As one woman said "Why are they throwing us out when we have done nothing wrong; criminals are put into jail, but what have we done?" Others would say things like "We and our buffaloes are *jangli*, i.e. of the (wild) forest. How come they let the wild animals stay but not us when we are equally part of *jangal*?"

Although regarded as one of the best preserved ecosystems of the Shiwalik foothills and the home of large mammals such as elephants and tigers, Rajaji can hardly be defined as "pristine nature". Like other national parks in India, it has a large human population both within the park area and in towns and villages on the periphery. Modern development has also led to major encroachments within the park area. Among the more significant are a large ammunition dump, an electricity plant with an adjacent township, a chemical factory, a railway line, a railway station, a number of settlements and several major roads. The area has also been part of forest development schemes where indigenous species, providing food for wild animals, have been cut down and replaced with plantations of commercially valuable trees. However, in spite of all these threats to the fragile ecosystem of the park, the Van Gujjars were considered to be the main destroyers of forest by park officials, as well as by local "nature lovers" lobbying for a "park without people" and consequently a strict implementation of "fence and protect". But, as argued by Mustooq, a Van Gujjar leader, "We are the weakest part, so why start with us? What use is it that we have been removed when the ammunition dump and the industrial plants are still there?" While forest officials claimed that Van Gujjars ignore all lopping regulations, with the result that trees dry out and die, the message from the Van Gujjars was "We are not the ones who destroy the forests; how can we destroy the trees when our whole livelihood is dependent on them?" The environmental conflict over Rajaji is a manifestation of a latent class struggle over resources between, on one hand, a local elite, claiming the park for its natural beauty, and on the other, the Van Gujjars, forest-dwellers losing control over common assets needed for their survival.

As it turned out, it was not that easy to evict the Van Gujjars from the park. With the help of a local NGO they resisted dislocation and fought for their right to the forest. The conflict that followed eventually resulted in a stalemate between the Forest Department and those supporting the Van Gujjars, with the result that the latter were not immediately evicted from the park area. However, conservation laws clearly demand "parks without people", and during the past 15 years about 1,300 families, earlier living in the Rajaji National Park during the winter, have been settled in two colonies outside the Rajaji Park, presumably to subsist as petty agriculturalists. Approximately 3,000 families are still in the forest on an ad hoc basis. The result of the conflict was that the Van Gujjars lost out and the Forest Department and the concept of conservation prevailed, as more and more of the Van Gujjars' summer pastures in the high altitudes have been converted into national parks during the last decade. Due to their complete dependence on trees for survival, the Van Gujjars were once again one of the communities hardest hit by policies for preservation of wildlife, just as they had earlier been victimised by colonial forest policies.

Discussion

In this chapter we have looked into one and a half centuries of Indian forest policies. We have seen how, prior to the colonial onslaught, India's forests were integrated parts of agrarian landscapes, simultaneously culture and nature, and vital for the livelihood of rural communities. The British, however, introduced a dichotomy between, on one hand, "cultivated fields", and on the other, "forests and wastelands". For the early administrators the main aim was to extend agriculture. To them, forests were mainly "an obstruction to agriculture and therefore a limiting factor to the prosperity of the country" (Stebbing, vol. I, 1922–1927: 61). Progress was seen as an ongoing process that converts the "wild and barren landscape" into fertile fields and villages. The excessive felling of trees from India's forests during the first period of colonial rule may be seen as making space for an ordered landscape of peasants paying revenue to the state. Trees that were important for subsistence for local people were converted into timber and fuel commodities for the growth of British imperial power and thus for the inclusion of Indian forests in the global market with its insatiable demand for resources. However, by the middle of the nineteenth century it was realised that trees were a finite resource and that a new policy of conservation was needed in order to secure the long-term supply. A scientific forestry was introduced that saw forest-dependent people as "wild and uncivilised" (in contrast to the peasants in the village) and the most serious threat to an ordered management of forest. Through the Forest Act of 1878, centuries of rural populations' customary rights to forests and "other wastelands" were obliterated by the colonial administration, as legal rights were converted into mere privileges. As in Europe, the commons, the resources of the poor, were taken over by a new elite.

In the second half of the twentieth century conservation again became a catchword. Now it was no longer the conservation of a well-managed forest for the production of timber that was the aim, but the conservation of forest for the preservation of wildlife. As before, however, human forest dwellers are not seen as belonging to the forest. On the contrary, their use of the forest is seen as competing with the needs of wild animals. Again, they are in the wrong place and looked upon as the greatest threat, as their forests are turned into enclosures from which they are barred. Instead, new groups of "nature lovers" enjoy the beauty of the forest.

We conclude by quoting Mustooq as a representative of India's forest dwellers, expressing his need for forest: "The leaves of the forest, the soil of the forest and the water of the forest. Those are the life, the blood and the living and dying of the Van Gujjars." Many activists in India now criticise the "anti-people" administration of forest inherited from the British and call for truly participatory systems of forest management that include local people and their needs for livelihood (Gadgil 2008; Gadgil and Guha 1995; Gaur 2008). So, perhaps there is still hope for Mustooq and his people (Gooch 2009).

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Note

1 All quotations by the Van Gujjars are translated from Hindi.

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15 Grass

From local pastures to global energy markets in eastern Tanzania

E. Gunilla A. Olsson and Lennart Bångens

The *miombo* ecosystem, a mosaic of tropical dry grassland and woodland, is distributed from coast to coast in southern central Africa, providing livelihood and a large variety of subsistence resources for almost 40 million people (Sileshi *et al.* 2007). In eastern Tanzania the *miombo* areas are sparsely settled but used for resource extraction, including livestock grazing by local communities. The Tanzanian government has classified the land as underutilised and appropriate for investment and intensive cultivation, with the aim of obtaining economic revenues for the country. Recently, biofuels have emerged as the major option for agricultural development and land investments in eastern Tanzania. This chapter will discuss some aspects, in particular the consequences for rural livelihoods, of transforming the *miombo* in eastern, coastal Tanzania into agrofuel plantations. We will show how this transformation is made possible by applying new perspectives on the use value of the land, from a valuable but priceless natural resource area (i.e. pasture for livestock) in a subsistence economy, to valuable land for sugarcane production (for ethanol) in the global market economy. Changes in ecosystem services and the long-term sustainability of the ecosystem are also considered.

Ecological characteristics and traditional use of the miombo

The *miombo* ecosystem generally occurs on nutrient-poor soils in southern, subhumid tropical climate zones with one wet season (Campbell *et al.* 1996). Characteristic climate data for dry *miombo* vegetation as in Dodoma, Tanzania, are 553 mm of annual precipitation and a mean annual temperature of 22.6°C (Frost 1996). The *miombo* is a deciduous woodland/grassland system generally characterised by three genera of tree species, *Brachystegia*, *Julbernardia* and *Isoberlinia* (Campbell *et al.* 1996), although there are considerable geographical variations. In eastern Tanzania the *miombo* harbours six endemic species of *Brachystegia* (Frost 1996). The whole *miombo* ecosystem has an estimated 8,500 species of higher plants, of which 54 per cent are endemic (Rodgers *et al.* 1996). Overall diversity of *miombo* wildlife is enhanced by the inclusion of islands of non-*miombo* vegetation. Particularly valuable from a biodiversity point of view are the river terraces with more nutrient-rich soils than the *miombo* soils and more palatable grasses benefitting wildlife, e.g. the Rufiji River (ibid.). The dynamics of the *miombo* system can be attributed to three interacting disturbance factors: humans with their livestock, fire and wildlife (especially elephants; Anonymous 2005).

The *miombo* woodland ecosystem in Africa is vital for millions of rural and urban people in the region as it provides a number of ecosystem services belonging to all four categories of services classified in the Millennium Ecosystem Assessment (MEA 2005). From the *miombo* woodland system a number of resources are provided, such as food crops, meat from the livestock that graze there, fertilisers, fibres, medicines, firewood, construction and craft materials, cultural and spiritual services, as well as regulation of climate, erosion and water (Campbell *et al.* 1996). The *miombo* also provides a food buffer during drought periods. In a recent study of human use of non-timber forest products (NTFP) from *miombo* in Malawi, it was reported that 37 different leaf vegetables, 2 root vegetables, 21 fruits, 23 mushrooms and 14 caterpillar species were collected (Lowore 2006). Indigenous fruit trees in the *miombo* are a valuable food source and also a cash crop for local markets, as is honey from wild bees. The high abundance of bee plant species in the *miombo* woodland makes the eco-region one of the major producers of honey and bee wax in Africa (Chikamai and Tchatat 2008). The NTFPs significantly contribute to household economy in rural areas. In particular, poor households are highly dependent on forest resources, above all for supplementary food, firewood and medicinal plants (Chirwa *et al.* 2008; Syanpungani *et al.* 2009). Interestingly, there are indications that this resource use contributes to and maintains the biological diversity of the system. Traditional use of the *miombo*, such as for small-scale crop cultivation, livestock grazing and the extraction of NTFP has been shown to increase plant species diversity in comparison with prohibition of human resource use, as occurs in strictly protected areas (Banda *et al.* 2006).

Different perspectives on the use values of *miombo*

In Tanzania there is a widespread perception that pastoralists do not utilise land in an economically efficient way (Hesse and MacGregor 2006; Olenasha 2005). This view underlies the effort of the government to redistribute land to commercial investors with the aim to generate better economic revenue for the benefit of the national economy. However, even lands that seem unoccupied may be used for seasonal livestock grazing, extraction of forest products or other livelihood uses that have great value in the informal household economy in rural communities (Olenasha 2005). In eastern Tanzania, most of such land used by pastoralists is *miombo* woodland, with patches of coastal forest and thicket (Gordon-Maclean *et al.* 2008). Tanzania has organised a Land Bank for village land that classifies village land suitable for investment and more intensive production than current resource use. The administration of the Land Bank is performed by the Tanzania Investment Centre (TIC), which lists “idle” land suitable for investment (Olenasha 2005), e.g. biofuel production. *Miombo* ecosystems are included in those lists. As village land it cannot be directly allocated to foreigners or foreign-owned companies, but this can be organised through a series of transactions involving compensation to the villages for land offered to an investor. The value of the land is determined by the degree of cultivation, which means that bushlands yield compensation to villagers only to the extent that they include arable fields and planted trees (Sulle and Nelson 2009).

It is also possible to establish joint ventures between private companies and villages where the land is used for commercial purposes but land rights still belong to the villages, although subject to certain limitations such as local customary rights being set aside for the contract period (Sulle and Nelson 2009). The former Zanzibar Peoples' Ranch (RAZABA) in Bagamoyo was acquired in 2008 by SEKAB, a Swedish biofuel production company, through TIC as a 99-year leasing agreement (ibid.). This land was officially said not to have been used for many years, although 14 local households and some pastoralists were compensated for the land transfer (Songela and Maclean 2008).

Even when negotiations take place directly between villages and investors the process is very difficult for villagers to follow, and there are several examples where villagers have lost most of their land, e.g. Utunge village in Rufiji, which was asked to cede 72 per cent of its land to the SEKAB investment in sugarcane (Sulle and Nelson 2009).

Proposed investments in agrofuels in the coastal region of Tanzania are located in the districts of Bagamoyo, Kisarawe and Rufiji. The total area acquired for agrofuels in Bagamoyo is 64,000 ha, of which 22,500 are sugarcane, 25,000 white sorghum, 30,000 jatropha and 19,500 oil palm (but this will probably not materialise; Sulle and Nelson 2009). The area for Kisarawe is 8,200 ha for jatropha, and for Rufiji some 400,000 ha for sugarcane, 860 ha for oil palms (ibid.) and an unknown area for jatropha (WWF 2009).

In sum, although the majority of Tanzanians live on and off the land, either directly as farmers or extracting resources from the surrounding ecosystem, the full economic value of the ecosystem has not been measured, particularly not for land that it is viewed as 'idle', which has favoured the ceding of land for industrial use.

Land use and ecological consequences of agrofuel plantations

If the planned large-scale biofuel operations in eastern Tanzania materialise, the land will either be owned by the company or by farmers who will offer their land for contract cultivation for the company over an agreed time period, i.e. a form of outgrower's scheme. Local community access to natural resources, e.g. for livestock grazing, will disappear. Plantation land will be divided into blocks to facilitate mechanisation and rational agricultural practices (Sulle and Nelson 2009). It will be used for industrialised production of agrofuels either with short-rotation crops like white sorghum and sugarcane or with woody species such as jatropha and oil palms.

The ecological effect of this conversion will be a change from a heterogeneous landscape with varied habitat and high biodiversity to a homogenous landscape with monocropping and lower biological diversity (UNEP 2009). The basic idea of monocropping is the promotion of a single, cultivated species. Other species are seen as competitors with the focus crop species and are targets for eradication, which leads to lower biodiversity at both landscape and habitat scales. Irrigation, fertilisation and the use of pesticides are conventional measures to arrive at maximum biomass production. This uncontroversial and conventional wisdom in agricultural production generates problems when applied at very large scales.

Sugarcane demands large amounts of nutrients and water to yield optimal production, but soils in the *miombo* region are generally dry and nutrient-poor. However, this does not inhibit the growth of jatropha, even if it, too, grows much better with added nutrients and water (Achten *et al.* 2008; Ariza-Montobbio and Lele 2010). In fact, the water needs of jatropha may exceed those of sugarcane cultivation by five times (Gerbens-Leenes *et al.* 2009). The extent to which jatropha plantations require pesticide treatment is as yet undetermined, but regular irrigation and fertiliser application are expected to increase pest attacks (Achten *et al.* 2008).

Water is a crucial resource in the dry climate of coastal Tanzania. The irrigation needs for the SEKAB plantations in Bagamoyo will be met by diverting water from the Wami and Ruvu Rivers (ORGUT 2008; Mwamila *et al.* 2008). The infrastructure for irrigation of the SEKAB plantations in Bagamoyo is already in place, but river flow in the Wami River is too low to support a 20,000 ha irrigation system (ORGUT 2008). The tapping of irrigation water for the plantations has unknown consequences for the water needs of local communities further downstream. Moreover, the Wami River is one of the major sources of drinking water for Dar Es Salaam,[1] and water access in the city might be affected by the irrigation operations.

Another consequence of the conversion of the *miombo* ecosystem into agricultural plantations is the release of carbon into the atmosphere from soil and biomass that will inevitably occur when grasslands are tilled and woodlands are cleared. Paradoxically, the magnitude of this release could equal or even exceed the reduction of carbon dioxide emissions gained from replacing fossil fuels with the agrofuels (UNEP 2009; WWF 2009).

The planned biofuel plantations in coastal Tanzania are located close to major wildlife reserves: in Bagamoyo they border the Saadani national park, and the Rufiji plantations border the Selous Game Reserve (WWF 2009). These protected areas have populations of large migrating mammals such as elephants. The biofuel plantations will block migration routes and force animals to find new routes through village farm lands, which will aggravate the conflict between humans and wildlife in the region (WWF 2009).

Implications for local communities of changed ecosystem dynamics and loss of land use rights

The transformation of the *miombo* ecosystem into plantation land for biofuels will have numerous consequences for rural communities in terms of deteriorated ecosystem services, as has been the case with biofuel plantations in, e.g. India and Brazil (Ariza-Montobbio and Lele 2010; Hall *et al.* 2009). The loss of village land to agrofuel plantations will imply a significant reduction of available land for food production, both arable for food crop cultivation and pasture for livestock grazing and meat production. This is an obvious loss of ecosystem services. Changes in hydrology at the landscape level can also be anticipated due to the large-scale irrigation efforts for plantations, whether for sugarcane or jatropha; such changes will no doubt involve water flow in the river as well as groundwater levels. This will have direct consequences for the rural communities in the region, in terms of access to drinking water as well as possibilities for local food production on remaining pasture and arable land.

The effects on humans and ecosystems of the toxins in jatropha have not yet been investigated (Achten *et al.* 2008), but jatropha is known to be toxic to mammals, whether through skin contact or ingestion (Li *et al.* 2009). Cultivation of jatropha as a perennial mono-crop leads to a reduction in crop diversity by permanently occupying agricultural land. As crop diversity helps to buffer against variability in climate and pest attacks, reduced crop diversity will decrease the sustainability of livelihoods (Ariza-Montobbio and Lele 2010).

If the villages have sold their land to the investment companies via the TIC, or if they have agreed to some type of contract cultivation of feedstock for agrofuels on their land, the implication for land use will be the same, i.e. the shift from traditional use of the *miombo* ecosystem to plantation cultivation. The possibilities for resource extraction from the *miombo*, e.g. harvest of timber for construction and crafts and of NTFPs such as medicinal plants and wild honey, which have yielded some cash for the household, will disappear, contributing to a dependence on the market system and a cash economy. Extreme weather events such as flooding and droughts may occur more frequently due to climate change, and will increase the vulnerability of local communities. The loss of food buffers traditionally based on the *miombo* ecosystem and the changed hydrological regime in the region due to the plantation activities will aggravate this vulnerability. The food security of the rural communities may thus be seriously jeopardised. The increasing external dependency of households will decrease the resilience of the local agro-ecosystem and local livelihoods.

Without denying problems of poverty and scarcity of resources in the traditional system, the new situation will require employment opportunities with salaries from plantation work that will allow villagers to obtain food and other necessary resources to replace those that were previously extracted from the *miombo* ecosystem. It also presupposes that there will be food for sale, which is not automatically guaranteed, since the plantation enterprises will have occupied large parts of the cultivated land in many villages. There are considerable uncertainties about how many people will actually be employed in the new plantations. There are legitimate fears that it will be just a small portion, compared to the total rural population that now lives in the vicinity of the plantations. There is thus a strong risk that a significant number of people will lose their base for earning a living, having neither land for food production nor employment. This would, of course, contribute to accelerated urbanisation and the growth of slum areas in Dar Es Salaam.

Can sustainable use of the African *miombo* include biofuel production?

As we have seen above, maintaining the *miombo* ecosystem demands human activity. Scholes' (1996) suggestion for sustainable management includes small-scale agroforestry and would result in a landscape which is both agriculturally productive and rich in carbon. Syanpungani *et al.* (2009) add to agroforestry the payment for ecosystem services (PES) such as carbon sequestration, as well as ecotourism. Non-consumptive use of forests and woodlands such as PES "may be well suited elements for conservation of the Miombo woodlands and its biodiversity also for the well-being of the rural people" (Syanpungani *et al.* 2009). To manage the *miombo* in this way is certainly a challenge, with increasing population pressure on its biological resources.

Other pressures and challenges to sustainable management of the *miombo* include the heightened pressure on resources from immigrating groups of people practising more intensive pastoralism. This has led to damage to crops for the resident farming population (Nduwamungu *et al.* 2009). The new highway between Dar Es Salaam and Morogoro increased accessibility to the land and facilitated different kinds of resource extraction from the miombo, e.g. charcoal and timber (ibid.).

Can biofuels be a sustainable land use in this region and under what conditions? The question cannot be addressed in isolation, as feedstock for biofuel production is a monocrop and seldom introduced for the purpose of local economic development in the communities living in the vicinity of the land concerned. In this respect, biofuel production is similar to other types of agricultural production. The same challenges are applicable to biofuel operations in terms of maintaining ecosystem services, local and regional biodiversity and rural livelihood sustainability. The cultivation of feedstock for biofuel production in the *miombo* region of eastern Tanzania, with its dry climate and nutrient-poor soils, in combination with high and sensitive biological diversity, make the challenges even greater. Large-scale biofuel operations may be economically profitable when all the inputs are available (water, nutrients, pesticides, energy, etc.) but there is always a cost in the form of environmental degradation and deteriorating livelihoods (Pereira and Ortega 2010). Even the carbon gain from substituting fossil fuels with biofuels can be questioned, if tilling grassland and clearing forest are involved (ibid.).

However, a successful establishment of biofuel operations in a context of sustainable and viable agro-ecosystems and rural livelihoods is not impossible. The major critical variables to consider are: (1) *ecosystem functions*, involving ecosystem services (water flows, local climate regulation, vegetation cover, soil quality, carbon sequestration) and biodiversity at local and landscape scales; (2) *rural livelihood viability*, involving access to local resources such as land for food cultivation, pasture for livestock, collection of plants for food and medicine, honey, etc.; (3) *local participation in the decision-making process regarding land use and biofuel processing*, involving participation in agreements on the distribution of land use for biofuel feedstock in combination with food production; (4) *local energy needs met by the biofuel production*, so that at least part of the biofuel energy produced is used within the local community.

Several of these criteria are also emphasised by Milder *et al.* (2008), who provide a useful comparison of different scales of biofuel production systems, considering environmental and livelihood conditions. They conclude that biofuel development has the greatest potential when built up as medium-scale operations within the local community and allowing multifunctionality of the agro-ecosystem and thus maintaining food security and safeguarding local electricity needs (Milder *et al.* 2008). An example of such a system from Mali is provided by Denruyter *et al.* (2010). Large-scale plantations have immediate and long-term effects on ecosystems and rural livelihoods, with repercussions on most aspects of traditional rural life (Milder *et al.* 2008; Martin *et al.* 2009; Pereira and Ortega 2010).

There is now an ongoing discussion on the need for certification schemes (Buchholz *et al.* 2009; Kaphengst *et al.* 2009) and the potential of biofuel feedstock production for carbon sequestration (Chisholm 2010). Surprisingly, however, the biodiversity component of the environment is generally neglected in these discussions. High and unique biodiversity is a key characteristic of the *miombo* ecosystem in Tanzania.

In the SBSTTA[2] meeting for the UN Convention on Biological Diversity in Nairobi, in May 2010, biofuel production was one of the most hotly debated issueso (www.biodiv.org). It became very clear that the production of biofuels and agrofuels in developing countries is significantly related to land use rights and that these issues are politically very sensitive from a global perspective. The identification of suitable land for biofuel production classified as “degraded”, “waste” or “idle” land was discussed at length, with strong opposition from a number of African countries. This is directly related to questions of traditional land use rights, including resource extraction on non-arable communal (bush)lands discussed in this chapter. There is an urgent need for regulations and tool-kits for handling proposals from potential investors in biofuel operations. This is especially urgent in many developing countries that lack national legislation for investments in land.

Recent land laws and policies have changed the perception of public and communal land in Tanzania. Land is increasingly becoming private property – a commodity – which changes the conditions for land use by local communities lacking legal right to the land. There is a clear shift in Tanzania towards formalisation of property, including ownership and use of land, which will have direct effects on ethnic communities with semi-nomadic lifestyles, such as the Maasai people inhabiting the *miombo* in Tanzania.

Conclusions

The conversion of socio-ecological systems of rural villages relying on local subsistence in the *miombo* region of eastern Tanzania to a market economy, through the establishment of large-scale biofuel feedstock production for export on common village lands implies:

- a shift of influence and power over land use from local communities to (foreign) companies;
- a decreased and/or lost resource base for subsistence economy communities;
- changed land use and impact on the ecosystem – changes in ecosystem services (decreased water availability, changed local climate, decreased access to farming land and scarcity of food), changes in biodiversity dimensions in terms of species, habitats and landscapes, also impacting food production;
- jeopardised food security;
- changed diversity of land use: from maintenance of environmental heterogeneity to efforts to increase homogeneity (i.e. conventional strategy for plantation operations). Carbon sequestration in the biofuel plantations can be used as an additional argument for planting of perennial crops such as jatropha, although the degradation of biodiversity at all scales is still valid;
- changed sustainability of the ecosystem with decreased resilience and increased vulnerability of local livelihoods through a stronger dependence on the market for economic survival.

Drivers of this development are:

- the climate change paradigm with a "fundamentalist" carbon message (fossil fuel to be replaced by "carbon-neutral biofuels" and "carbon sequestration by plantations" as a global good);
- poverty and underemployment in rural areas, which raises high expectations of biofuel production as a vehicle for economic development;
- the fact that most land is owned or controlled by the state, which enables the government to offer land use leases and land use rights to foreign investors. The land tenure system in Tanzania has imprints of former colonial rules and unresolved issues on land rights and customary land use (Olenasha 2005). Such land use by pastoralists and local farmers in contemporary Tanzania is still neglected in the ongoing reformation of the land tenure system;
- negotiations on land use rights between village chiefs and investor companies, which are often successful for the companies due to promises of future wealth for the village;
- changed perceptions of the use value of land: from valuable and highly resource-rich areas within the subsistence economy to land for industrialised monocropping. This is a change in perspective, from local communities' views to those of government and commercial investors.

The analysis of the sustainability of biofuel operations must include the impact on ecosystems at local and landscape scales and on livelihood conditions for rural communities. This analysis must take into account that they are not "just" farmers and that their livelihood is very closely linked to and dependent upon the local and regional ecosystem.

Notes

1 Dawasco has two pumping stations at upper and lower Ruvu, which supply water to Ilala and Kinondoni districts, while Temeke District is served by the Mtoni station along Kizinga River (http://allafrica.com/stories/200908260552.html).

2 The SBSTTA is the Subsidiary Body of Scientific, Technical and Technological Advice to the Parties of the UN-Convention on Biological Diversity. This body has regular meetings before each negotiation meeting of the COP (Conference of the Parties) to the convention. It supplies scientific arguments and prepares the issues to be decided on at the COP.

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16 Forests

Capital accumulation, climate change and crises in Chile and Sweden

Cristián Alarcón Ferrari

On 20 December 2006, the General Assembly of the United Nations (UN) declared that 2011 would be the International Year of Forests. It stated that 'concerted efforts should focus on raising awareness at all levels to strengthen the sustainable management, conservation and sustainable development of all types of forests for the benefit of current and future generations.' The background for such a statement is the recognition that forests are threatened worldwide. In spite of such discursive claims of 'concerted efforts' at the level of international organizations, enormous socio-environmental struggles and conflicts around forests, trees and forestlands will persist. Though conflicts and struggles over forest resources are not new phenomena, there are two unique components today. First, tree biomass and the biophysical processes of forests play a critical role within the emerging climate change regime. Second, an energy transition away from fossil fuels involves increasing extraction of energy from forest biomass. Forest companies, shaped by the capital accumulation process and finance, largely influence the appropriation of forests. As a consequence, highly industrialized and mechanized forest sectors pursue constant increases in productivity and use of forest resources. Thus, forest crises are at the center of social-environmental conflicts.

The question of how to define the sustainable yield basis for forest harvest, as well as the regulation of the production and consumption of forest resources, is shaped by the logic of endless capital accumulation within a world-system of uneven development. The World Commission on Forests and Sustainable Development, in the report 'Our Forests, Our Future' indicates that 'the less visible underlying or root causes' of the forest crisis are forces 'embedded in how we organize our economic and political systems, and in governance structures that emphasize private gain over the public interest' (WCFSD 1999). Yet the main proposals of the commission for governing forests operate within the logic of capital.

Forests have long been tied to accumulation cycles, including the primitive accumulation process. However, today capital accumulation contributes to forest contradictions in new ways. First, there is an increasing contradiction between production and biodiversity. Second, there is a crisis rooted in the loss of native forests and expansion of industrial tree plantations. Within this context, global trade of forest products creates the conditions in which national patterns of consumption take place far away from the point of production and extraction of natural resources, a process implying environmental load displacement (Hornborg 2008).

Global climate change is also linked to the forest crisis. 'Forestry, including deforestation, represented 17.4% of GHG emissions (CO_2-eq.) in 2005' (Intergovernmental Panel on Climate Change (IPCC) 2007). Forests and trees can be both sources and sinks of greenhouse gases (Dixon *et al.* 1994; Ogden and Innes 2007). Climate change affects forest health and forest ecosystem dynamics.[1] Thus, the various objectives for forest use and management may conflict with policies that address climate change. The IPCC's report from 2007 stated: 'In the long term, a sustainable forest management strategy aimed at maintaining or increasing forest carbon stocks, while producing an annual yield of timber, fibre, or energy from the forest, will generate the largest sustained mitigation benefit' (IPCC 2007: 543). However, the report states that: 'The longer-term mitigation prospects (beyond 2030) within the forestry sector will be influenced by the interrelationship of a complex set of environmental, socio-economic and political factors' (ibid.: 577).

In the case of industrial forest sectors, it is important to consider that the forest carbon cycle 'is comprised of a biological cycle (i.e. forest ecosystem) and an industrial cycle (i.e. forest products)' (Gower 2003). Thus the net capacity of forests and tree biomass to sequester greenhouse gases has reshaped the global forest agenda. An example of this shift includes the proposals of Reducing Emissions from Deforestation and Forest Degradation (REDD) schemes. These schemes allow groups to generate carbon credits that can be sold on the global market. As a result, forest companies now claim that they are part of the solution to climate change. Furthermore, bio-energy is seen as a techno-fix where woody biomass can be used as part of an energy transition. Capitalists propose to use forests to address climate change and to maintain extraction of forest biomass, to meet production needs, such as for the production of paper. In this regard, climate change implies an aggravation of the global forest crisis that is taken as a new possibility for capital accumulation vis-à-vis forest resources.[2] Capitalism has a specific way of organizing social–ecological relations; at the same time, capital, as a social relation, develops in response to various challenges. Capital accumulation shapes and reshapes the various structures of political ecology within the capitalist world-system. Under this set of social relations, global forests, as well as their role in a global ecology and a global carbon cycle, are the historical material of the current global political ecology of capitalism.

Forestry developments and socio-ecological crises

The global forest crisis, along with the reshaping effects of climate change in the global forest sector, can be observed in geographically distant countries such as Chile and Sweden. In 2005, Sweden's total forested area was 27,528,000 ha and it had 667,000 ha of forest plantations (FAO 2007). In the same year, Chile's total forested area was 16,121,000 ha and it had 2,661,000 ha of forest plantations (FAO, 2007: 114). In 2009 both countries were classified as among the world's five largest exporters of wood pulp and are major players in the global forest sector (*Swedish Statistical Yearbook of Forestry* – Loman 2009).

Silviculture was introduced in Sweden in the beginning of the 1800s (Eliasson 2002), and based on the large naturally forested areas covering extended parts of the territory, market-oriented exploitation of forests began in northern Sweden during the first decades of the nineteenth century (Östlund 1993). The utilization of Swedish forests has been the subject of several past conflicts and struggles, such as those between the state and the peasantry. The state was interested in exploiting forests to use oak timber for the navy. The peasantry and other groups recognized that forested land is also useful for food production (Eliasson and Nilsson 2002). The intensive extraction of forest resources in which 'Virgin lands of endless forests in the northern parts of Sweden were exploited' contributed to the formation of a 'new entrepreneurial and business class ("the tree barons")' (Södersten 1991). The uncontrolled use of the forests led to the Forestry Act of 1903, which required forest owners to replant trees after logging.

In 1993, the Forestry Act in Sweden was reformed. It expressly stated that forest management should ensure sustainability and preserve biodiversity. The Swedish forest sector has developed highly technological ways of pulp and paper production. It is one of the leading forestry industries in the world. Swedish companies are important exporters of forestry machinery and technologies for production of forest products (Larsson and Malmberg 1999). Since the 1920s, the standing volume of Swedish forests, and therefore the carbon storage, has increased. Many small forest owners are part of this industry. Productivity in the sector has increased dramatically because of the employment of modern technology and machinery, which has also displaced skilled labor. However, at the same time, thousands of temporary, immigrant and ill-paid workers from poorer areas of Europe have been used to work on-the-ground forest activities (Norberg 2009). The Swedish balance of exports and imports of forest resources is striking. According to Nilsson (2004), 'During the last five years an import of forest raw materials of over 10 million m^3 has been necessary to satisfy the domestic demands of some 95 million m^3.' The national forest statistics indicate that in 2007 Sweden's export of forest raw material reached 4,672,000 m^3, while imports were 9,952,000 m^3 (Skogsstyrelsen 2008: 258). The following data concerning trade of roundwood illustrates this point: According to data from 2008, imports of roundwood into Sweden reached 6.8 million cubic meters of solid volume, excluding bark; exports of roundwood from Sweden reached 2.5 million cubic meters of solid volume, excluding bark (Skogsstyrelsen 2009: 318). Within this context, total roundwood production in Sweden was 69.0 million cubic meters of solid, excluding bark (Skogsstyrelsen 2010: 357, data from 2008). This means that about 73.3 million cubic meters of solid volume excluding bark of roundwood were consumed in the country during 2008 (own calculation).

In the case of Chile, there are some key factors that explain the rapid pattern of capitalist growth of the forestry sector post-1973. First, a long-term national project of forestry development can be traced to the period before the dictatorship that began in 1973 (Clapp 1995; Camus 2006; Miller 2006). Prior to the coup, there was a state-oriented project to convert Chile into a forestry nation through the active and strong participation of the state, its agencies and state-owned companies. Even in the 1950s there were tree plantations and an incipient but increasing forestry sector, on which the state plan attempted to build. Second, a new legal regulation contained in the Decree Law 701 (DL 701), passed during the dictatorship, created a system of subsidies and tax breaks that favored private forestry companies. The DL 701 created incentives that benefitted specific landowners to encourage forest production. Tree plantations also received incentives. A classification of land areas was introduced to define regions that were specifically suitable for tree planting. According to the DL 701, owners of plantations were entitled to receive economic subsidies and finance that would span the necessary time to start growing the trees. Furthermore, they would also have professional consultancy in the process of managing the plantations. Thus, the role of the DL 701 was conceived to accelerate the development of the forest sector that was initiated under earlier state-oriented policies. But now the private sector was to be the main beneficiary, which followed the neoliberal reforms in Chile. To expand the role of private companies within the sector, the policies of the dictatorship encouraged privatization of previously state-run operations and deregulation of the labor market within the forestry sector. Other related economic activities, such as those carried out in maritime ports, were also privatized and transformed to satisfy the needs of the forestry companies. It is important to note that the private sector in forestry was originally formed for national and foreign industries, but today this sector is controlled by a national capitalist class with strong international connections. Third, certain natural conditions favor fast-growing trees, mainly eucalyptus and pines (Clapp 1995). Exotic trees were introduced in the country for different reasons, such as to replace native forest used within mining activities and to stop desertification. Fourth, pro-capitalist labor regulations have allowed forest companies to lower production costs, in part through a low-paid workforce. In addition, this sector uses an extended system of subcontractors and employment flexibility, which creates difficulties when attempting to organize workers and unions.

Both the Swedish and Chilean forestry sectors are often presented as successful examples of sustainable forest development. Yet a closer examination reveals social and ecological contradictions. The loss of biodiversity, which is intimately associated with forestry activities, remains an important issue in both countries. Sweden has one of the most managed and intervened-in forested areas in the world, causing a significant loss of biodiversity. According to a study – based on information on 1,487 red-listed species by Berg *et al.* (1995: 1629–1630), 'Forestry is … the main threat factor to most (94,8%) of the species.'

Recently, a group of university professors and researchers (Jonsson *et al.* 2008) opened a public debate about the issue. They published a letter in a nationwide newspaper under the title 'Forest policy threatens biodiversity' (my translation). They linked the loss of biodiversity within Swedish forests with the production of forest products. The article criticizes both the environmental policies in the country and the role of the forestry sector. For example, in 1998 the Bill on Environmental Quality Goals was passed in Sweden, indicating establishing 'sustainable forests' as one of the goals. However, in 2008, a national evaluation of that environmental goal indicated that: 'the objective Sustainable Forests will be very difficult or not possible to achieve by 2020, even if further action is taken' (Swedish Environmental Objectives Council 2008).

In the case of Chile, several studies have highlighted the loss of forest biodiversity as a consequence of industrial forestry activities. One study indicates that:

> A considerable amount of Chile's native forest has been converted to plantations, most of which are dominated by exotic species, primarily Monterey pine (*Pinus radiata*) and several species of eucalyptus (*Eucalyptus spp.*). Most of the country's timber production comes from these fast-growing plantations, which in large part have been established by clearing native forests
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> (Neira 2002: 8)

The loss of native forests is directly associated with the increase in exotic-species plantations (Echeverria *et al.* 2006). It has been estimated that between 1960 and the end of the twentieth century, native forests had decreased by approximately seven million hectares (Camus 2006). It has also been estimated that '20% to 30% of the current plantation area has been illegally converted from native forest, contributing to biodiversity losses' (Giljum 2004: 255). Between 1996 and 2010, it was estimated that Chile's production of pulp would increase from 2,123,000 tons to 4,056,000 tons, while consumption would increase from 479,000 tons to 514,000 tons (FAO 1999: 37). To increase pulp production and be competitive, the Chilean forestry sector needs to increase the use of machinery, the employment of cheap labor and the availability of raw forest material, which means expanding tree plantations. However, given the global economy, a doubling of pulp production is not associated with a doubling of national consumption. Poverty in the main areas of forest development is among the highest in the country, and a number of socio-environmental conflicts have taken place during the last years.

Wood biomass, climate change and political ecologies of capitalism's growth imperative

The recent intensification of the development of the forest sectors in Chile and Sweden is related to the competitive dynamics of free trade and the promotion of exchange of commodities world-wide. Global competition has increased the mechanization of production in the forest industries. It has also forced national forestry companies to seek out other geographical areas for production. In Chile, these economic factors have propelled forestry companies to increase industrial tree plantations, which displace native forests. Tree plantations allow companies to shorten the rotation periods, which increases the rate of the circuit of capital and therefore profit. In Sweden, forest companies have increased the use of fertilizers and have planted high-yielding species and have heavily invested in research on tree biotechnology to achieve the same goal.

The conflict between production and biodiversity is a major part of the forest crisis in Sweden, yet it has received little attention. Plus, there is considerable confusion when assessing this situation. Sweden imports a considerable amount of forest resources. In 2008, for example, it imported 4.7 million cubic meters of roundwood, 1.5 million cubic meters of chips and particles and 0.9 million cubic meters of pellets (in all the cases quantities mean cubic meters of solid volume excluding bark) (Skogsstyrelsen 2010: 308). These imports take the form of forestry raw materials or wood in furniture. Forestry companies have employed new strategies to maintain the pace of capital accumulation, including invoking climate change reasons for competition purposes. The Swedish Forest Industries Federation launched an active media campaign to highlight both its commitment to address and solve climate change. Through short videos available from its website and YouTube this federation states that forestry companies are part of the solution to climate change, that forests are the best natural remedy to climate change, and that wood-based products are better alternatives as construction materials. These communicative efforts stem from reports that were used to promote this sector's participation in the climate change discussion. One of the forestry industry's reports is titled 'Tackle Climate Change: Use Wood' (Swedish Forest Industries Federation 2006). It offers a number of antecedents and data suggesting that the use of wood as a material for construction is better in terms of climate change mitigation than the use of concrete. This campaign attempts to instill in consumers an environmentally friendly attitude toward the use of wood. The concrete business association then attempted to counter the claims of the forestry industry. On its website, it presents reports that note that cement production reduces the use of fossil fuels. This industry produced a report that attempts to demonstrate how concrete can be used to stop climate change. The cement business organization also published an interview with Ronny Andersson, Professor at the Faculty of Engineering at Lund University, titled 'Concrete vs. wood' in its official magazine (Tysbo 2009).

The main point here is that the forestry sector is attempting to present itself as part of the 'green economy,' thereby addressing social and environmental concerns with global climate change through the further expansion of its operations. The forestry sector claims that forest activities such as clear cutting and replacement of old trees with new plants are ways of confronting climate change. In their videos, they emphasize the role of trees as carbon sinks in Sweden and the fact that forests are not going to run out in the country. While scientific reports also note that forests are also sources of carbon dioxide, this information is never part of the industry's advertisements. The fact that Sweden is importing significant quantities of forest resources, as mentioned earlier, is never presented as a relevant issue when explaining the balance between the use of forest and the growing of new trees in the country. The conflict between production and biodiversity is finally lost in this public discussion, which is tragic given that it is central to the evaluation of progress in achieving the national environmental quality objectives.

In addition, the use of biomass as a source of energy in the industrial production of forest products is primarily a matter of lowering costs and remaining competitive. But the use of biomass is generally presented as a way to address climate change concerns. An energy transition that involves more use of wood for bioenergy purposes has increased prices of forest raw material. This trend has produced a struggle over forest resources between the pulp sector and the bioenergy sector, since the forest owners can sell the raw material in whichever market is paying the best price for the wood. For forest owners this development means better revenues prospects. The important point that must be emphasized here is that the struggles and conflicts that surround forests are complex and complicated, and that capital responds to social and ecological challenges in ways that ultimately maintain its interests.

In Chile, forestry companies have also strategically incorporated climate change in their strategies. CELCO/ARAUCO is a firm that was formerly state-owned, but it was sold to private interests during Pinochet's dictatorship. The company is infamous in Chile and world-wide because of recent incidents in its pulp mill plants. The firm uses a system of subcontracting in its production chain. Much labor unrest has emerged. In May 2007, trade unions within the company's subcontractors went on strike. Police forces shot dead a subcontracted worker outside a pulp mill during the strike against the company. Additionally, the company is involved in a conflict with indigenous Mapuche communities of fishermen at the Mehuin Bay. This conflict originated with CELCO's plans to build a pipeline to discharge sewage from the pulp mill into Mehuin Bay, from where Mapuche communities extract and manage marine resources as a part of their livelihoods. Furthermore, there are several cases in which the company has developed tree plantations on lands reclaimed by Mapuche communities.

In terms of environmental records, CELCO/ARAUCO'S pulp mills have caused at least three serious environmental problems. The sewage dumped from one of its pulp plants caused an ecological disaster and the massive death of back-necked swans in a nature reserve in 2004 (Mulsow and Grandjean 2006; Jaramillo *et al.* 2007). Moreover, in 2007, another of the company's pulp mill plants twice dumped toxic sewage in a river, causing massive fish death. Despite these disasters, the company is seen as a green business. The firm uses new technologies to produce its electricity through burning biomass. As a result, it has registered these projects with the Clean Development Mechanism (CDM) established within the Kyoto protocol and makes additional profits through selling carbon credits. The largest part of the electricity produced from biomass is consumed in the production of pulp and wood panels. CELCO/ARAUCO then sells the surplus energy that is not consumed within its operations. This electricity is considered carbon neutral.

The biomass utilized in generating electricity in CELCO/ARAUCO's power plants comes from industrial tree plantations of pine and eucalyptus. The company is one of the two largest forestry companies operating in Chile. Its activities create the ecological contradictions that surround biodiversity and industrial tree plantations in the country. Yet the firm is seen as a successful model of 'sustainable development' given that it receives carbon credits for its CDM projects. The same pulp mills that generate carbon credits in Chile today exploit local forests and cause local social and ecological crises. At the same time, these CDM projects must use expensive, advanced technology from abroad (Toland 2006). As a result, operations in Chilean pulp mills exploit cheap labor at home while purchasing expensive machinery and technology from Sweden and Finland (ARAUCO 2004).

The contacts between capitalists in Chile and Sweden go beyond mere commercial activities. In the context of increasing mobilization against environmental damage caused by CELCO/ARAUCO's pulp production, representatives of Swedish forestry companies visited the area and supported the Chilean company in the national media. Some months later, Stora-Enso and ARAUCO announced a new partnership in order to start forestry projects in Brazil. The accumulation of capital in Chile has led to the internationalization of Chilean forestry companies, as operations have expanded to Argentina, Uruguay and Brazil. This reallocation of pulp production in the South is linked to the closing of pulp mills in countries like Sweden.[3] Nevertheless, capital continues to reconfigure itself. There are plans for a Chilean–Swedish–Finnish partnership to construct a large pulp mill in Uruguay. At the same time, a major Swedish forestry company (Svenska Cellulosa Aktiebolaget, SCA) has announced plans to increase pulp production capacity in Sweden. The new wave of investments in pulp production is predicated upon the dramatic rise of over 65 percent of wood pulp prices between June 2009 and June 2010 (Tapper 2010). Here, again, the logic of endless accumulation of capital continues in the midst of the global forest crisis, as if the biophysical world does not exist.

Today's social appropriation of forest ecologies, as in the cases of Chile and Sweden, is linked to historical and contingent crises, configurations of social power and the logic of capital accumulation, which shape the exploitation of forests and the conflicts that surround them. These factors and how they play out will influence both forest ecosystems and the political ecology not only of Chile and Sweden, but of the whole planet. A political ecology assessment requires an understanding of how the capitalist world-system shapes the relationships between labor processes, capital, social power and ecologies.

Notes

1 For example, an immense area of the boreal forest in Canada has been infested by the mountain pine beetle, an outbreak that was caused by the disappearance of a natural barrier because of climate change. These changes have led to the loss of forest resources. One effect of the infestation is that Canada will not be able to fulfill its Kyoto protocol compromises since its national emissions have not reached the expected

compensation through the national forests' net greenhouse gas sequestration (Kurz *et al.* 2008a, 2008b). Even more recently, a study focused on the Amazon has shown that: 'The two recent Amazon droughts demonstrate a mechanism by which remaining intact tropical forests of South America can shift from buffering the increase in atmospheric carbon dioxide to accelerating it.' The study adds that 'If drought events continue, the era of intact Amazon forests buffering the increase in atmospheric carbon dioxide may have passed' (Lewis *et al.* 2011).

2 Corporate power has put the issue in the following terms: 'Climate change has become the great environmental challenge for the 21st century. The global debate on climate change is focusing on energy and forests' (PriceWaterhouseCoopers 2008).

3 Redistribution of pulp-producing processes has been seen as a threat to the forestry sector in Sweden, and this motivates defense due to the 'national interest' involved in the matter. A report from 1992 states:

> The division of tasks traditionally characterizing the international forest industry is in a state of change. The role of the Swedish forest industry as a major supplier of pulp, newsprint and kraft liner is threatened by increased exports from the United States, Brazil and Chile, and by investment in facilities for processing recycled and virgin fiber in close proximity to the main West European markets.
>
> (Ingenjörsvetenskapsakademien 1992/1993)

Yet in the case of Chile, the historical analysis of corporate communication shows that: (1) Stora, then a Swedish forestry company, was operating in Chile between 1989 and 1994. Stora had a partnership with a Chilean forestry holding, CELCO/ARAUCO, and was developing forestry activities mainly for the international markets; (2) the Swedish company ÅF-IPK provided technological expertise to another Chilean forestry holding in the construction of a pulp mill, which started operations in 1992. In other words, Chile as a threat to the Swedish forest industry is a myth.

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17 *Jatropha*

A magic bullet filled with oil

Marie Widengård

This story is about *Jatropha curcas L.* (JCL), the oil-rich shrub that was to kill three birds with one stone, namely to mitigate climate change, secure energy and reduce poverty at the same time. As such, it is a story of controversy, of political priorities and magic claims. How did a poor man's crop suddenly conquer powerful boardrooms, political agendas and vast territories worldwide?

The global fame of *Jatropha* can be explained in many ways. This chapter tries to explain how *Jatropha* entered the political scene, and what is keeping it there. The story is inevitably eclectic and selective and based on my ordering and interpretation of the world, e.g. of some 50 reports and articles, four biofuel conferences and around 20 interviews with farmers, investors, researchers, NGOs and aid agencies, mostly in Zambia. In my story, *Jatropha* is a global commodity in the making, pushed forward through illusions, resisted as a symbol yet coveted for what it might be able to do.

Jatropha goes global

JCL is a large shrub with roots in tropical America. Its global journey is said to have begun in the sixteenth century, when it was picked up by Portuguese explorers and spread to Africa and Asia via the Portuguese colonies (Heller 1996; Grass 2009). As *Jatropha* travelled from one continent to the other it became popularly known as a provider of soap and light, a living fence, spiritual cleanser, abortion pill and medicine against worms, diarrhoea, gonorrhoea, malaria, cough and skin diseases (Heller 1996; Charles 2008; Clayton 2010; FAO 2010). *Jatropha* reached its first international peak in the early 1900s when it was planted massively in Cape Verde to provide the Portuguese market with oil (Heller 1996). It was used during the Second World War as a diesel substitute in Madagascar, Benin and Cape Verde, but as the flow of petroleum stabilised, *Jatropha* returned to its small-scale context (FAO 2010). Today, as the discourses on climate change and peak oil converge, *Jatropha* is "experiencing a renaissance" (Grass 2009: 27). Now the news of its "magic" properties travel rapidly over the internet, into the boardrooms of multinational oil companies and onto the agendas of governments, transnational roundtables, conferences, media, civil society and academia. Compared to maize, sugarcane, palm oil and rape, *Jatropha* is viewed as offering a winning hand in the desperate search for alternative fuels.

Jatropha becomes agrofuel

In contrast to many other types of fuels, *Jatropha* makes certain claims in reference to sustainability (Achten *et al.* 2010). It particularly maintains being a win–win solution for the mitigation of climate change, provision of energy and development of rural areas. However, in my reading, *Jatropha* just happened to be in the right place at the right time, holding a set of timely and multifunctional cards. I argue that *Jatropha* became especially convenient when biofuels were blamed for causing global food price spikes in 2007–2008 (Holmes 2008). The so-called food-versus-fuel debate created a discursive shift in which biofuels gained the reputation of doing more harm than good (Leopold 2009; Ulmanen *et al.* 2009). Crop-based biofuels were further associated to food through the term of agrofuel. Using food for fuel became "unethical". There was a shift away from thinking that food crops would be used for energy and, as a consequence, funding spiked for research and development of alternative fuels that would not compete with food, such as second-generation biofuels produced from cellulose or algae. This is why *Jatropha* became so popular because, in light of blending requirements of renewable fuels, it remained one of the few available options that could be scaled up fairly cheaply and quickly.

Its first asset was its toxicity (if you eat more than four seeds you will die). *Jatropha* could therefore dodge the food-versus-fuel debate. *Jatropha* would never risk diverting food for people to fuel for cars, and countries would not have to deal with food–fuel allocation politics. Its second asset was the fact that *Jatropha* can grow practically anywhere along the subtropical and tropical belt, even on marginal, poor or dry lands. As such, *Jatropha* escaped the concerns that agrofuels might compete with farmland for food production by claiming that only marginal land of "no economic use" would be utilised. Farm land, the argument went, would not have to be converted from food to energy purposes.

Moreover, *Jatropha* had another set of arguments in its favour. A major bonus was its ability to avoid the land-grab debate and instead offer a win–win solution. Seeing that the large-scale plantation model and the appeal of increased employment opportunities did not suffice in the campaigns, the advocates of *Jatropha* claimed it to be a suitable cash crop in smallholder production schemes. Local people would thus not have to be displaced to leave room for large-scale plantations, and companies did not have to enter difficult negotiations for land. Instead, *Jatropha* would provide incomes that resource-poor farmers had long hoped for across the poor tropical belt. Farmers, investors, politicians and NGOs alike were also given the impression that *Jatropha* did not need much water, maintenance or labour, and that it did not attract pests or diseases (Openshaw 2000; Ariyanchira 2005; FAO 2008). Instead, *Jatropha* would require labour during the off-season and provide income when poor farm households were most in need of it (Portale 2010).

Using the outgrower scheme model, rural people would also be able to profit from the by-products that *Jatropha* would provide. This would include the use of its seed cake as fertiliser and feedstock for biogas, cooking and lighting (Achten *et al.* 2008). *Jatropha* was also able to escape the debate around unequal trade and resource flows between North and South because while ethanol has a given market in the North, biodiesel answers better to the fuel demands of the South. Thus the official policy of African governments was that *Jatropha* would be used domestically, while NGOs said that *Jatropha* oil could be used to power diesel engines, generate electricity, run mills, and pump water in areas where the electricity grid was unlikely to ever reach (FAO 2010). *Jatropha* also gained from being a perennial, as it only needed to be planted once every fiftieth year and was said to serve as a carbon sink as well as a nutrient and water pump. "No effort, only profit" or "win–win" became its slogan (SenterNovem *et al.* 2009); "The only real limitation of this crop is that the seeds are toxic and the press cake cannot be used as a fodder" (Heller 1996: 42). However, *Jatropha* had already become a global catchword and if toxicity, frost sensitivity or low yields were a problem, it was made clear that biotechnology could fix it (e.g. Divakara *et al.* 2010; FAO 2010).

With so many advantages, *Jatropha* took on the role of saviour in the biofuels discourse. Under the banner of "pro-poor" and "magic bullet of rural development", *Jatropha* made a remarkable and rapid career. It became known as a major source of hope in the transition away from diesel towards renewable transport fuels.

Jatropha conquers land

In 2008, FAO and GEXSI reported that international and national investors were rushing to establish *Jatropha* cultivation in Belize, Brazil, Cameroon, China, Colombia, Egypt, Ethiopia, Gambia, Ghana, Guatemala, Haiti, Honduras, India, Indonesia, Lao, Madagascar, Mali, Mexico, Mozambique, Myanmar, Nigeria, the Philippines, Senegal, Thailand, Tanzania, Vietnam, Zambia and Zimbabwe (FAO 2008). The same year it was estimated that *Jatropha* covered 900,000 ha worldwide, of which more than 85 per cent was located in Asia, followed by Africa with 13 per cent and Latin America with the remainder (GEXSI 2008). The same report estimated that *Jatropha* would claim 1.5–2 million hectares each year for the next 5–7 years. This suggests that *Jatropha* would cover 13 million hectares by 2015. Another report stretched this estimate to 22 million hectares (Sanderson 2009). According to a recent modelling exercise, the potential area of *Jatropha* cultivation lies between 59 and 1,486 million hectares (Li *et al.* 2010).

It is difficult to give an exact figure on how much land *Jatropha* occupies or abandons each year, but what is clear is that it has become a familiar ingredient in the Asian, African and American landscape, where it is seen in large-scale plantations, as intercrops, along roads and railways and around fields as a living fence. It is also clear that many countries earmark large tracts of land for future cultivation. In India alone, where the possibility of converting *Jatropha* into biodiesel "captured the imagination of researchers, NGOs and policy makers alike" (Jain and Sharma 2010), the government has earmarked 11–14 million hectares for *Jatropha* (Harrabin 2007; Hind 2007; Ariza-Montobbio and Lele 2010).

Jatropha (de)constructed

The process of global objectification of *Jatropha* into a global fuel has not gone unnoticed. In fact, there is a war against biofuel companies (Nyari 2008), and many groups have taken a stand against biofuels, including *Jatropha*. The global story of *Jatropha* is thus divided into two realities. The first story constructs *Jatropha* as an oil-rich bush promising biodiesel, green gold for farmers and a magic bullet of rural development. This narrative tries to maintain *Jatropha* as a positive-sum, win–win solution to problems of climate change, poverty, energy security and inequalities across the North–South divide.

The contrasting story deconstructs hype into scam, claims into myths and wonders into blunders. In this story, *Jatropha* becomes the "hell" or "corp" crop because it is corporate-run and turns smallholders into corpses (Pastapur Consultation Group 2007; GRAIN 2008a). It depicts *Jatropha* as another resource curse, citing reports of displacements, silenced and marginalised people, and concentration of power, property and wealth: "And wherever you look, the new biofuels industry, promoted as an answer to climate change, seems to rely on throwing people off their land" (GRAIN 2008b). While the first story constructs *Jatropha* as a sustainable fuel, the second represents *Jatropha* as a player in a zero-sum game (Hornborg 2009). Instead of suggesting a clean fuel, the second story conjures the metaphorical image of biomass flowing away from hungry mouths in the global South to feed cars in the global North (Holmes 2008). This account defines *Jatropha* as a saviour of nothing but rich countries' love of mobility (Oxfam International 2008; Niza and ActionAid 2010). The second storyline is particularly invoked by a large transnational movement against political decisions to replace fossil fuels with agrofuels and to legitimate land-grabs for climate change reasons (Via Campesina *et al.* 2010). Because *Jatropha* is fairly new, the second story draws on the discourse around sugarcane, palm oil and soybean plantations, rendering *Jatropha* a culprit of neo-colonialism, climate colonialism and slave-like working conditions. The debate on agrofuels has thus become a battle between different truths (GRAIN 2007: 42–45):

> The truth is that the agrofuels boom in Africa is not about rural development and improving the living standards of poor farmers. On the contrary, it is about foreign companies taking over the land: by striking deals with government officials and lobbying for legal protection, subsidies and tax breaks; by acquiring scarce fertile land and water rights; by coercing farmers into becoming cheap labour on their own land; by introducing new crops in large-scale plantations; by introducing GM crops through this backdoor; by displacing people and biodiversity-based systems; and by enslaving Africa even more to the global market.

The problem, according to GRAIN (2007: 44), is that:

> agrofuels are already being defined as a global commodity, to be traded on the world market, and that such commodities are controlled by the local elites in alliance with multinational companies, and access to them is limited to those that can afford them.

However, most actors apply the disclaimer that, under the right conditions, agrofuels offer important opportunities for poverty reduction by stimulating stagnant agricultural sectors and by creating jobs for agricultural workers and markets for small farmers (e.g. Oxfam International 2007). In the right hands, they argue, *Jatropha can* be good.

Jatropha as a floating signifier

The concept of *Jatropha* has become a floating signifier whose meaning is relational and contextual (Hall 1997). In this line of thinking, *Jatropha* is subject to a constant process of redefinition and appropriation. It is constructed, deconstructed and reconstructed rapidly and differently, depending on place and space. *Jatropha* is constituted in an assemblage of discursive, material and natural actors involving material flows, infrastructure, environments and *Jatropha*'s own properties and genes (cf. Latour 2005). In the words of Mehlman (1972), a floating signifier may "mean different things to different people; they may mean whatever their interpreters want them to mean". Thus, in contrast to discursive nodes that signify controversies within a discourse, a floating signifier participates in different discourses in a discursive battle over its meaning (Jørgensen and Phillips 2000). This is why *Jatropha* is imagined in such diverse ways. For a fuel consumer *Jatropha* might be "a sustainable fuel", while for a farmer in Mozambique it may be a "socio-economic pitfall" (UNAC and JA 2009). Like everything else, *Jatropha* is thus understood differently in different contexts and by different groups. But why is this particularly obvious in the case of *Jatropha*?

Jatropha as wild and illusive

Jatropha has been held to promise a reliable source of income for poor rural farmers and energy self-sufficiency for small communities – all while reducing fossil-fuel greenhouse-gas emissions and soil erosion. But there is one recurrent sobering concern:

> despite the fact that *Jatropha* grows abundantly in the wild, it has never really been domesticated. Its yield is not predictable; the conditions that best suit its growth are not well defined and the potential environmental impacts of large-scale cultivation are not understood at all.
>
> (Fairless 2007: 652–653)

Jatropha holds the potential of becoming an important energy crop (Achten *et al.* 2008; Grass 2009). But it could also fail. As such, *Jatropha* challenges the "pioneers" and "risk takers" to mould, breed, improve and stabilise it to meet the desired needs. While breeding towards improved varieties has just begun and elite varieties start hitting the news, the *Jatropha* plantations of today comprise, at best, marginally improved wild plants, and neither yields nor environmental effects are well documented (BiofuelsDigest 2010; FAO 2010). According to a review by Achten *et al.* (2008), it is almost impossible to lay out a coherent and realistic business plan for project coordinators or investors because almost every step in the cultivation stage is uncertain. The main knowledge gaps concern the cultivation of the crop (because of the lack of agronomic data), description of best practice and potential environmental risks or benefits. Various reports also list several pests and diseases that have already been observed, and there are worries that *Jatropha* spreads diseases to neighbouring food crops, e.g. cassava (Heller 1996; Jongschaap *et al.* 2007). *Jatropha* is therefore a great challenge to producers, especially to small-scale farmers who have been contracted as outgrowers in Africa, Asia and Latin America. In contrast to second-generation biofuels, where experiments and risks are mostly confined to the North and to laboratories, the risks related to *Jatropha* are quite differently distributed. Project Jatropha, as I see it, is a global *in situ*, real-time experiment of social, environmental, economic dimensions, in which a substantial part of the risk is passed on to resource-poor farmers living on less than US$1 per day.

Poor knowledge is a good breeding-ground for illusions. "*Jatropha* was the hallelujah crop", says Bart Muys, a forest ecologist, but in reality "it is just another crop with its own characteristics" (cited in Sanderson 2009). While *Jatropha* may grow on poor, dry soils, it does not grow *well* enough to be economically interesting (FAO 2008). Thus, while *Jatropha* can survive in very dry conditions, it doesn't necessarily yield a lot of seeds (Sanderson 2009). Nowadays, because yields differ from tree to tree, from various spacing patterns, and depending on soils and the amount of fertilisers, chemicals and water, there is a humble range where *Jatropha* is said to produce between 0.4–15 tonnes of seeds per hectare and year (Openshaw 2000; Grass 2009). Still "under debate" and "being researched" is whether *Jatropha* is the most water-demanding energy crop (Gerbens-Leenes *et al.* 2008; Van Eck 2009), whether it demands a lot of labour (GEXSI 2008), whether it spreads like a weed (FAO 2010), whether it is resistant to diseases and pests, whether it provokes or prevents cancer (Achten *et al.* 2008), whether farmers will produce it instead of food, whether its toxicity is harmful or culturally accepted by farmers, workers and fuel users, whether it is a development opportunity for small-scale farmers and poor communities, and so on.

Jatropha and the search for truth

The search for the truth or reality of *Jatropha* is central to the narrative. There are innumerable accounts in which the claims of *Jatropha* are turned into myths, facts are contested, expectations are checked against results, hidden agendas are brought to the surface, and researchers are found digging for the roots of the new enthusiasm (Openshaw 2000; Fairless 2007; Jongschaap *et al.* 2007; Achten *et al.* 2008; Burley and Griffiths 2009; *Ecologist* 2009; SenterNovem *et al.* 2009; UNAC and JA 2009; Ariza-Montobbio and Lele 2010; FAO 2010). There is a constant struggle to delineate "the differences between rhetoric and reality", to separate "the evidence from the hyped claims and half-truths" or "to prevent the baby being thrown out with the bathwater". This is attempted by communicating the particularities of *Jatropha* and by calibrating overly optimistic promises with real outcomes. Here, *Jatropha* is no longer seen as either "sustainable" or "exploitative" by default, but "reality checked" against certain criteria and goals.

This third storyline may seem more real because it tries to deal with "reality" such as real yields and real bankruptcies. It recounts what happens when the expectations are brought down in volume and scale. This is where BP pulls out, Toyota moves in and General Motors partners with the US Department of Energy to demonstrate *Jatropha*'s viability as biofuel feedstock, and where NASA brings *Jatropha* to space to study if microgravity can help its plant cells grow faster (JatrophaWorld 2010). This is where FAO (2010) reports that the expectation that *Jatropha* can substitute for oil imports will remain unrealistic unless there is an improvement in the genetic potential of oil yields and in production practices. Until then, this story talks of small-scale, community-based *Jatropha* initiatives for local use, like small *Jatropha* plantations and agroforestry systems such as intercropping or fencing (Achten *et al.* 2010). This is where *Jatropha* oil is extracted with simple technology and used as fuel for stoves, lamps, pumps, mills and generators and where it is once again a living fence, medicine, soap, nutrient and water pump (Achten *et al.* 2008; FAO 2010). It is thus a story where the large and small scales converge, and where global hype turns into local pro-poor opportunities (Achten *et al.* 2010). Could this become the true story of *Jatropha*? Could *Jatropha* become local, embedded, small, concerted and win–win? Could it join together discourses and actors that normally would not see eye to eye? Could *Jatropha* cross structural barriers?

According to Saïd Mouline, head of Morocco's Centre of Renewable Energy, it is not just a romantic notion to believe that Africa could catch up on its huge energy gap by adopting new approaches, such as off-grid energy generation from renewable sources (Marks 2009). There are many "coulds" in this story and it highlights the dilemma of learning from history *and* believing in change. *Jatropha* as a commodity is in its early phase of formation. And we are told that it all depends. Yet I cannot get rid of my doubts as I watch the PR movie about *Jatropha*, labelled "win–win" or "shinda–shinda" in Swahili: *"You invest nothing, you get money"* (SenterNovem *et al.* 2009). Today we know that that is far from the truth.

Jatropha and some reality checks

The advocates of *Jatropha* have not refrained from using magic in their campaign, by suggesting that it will provide development as through a miracle. But as the evidence from the field has begun to arrive, it indicates that the so-called magic bullet is associated with the ordinary set of challenges of poor soils and yields, lack of infrastructure and agricultural extension, unclear contracts, gender and power unbalances and a general ignorance of the risks taken by small-scale farmers in developing countries. In 2010, FAO released an extensive review on *Jatropha*, identifying what we know but also showing significant knowledge gaps (FAO 2010). According to this review, *Jatropha* gives only marginal yields on marginal soils; it needs water and nutrients and will attract pests and diseases the same as any other plant. Private interests tend to target fertile land to increase the return to capital invested and to situate plantations in areas with better transport links. *Jatropha* can only compete with diesel if its production costs and seed prices are minimised. We know that farmers are unsatisfied with seed prices as it is. In order to compete with diesel, *Jatropha* must be subsidised or exempted from tax. We know that developing countries have problems implementing such policies.

We know that there will be less greenhouse gas (GHG) emission savings if the oil is processed to biodiesel and shipped to overseas markets. Detailed life-cycle analyses of GHG emissions are not available for *Jatropha*, but there is strong evidence that net GHG emissions will be lower if feedstock production is on marginal lands, if cultivation is less intensive with less use of fertilisers and less irrigation, if by-products are put to use, and if the end product is pure vegetable oil rather than biodiesel.

Small-scale production of vegetable oil has the greatest potential to benefit small farmers and rural development. Access to energy is central to reducing poverty and hunger, improving health, increasing literacy and education, and improving the lives of women and children, as it creates healthier cooking environments, extends work and study hours through the provision of electric light, provides power in remote regions to drive cellular communication equipment, and increases labour productivity and agricultural output through mechanisation. We know that deforestation must be reduced but also that local people are sceptical to the use of toxic oil. The high viscosity of *Jatropha* oil compared to kerosene presents a problem that necessitates a specially designed stove, and these lamps and stoves are expensive and difficult to use. It is thus partly a technological fix. While *Jatropha* is not a food crop, the use of the plant for biofuels still raises issues about competition with other forms of land use, including food production (Burley and Griffiths 2009). Taking advantage of the opportunities that *Jatropha* presents for rural development will require pro-poor biofuel governance. According to FAO (2010), all this is what we know. The question is what we do.

Jatropha 1.0 is dead: long live version 2.0

The real story of *Jatropha* is produced in this very process, in the negotiations that we hear about, through the reports that we read, and by means of the metaphors that we adopt. *Jatropha* is constituted in battles coloured by the global discourses on development, ecological modernisation, carbon trading, certification schemes, sustainability criteria and life-cycle analyses. This is where *Jatropha* as a global fuel becomes a reality. To fit these discourses, *Jatropha* might change its genetic composition, or it might even become a tree, because if *Jatropha* is classified as a tree, forests can be cut down and replaced by *Jatropha* "trees" with no deforestation having taken place. But how much can we change *Jatropha* until it becomes something different? As I write these words, the answer is already in the news (Lane 2010). Wild and illusive *Jatropha* is proclaimed dead. *Jatropha* has been reborn as Version 2.0, with new environmental, social and economic claims. *Jatropha* has failed – not as a feedstock but as a "business model", in the words of SG Biofuels CEO Kirk Haney (cited in Lane 2010). The making of that *Jatropha* is however another story.

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18 Atoms

Nuclear estrangement from Chernobyl to India

Bengt G. Karlsson

> I tell the nurse on duty: "He is dying." And she says to me: "What did you expect? He got 1,600 *roentgen*. Four hundred is a lethal dose. You are sitting next to a nuclear reactor."

In the opening story of Svetlana Alexievich's book, *Voices from Chernobyl: The Oral History of a Nuclear Disaster* (2005), Lyudmilla Ignatenko narrates how her husband Vasily is called out in the middle of the night as there is a fire in one of the reactors. Vasily works as a fireman at the Chernobyl nuclear power plant and is one of the first to arrive at the scene that fatal night in April 1986. He and his comrades would never return, most of them died already during the coming days and weeks. Lyudmilla stayed with her husband at the hospital to the end, despite everyone telling her that she was mad and that she and her unborn child would be damned by the unprecedented doses of radiation that Vasily had been exposed to and now passed on to them. He, they said, was no longer a person but a radioactive object, a "nuclear reactor" as it were.

In this chapter I will discuss what it implies to inhabit a nuclear landscape, a life-world marked by radioactivity. As I will argue, one of the critical features of nuclear life is the compelling sense of estrangement, i.e. life at odds with the ordinary. My take will be personal and, one could say, exploratory. I came of age politically with the anti-nuclear movement in the late 1970s and have since remained convinced that the nuclear path is a fatal one. Even if my role is no longer that of an activist, such a conviction pervades much of my thinking. For me, this has evolved into a quest for a critical anthropology of life rendered nuclear. The discussion will circle around three interrelated themes: risk, uncertainty and livelihoods.

Green and peaceful atomic fissions

With the Chernobyl accident in Ukraine and the previous incident at Three Mile Island in the United States, many believed that the fate of the nuclear energy industry was forever sealed. Splitting atoms to produce energy had after all proven too risky for us mortals to be engaged in. Indeed, many countries halted ongoing nuclear energy programmes and orders for new plants dropped to almost nil. But now, some 20 years later, the situation seems almost the reverse. Public opinion in several countries has changed to a pro-nuclear stand. More and more countries are also lining up to build new nuclear power plants.

One way of explaining the remarkable recovery of the nuclear industry is that it has managed to re-brand itself as "green". At a G8 meeting in Japan, the then US President George W. Bush told the world's leaders to invest aggressively in nuclear power as a measure to protect the environment. At a news briefing, Bush's senior advisor on environment and natural resources, James Connaughton, went so far as to say that a country's willingness to use nuclear energy is a "litmus test" for seriousness on climate change (cited in *The Spiegel Online International* 7 August 2008). But even people with stronger environmental credentials, like the father of the Gaia-hypothesis James Lovelock, have turned born-again nuclearists. In Lovelock's recent, apocalyptic book, *The Vanishing Face of Gaia: A Final Warning* (2009), we learn that although it is probably already too late to do anything about climate change – step by step Gaia is moving towards the hot state, the root cause being a population far beyond the capacity of the planet – the sole ray of hope comes from nuclear energy. He applauds British Prime Minister Gordon Brown for his bold decision to re-start the British nuclear programme and spares no positive adjectives portraying nuclear power as safe, cheap and clean. To think that wind, sun and water would do the job to replace oil and coal is unrealistic mumbo-jumbo. Nuclear energy, he argues, is falsely feared and he assures that not even the radioactive waste is actually much of a problem; he for one would happily store nuclear waste in his own backyard (2009: 68–76).

The existing non-proliferation framework is built on the key idea that every state has the right to peaceful nuclear technology, but that nuclear weapons capacity is to be restricted to the existing nuclear weapons states. The International Atomic Energy Agency (IAEA) was created for this very purpose and has a double mandate of, on the one hand, promoting the use of peaceful nuclear power and, on the other, stopping the spread of nuclear weapons. President Obama's call for a tighter global nuclear arms regime comes with a bold message that his ultimate vision is "a world without nuclear weapons" (*New York Times* 2010). But such a vision seems incompatible with the spread of nuclear technology for civil energy purposes. With the necessary skills, facilities and materials made readily available, certainly some states or groups will appropriate the atom for non-peaceful purposes.

The nuclear experiences in many countries also reveal how closely intertwined the civil and military aspects are. With the 1998 series of bomb tests in the Rajasthan desert, India has also moved ahead to join the exclusive club of nuclear weapons states. Canada provided India with its first civil nuclear reactor, a plant that eventually produced the plutonium used in its first bomb test in 1974. Because of this test and India's reluctance to join the Non-Proliferation Treaty, the country was cut off from further international nuclear collaboration (Abraham 1998; Perkovich 1999; Kapur 2001). Its isolation remained in place up to 2008 and the signing of the bilateral agreement between India and the

United States on nuclear collaboration. Following this agreement, other major nuclear states like France and Russia have signed similar deals to open up for export of nuclear technology and fuel to India. The compromise that paved the way for the Indo-US deal was a formula by which civil and military nuclear programmes were to be separated, with collaboration only in the field of civil nuclear power (Chari 2009). The question is whether such a separation really can be made.

A related issue with nuclear programmes is that they tend to end up as classified operations that are kept away from public scrutiny and democratic decision-making. Again in the case of India, to quote Itty Abraham,

> It has long been known that the Indian Department of Atomic Energy (DAE) is India's most secretive government agency.... Official secrecy was used to cover up technological failures and environmental hazards and to intimidate and harass the few uncowed members of the press seeking to cover the nation's most sacred of holy cows.... The DAE's anti-public behaviour has been, for half a century, a scandal in a democratic society.
>
> (Abraham 2007: 33)

As we will see, the culture of secrecy prevails in nuclear programmes more or less universally, not least in the case of major weapons states like the United States and Russia (Gusterson 1996; Kuletz 2001; Garb and Komarova 2001).

It is often argued that at the present junction the choice is between the fossil and the atom – in fact, as oil is "peaking", between coal and nuclear energy. Global climate change compels us to choose the "green option" and hence go nuclear. But there are reasons to be cautious here and look at the wider repercussions of taking the nuclear path, not least in terms of the increased risk of nuclear arms proliferation. The greenness of nuclear power is itself a contentious claim, oblivious to the consequences of radiation contamination. Such contamination cannot be detected directly with our senses, but remains nevertheless detrimental to human health for thousands of years. For example, the half-life of thorium 230 – discharged during the production of yellow cakes at uranium mills – is about 80,000 years.

Risk

Risk obviously pervades much contemporary thinking on nuclear issues. In anthropology, if you say "risk" you think of Mary Douglas. For the social sciences more generally, Ulrich Beck would come to mind. Interestingly, both of them have addressed the issue of nuclear power. For Beck, nuclear energy is an ultimate example of the modern risk society where "non-calculable uncertainty" is injected into the world. "With the past decision on nuclear technology and our contemporary decision on the use of genetic technology", he writes, "we set off unpredictable, uncontrollable and incommunicable consequences that endanger life on earth" (2002: 3). In a recent newspaper article he likens the choice of nuclear power with that of climbing "into an aircraft for which a landing strip has not yet been built" (Beck 2008). State, science and industry are the main agents responsible for introducing these runaway risks that threaten our collective survival. Mary Douglas, on the other hand, sees no inherent dangers in the use of particular technologies. For her, riskiness is primarily in the eye of the beholder. Who we are, the type of society or social organisation we are part of, determine what we worry about. Individuals most likely to be concerned with environmental destruction or pollution tend to populate the social periphery and have what she calls a "sectarian worldview". To Douglas, the anti-nuclear movement that emerged in the 1970s is a prime example of such people (Douglas and Wildavsky 1982).

One need not be of a sectarian bent, however, to agree that nuclear technology is a complex and high-hazard undertaking. In *Shouldering Risks: The Culture of Control in the Nuclear Power Industry* (2005), anthropologist Constance Perin explores what it entails to operate a nuclear plant safely. As we learn, this is far from an easy task. Negligence in maintenance or a minor mistake by those operating the plant can have fatal consequences. At the same time, safety measures are up against the "production imperative", i.e. to keep the plant on line and hence avoid costly shutdowns. Perin takes the position of a sympathetic outsider seeking to enhance the safety of the industry by rendering its culture of control visible. And certainly, as she argues, with almost 450 nuclear power plants in operation globally, the safety of these "is obviously in the world's best interests" (ibid.: xvii).

Perin makes a number of important observations. For example, the large number of ex-navy people that ventured into the nuclear industry from the 1950s onward brought along a military order with a top-down command structure. People were not supposed to ask questions, merely to follow commands. This might be useful in a submarine ready to strike, but obviously less so in the case of a civilian nuclear power plant where you need to ensure collaboration between a large number of staff, all with different expertise. A similar "military-style chain of command" exists in French nuclear facilities (Hecht 1998: 173).

Perin further explores how the deregulation of the power sector – for example, leading to significant cuts in staff – affects the safe running of nuclear plants. She talks about nuclear power plants as examples of "high hazard ventures", but never follows through the wider significance of this in terms of risks related to radiation contamination or how people working in nuclear plants deal with the fact that they are being exposed to radiation.

Shouldering Risks can profitably be juxtaposed with *The Nuclear Peninsula* (1993 [1989]), by French anthropologist Francoise Zonabend, a pioneering study of the La Hague nuclear waste processing plant in France. Zonabend opens with a note on the difficulty of doing research on social and psychological aspects of nuclear and other high-risk facilities. First of all, for local people the researcher is highly suspicious, probably placed in the anti-nuclear bracket and hence not to be trusted. After all, these people are economically dependent on the facility in question. In addition, people that live near or work in nuclear facilities prefer not to be reminded of and hence not talk about the possible dangers that this might imply. In general, people will not admit fear of nuclear risks. Almost without exception, when asked, everyone would swear to the reliability of the nuclear plant. This is not restricted to La Hague or Chernobyl, as research on the Ignalina nuclear power plant in Lithuania also disclosed that fear of radiation was routinely denied and that most people who worked in or lived in the vicinity of the plant expressed high trust in its safety (see Sliavaite 2005). This denial, according to Zonabend, pervades life more generally in La Hague. Those who work in the plant rarely discuss it with other family members. People in the vicinity of the plant would commonly respond that they cannot actually see the plant from their house, suggesting that this makes them less susceptible to nuclear risks. In the plant, labourers usually respond to questions about dangers of exposure to radioactivity with a ready-made discourse that confirms official assurances about the existing safety measures. It is only on rare occasions, when the interview is over, the tape recorder is switched off and Zonabend is getting ready to leave, that people might open up and offer a few glimpses of their suppressed fears and moral anguish (Zonabend 1993: 2–4).

To Zonabend, people's silence is an understandable strategy when dealing with something as opaque as "le nucleaire". People are rendered "impotent"; what can they say, other than to trust those who "know". But such trust is clearly frail. Zonabend gives the example of the mayor of one of the municipalities who is a vocal champion of nuclear power – once even sent to Japan to convince a rural community there about the safety of French nuclear technology (as part of a business deal to sell a French processing plant) – who suddenly diverts from his well-rehearsed script and expresses concerns regarding health effects of low-dose radiation. As she later finds out, the mayor refuses to eat fish or other seafood from the waters around the La Hague peninsula. Local people are also aware of the negative image of their place, that La Hague has become one with the fuel processing plant, commonly described as "the world's atomic dustbin" (ibid.: 27). In the end, what Zonabend discovers is a shared experience among people on the peninsula who, despite differences in form, "speak with one voice of a pain that cannot be denied, a buried anguish, a happiness lost forever" (ibid.: 7).

Uncertainty

With the series of explosions that destroyed reactor four at the Chernobyl plant, large amounts of radionuclides were released into the atmosphere. Not only were Ukraine, Belarus and Russia directly hit by the radioactive fallout, but so were several other European countries, including my native Sweden, affecting especially the reindeer-herding Saami population (Beach 1990). The overall impact of the Chernobyl disaster is still being debated. The 2005 report by the Chernobyl Forum under the International Atomic Energy Agency (IAEA 2005) estimates up to 50 deaths directly attributed to radiation from the disaster and extensive long-term effects, including some 4,000 cancer deaths. A recent study under the auspice of Greenpeace (2006) suggests a more severe scenario with approximately a 250,000 cancer cases, nearly 100,000 of which were fatal. In both studies, the authors point to the immense difficulties in establishing reliable figures.

The debate about the Chernobyl legacy is of course also a debate about the future of nuclear power. Greenpeace argues that the IAEA, along with the nuclear industry, has a vested interest in keeping the figures down. One problem here is that some cancers can take more than 40 years to develop and with such a time span it is obviously easy to suggest other possible causes than just the exposure people have been subject to due to the Chernobyl catastrophe. This is, in fact, also the message of the IAEA-led Chernobyl Forum report, stating that poverty and general lifestyle diseases, as well as mental health problems, are rampant in the former Soviet Union and "pose a far greater threat to local communities than does radiation exposure". An additional problem, according to the report, is the myths and misconceptions about the dangers of radiation, which has led to an equally harmful "paralyzing fatalism" among people in affected areas (Chernobyl Forum/IAEA 2005).

These statements are quite remarkable. Unwarranted fears and general poverty, rather than the exposure to radiation, are claimed to be the main issues in Chernobyl. This calls to mind the strange mandate of a UN agency to be a promoter of a particular industry or technology. Indeed, it seems legitimate to ask, as Greenpeace does, whether this role is compatible with that of a neutral investigator (Greenpeace 2005). In a recent article in the *Guardian*, journalist Oliver Tickell recalls the controversial agreement within the UN that gives the IAEA the right to veto any action by the WHO concerning health aspects of nuclear power. This "obscure" deal that now celebrates its 50-year anniversary prevents the WHO, Tickell argues, from "investigating and warning of the dangers of nuclear radiation on human health". Tickell backs his argument with the well-known case of the radiation biologist Keith Baverstock, who worked for the WHO between 1991 and 2003 but was fired after arguing that new research points to substantially higher risks with exposure to nuclear radiation than the existing models assume. Tickell closes his article with a quote from Professor Chris Busby, secretary of the European Committee on Radiation Risk, saying that the "subordination of the WHO to IAEA is a key part of the systematic falsification of nuclear risk which has been under way ever since Hiroshima" (Tickell 2009)

Anthropologist Adriana Petryna, in her fascinating monograph, *Life Exposed: Biological Citizens after Chernobyl* (2002), examines the controversy regarding the long-term effects of the disaster. The main disagreement concerns "*proven* versus *expected* health outcomes", with local scientists standing in opposition to international scientists affiliated with the UN (2002: 9, italics in original). Petryna mentions leukaemia as an example. The UN does not recognise any increase in leukaemia rates, whereas local scientists note a significant increase; a group of Belarusian physicians claims a four-fold increase among clean-up workers, who were most heavily exposed to radiation. Petryna also points to the noted increase of thyroid cancers among children in the exposed areas, something that the IAEA and the UN Scientific Committee on the Effects of Atomic Radiation do not accept, with reference to earlier research conducted on Hiroshima and Nagasaki survivors. These disputes, as we have seen, add up to a general disagreement about the total death toll of the disaster. Petryna also mentions a widespread indignation among local scientists vis-à-vis their colleagues affiliated to the IAEA, claiming that the latter underestimate the health effects of Chernobyl (ibid.: 166–167).

As Petryna insightfully shows, the nuclear disaster has had a transformative effect on Ukrainian society, central both to the process of post-Soviet nation-building as well as to evolving notions of citizenship. What I find most compelling in her stories is how Chernobyl rendered life opaque. For example, clean-up workers who were exposed to lethal doses of radiation commonly refer to themselves as "bio-robots". These living-dead survivors, as well as other affected people, spoke about a profound sense of powerlessness, a complete lack of agency that even concerned the control over their own bodies. One man described the radiation he had been exposed to as a "foreign burden", something unnatural, that had entered his body and left him without any peace. Others similarly mentioned that "it" (radiation) made their legs refuse to walk or tongues refuse to speak. Such experiences of weakness and bodily disorientation also mark the life of the Japanese *hibakusha*, that is, those who survived the Hiroshima and Nagasaki atomic bombs (Hersey 1985).

It is this opaqueness of nuclearity that I refer to as "nuclear estrangement". Anthropologist Joseph Masco emphasizes this aspect of nuclear life in his book, *Nuclear Borderlands: The Manhattan Project in Post-Cold War New Mexico* (2006). The invisible power of nuclear materials, Masco argues, produces a kind of sensory disorientation among people, turning the everyday into something "otherworldly, strange, and even dangerous" (2006: 33). Masco draws on Freud's notion of the "uncanny" or "unhomely", a psychic state of ambiguity where sensory impulses can no longer be trusted. But radiation obviously also does things with our bodies, i.e. causes cancer, death and mutations, and this is also true for other living organisms and nature more generally. Masco gives the fascinating example of a particular scrub that has evolved in the radioactive soil of a nuclear waste treatment area. As he points out, not only is this new mutant plant radioactive, but it obviously thrives in an environment that is highly contaminated (ibid.: 32–33). For human beings, however, a radioactive place is apparently both unhomely and unsafe.

Livelihoods

In some places, people's entire life-world has been marked by nuclear contamination. Chief John Anjain of the Rongelap atoll, Marshall Islands, described in a hearing before the United States Senate in 1977 how he saw a second sun rising in the west, there was thunder and then a strange cloud over the horizon. He continues:

> In the afternoon, something began falling from the sky upon our island. It looked like ash from a fire. It fell on me, it fell on my wife, it fell on our infant son. It fell on the trees and on the roofs of our houses. It fell on the reefs and into the lagoon.
>
> (Anjain 2009: 11)

The 1954 US Bravo bomb test changed forever the history of the Rongelap community. Decades later this devastating case of nuclear colonialism became an issue of historic restitution under the Marshall Islands Nuclear Claims Tribunal. But, asks anthropologist Barbara Rose Johnston (2009: 4), advisor to the tribunal, how do you compensate for "the loss of a way of life"? Water, fish, crops, the entire ecosystem, the resource base, was contaminated. As Lijon Eknilang, a Rongelap woman, explained to the tribunal, "Psychologically, you stop believing in everything around you" (ibid.: 6).

In anthropologist Valerie L. Kuletz' notable study, *The Tainted Desert: Environmental and Social Ruin in the American West* (1998), we similarly learn about the cynical devastation of Native American Indian lands and lives through atomic bomb testing, uranium mining and nuclear waste storage. Here, too, the people were initially unaware of the risks posed by radiation. An elderly woman of the Moapa reservation recalls how they used to go to the Nevada test site to watch atomic bomb tests. They also hunted rabbits and collected plants in the vicinity of the test site. During summer they would spend all their time outdoors, taking their water from open streams. Consequently, many now suffer from or have died of cancer. Their suffering, as with that of many of the other Native American peoples that inhabit nuclear landscapes, has largely been ignored or rendered invisible. Kuletz argues that the US nuclear history reveals a "consistent pattern of internal nuclear colonialism" (Kuletz 1998: xv). But despite the obvious imposition, the nuclear complex also provided a new source of income, although badly paid, and local people have become dependent on the mining industry (ibid.: 25). Storage of nuclear waste has become another, highly controversial, source of income for some Indian tribes. In this way, the issue of nuclear exploration now divides several Indian communities. Whereas some tribes have taken a strong stand against any nuclear activities, others seek to draw economic advantages from further mining and storing of nuclear waste on their lands.

Uranium mining has become one of the most controversial questions in the hill state of Meghalaya, in northeast India, where I have been working over the last decade. The question is whether or not to allow mining of what is considered to be the largest and best quality deposit of uranium in the country, located in a sparsely populated part of the small hill state of Meghalaya. The pro-mining camp in the state talk about uranium as a means to achieve development: local people will get jobs, the state finances will improve and the nation will get its much sought-after strategic mineral. Those that oppose argue that they don't trust the assurances of the Uranium Corporation of India (UCIL) and the flown-in government experts saying that uranium mining poses no dangers to the environment or to people's health.

An elderly woman, Mrs Spilliti Lyngdoh Langrin of Domiasiat village, has become a symbol of the anti-mining camp. Being one of the main landowners in the area, she and her matrikin had initially given permission for exploratory mining, but with all the people and commotion that the mining brought with it, the village soon decided to oppose uranium mining. When I met her in 2005, she said that it was one of the company drivers who first made her aware of the hazards of uranium. The driver had said that he thought Khasis were educated people, "But how then can you be so stupid that you allow this to happen?" As he explained to her, all their lands will be taken over by UCIL. He had seen that happen in Bihar, where he used to work. And he said further that when mining starts they will come to suffer from a number of diseases. Mrs Langrin then started thinking that something strange was indeed going on, as the company officials had fences around all their houses and the staff went into the administrative headquarters of the district Nongstoin to buy chickens and other foodstuffs. Cows had acquired some strange illness and a few people in the village had become sick. There had been no mining in their village, but extracted ore had been brought there and reloaded onto trucks for further transport. Her husband, Bah Niar Thongliong, joined our discussion, saying that everyone in the village opposed mining. He said that this is a peaceful place and they don't want people from outside to come here. Uranium mining is dirty, he said (Karlsson 2011).

Those who locally oppose the mining have support from the powerful Khasi Students' Union, as well as other prominent organisations in the state. However, with the main political parties and the state government in favour of the project, it seems increasingly unlikely that the uranium will be left in the ground as the anti-mining camp demands. In the midst of this heated controversy, uranium has also been discovered in the nearby Balpakram National Park. The park is not only a biodiversity hotspot, but also the most sacred place to the Garo people. Requests by the DAE to declassify a part of the national park to allow for exploratory drilling has prompted a strong reaction among the Garos, and the outlawed ethnic militia Garo National Liberation Army says in a press statement that they will welcome the department staff with "bullets, bombs and blood" (*Meghalaya Times* 2010).

India has a growing population of more than one billion, a booming economy and an increasingly affluent middle class that aspires to a Western-type lifestyle. Electrical power is in high demand, and without a massive increase in energy production it is assumed that the development of the country will be jeopardised. Nuclear energy has become the magical fix.

According to plans, by 2020 India is to generate 20,000 megawatts of nuclear power. This would mean a roughly five-fold increase from present capacity.

Besides the existing 17 nuclear plants, six new ones are under construction and several more are planned. The long-term strategy is even more ambitious, with nuclear power supplying one-quarter of the country's electricity by 2050, implying a 100-fold increase from the capacity at the turn of the twenty-first century.

Access to uranium is a requirement for this to happen. Even if the deal with the United States has paved the way for imports of uranium, for energy security reasons as well as for the sake of the nuclear weapons programme, India requires a domestic supply as well (Choudhry 2009). The question is how much longer the Indian government will accept keeping these grandiose plans on hold for the sake of some defiant indigenous communities.

Conclusion

I have explored some anthropological perspectives on nuclear issues in an attempt to develop a critical vantage-point for thinking about the current global revival of nuclear energy. In short, I have called for a wider discussion of what it entails for a country like India to go nuclear. Ionising radiation affects human bodies and renders life opaque. A nuclear world is more difficult to be at home in. It is simply a less happy place.

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19 Safflower

Liberalisation or participation in a Tanzanian village

Wilhelm Östberg

The lowland parts of Kondoa District, Central Tanzania, are dry and hot. Rainfall is scarce and erratic (Ngana 2004; Yanda 1995). For half the year many villagers get their water from pits dug deep into dry riverbeds – sometimes 10 km or more away from their homes. Some families use as little as 20 litres per day for drinking and cooking, which leaves little for washing; you just do not wash yourself or your clothes regularly during the long dry season. A few villages have access to drilled boreholes or piped water through a gravity scheme, and there the situation is of course different. But for most villages water is a major problem.

Farming in Kondoa

Farming is at a perilous place. The staple crop is bulrush millet and the general strategy for farming is to plant as early as possible in the rains – "chasing the rains" as the local saying goes. In this precarious farming environment, safflower *(Carthamus tinctorius L.*) appears to be a "saviour" crop. It is unusually drought-resistant, recommended to be planted towards the end of the rains and thus does not compete for labour with the ordinary food crops. Nor is it susceptible to attack from birds, livestock or game. Safflower can grow on the heavy and sometimes saline soils in the flat depressions (*mbuga*), which otherwise are used for extensive grazing. It produces edible oil with characteristics at least as good as sunflower oil, and it fetches a high price on the international market.

Safflower is a newcomer to Kondoa and is now rapidly being adopted by small-scale farmers in the drier parts of the district. Villages where safflower is currently grown include Atta, Huruvi, Isare, Kinyasi, Kwamtoro and Seria, but suitable soils and climate are found in many additional villages (see Figure 19.1).

Safflower is the latest addition to a long list of cash crops that Kondoa farmers have tried. Immediately prior to its introduction, and retained as notable cash earners, are simsim, sunflower and pigeon peas. In the early 1990s some farmers made good money on the sale of finger millet for brewing traditional beer around Arusha and Moshi. Groundnuts and castor oil have also been major income earners. Through several shifts such as these, Kondoa farmers have shown themselves to be responsive to market changes. The case of safflower is no exception.

The promoters

More or less the entire safflower production in Tanzania ends up with Quality Food Products – from now on simply called the Company. In Arusha it runs a modern factory producing safflower oil for export under the trademark Safflo. The Company was started in the second half of the 1990s by former directors of the Dutch seed company Pop Vriend, together with the expatriate manager of its Tanzanian subsidiary Pop Vriend (T). The Company has a de facto monopoly on safflower business in Tanzania.

Safflower is produced by farmers under contract to the Company, which offers seeds, ploughing and harvesting services, all charged for. The Company can also provide pesticides and spray pumps if needed. It pledges to buy all safflower produced at a guaranteed price, which is noted in annual contracts concluded with willing farmers. It initially contacted the District Agricultural Office and public information meetings were arranged, but soon the Company's

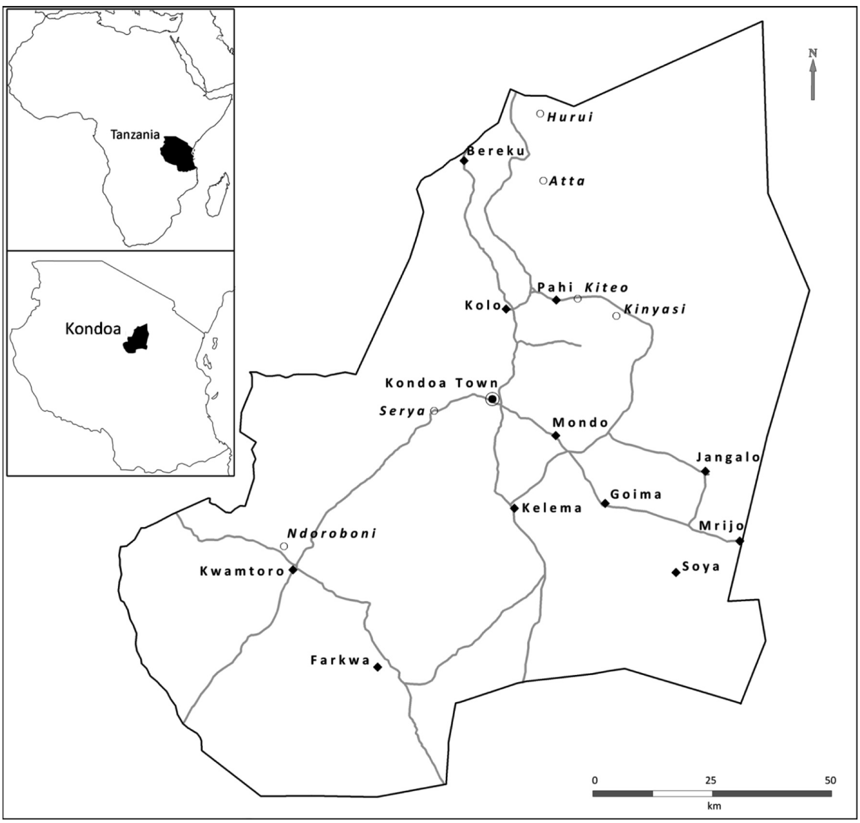

Figure 19.1 Kondoa District, showing major centres and roads. Map by Camilla Årlin.

Note: villages mentioned in the text are rendered in italics.

representatives made direct agreements with interested farmers and the Agricultural Office was not actively involved as the new crop became a reality in the district. The district office has no information on the crop (apart from what has been provided by the Company) and no independent advice or caution was provided to farmers trying the new crop. At the national level, the Ministry of Agriculture had not initiated research on safflower, neither did it have plans to start producing certified safflower seeds. In Kondoa, the initiative and competence regarding safflower production rested squarely with the Company.

Although enthusiasm over the new crop was considerable among the staff, opinions on the pros and cons of safflower were contradictory. Some agriculturalists in Kondoa described safflower as a pest-free crop, while others mentioned attacks by cutworms in the early stages of the crop and fungi in the late stages. In short, there were guesses, hopes and hearsay, but no established knowledge. The agricultural staff at Kondoa welcomed the new crop with a feeling of gratitude, almost submission, but they did not attempt to systematically create a knowledge-base independent of the information provided by the Company.

The conclusion so far is that the crop was introduced to the district without any well-informed assessment being made of its pros and cons. How great is, for instance, the risk of introducing new diseases to the district? Is it a predator crop? Will it exhaust the land? How reliable is the market? Is the Company financially sound, or do farmers take risks when they clear land and cultivate for it? The District Agricultural Office has no information to offer the district's farmers on any of these matters.

Mkukuta

Following the country's current policy directives, the administration has moved from being an organisation of experts that would lead developments in the district to becoming facilitators for villagers who collectively identify their development needs. The Ministry of Agriculture operates according to the Agricultural Sector Development Programme (ASDP) and the Participatory Agricultural Development and Empowerment Project (PADEP), which are applications of the overall National Strategy for Growth and Reduction of Poverty, known in Swahili as *Mkukuta*. The basic idea is that villages should identify their development needs while specialists of the district administrations help them achieve these goals. "Basket funds" provide the means to carry out agreed interventions.

This line of thinking is nowadays so widespread in development work all over the world that analysts conclude that we have entered the "age of participation" (Oakley 1991). Some also talk of the "paradigm of people". The era has been in the making for a considerable period of time (e.g. Chambers 1983, 1997; Gardner and Lewis 1996). The agricultural office is expected to actively cooperate with "stakeholders", including non-governmental and community-based organisations, other government agencies and commercial interests.

The strategic position for the Company

The Company does not own or lease the land where safflower is grown. The task to acquire land is delegated to the farmers contracted by the Company. Thereby it escapes possible criticism against land grabbing. If safflower farming depletes the soil, such problems are passed on to the farmers. On the other hand, farmers retain control over the land, and they have no obligations to the Company beyond a contract that runs for one year at a time.

The Company dictates the conditions for safflower growing, and farmers can accept or reject the terms but not really negotiate. The power of the Company lies in it being the only buyer of the product, and that it also more or less controls the entire process from ploughing to selling safflower oil on the world market. Since a market value in Tanzania of safflower cannot be established – as the Company is the only significant buyer – the suspicion lurks that the Company monitors the price against sunflower and other alternative crops, putting it at a level where they expect to get deliveries and not in relation to profits they may realise on the world market.

Changing perceptions of the benefits of fat

Safflower oil has similar characteristics and uses as sunflower oil, e.g. salad dressing, production of margarine, etc. It helps to reduce blood cholesterol and related heart and circulatory problems. Dajue and Mündel (1996) provide references to several studies on this topic. It is non-allergenic, and therefore suitable for the cosmetics industry. While the oil is mainly used in the food industry, other industrial uses of safflower oil are expected to expand as environmental concerns demand replacements for products based on fossil fuels (Dajue and Mündel 1996).

The farm-gate price for sunflower has increased dramatically over the last few years, which has a direct bearing for safflower cultivation. In Kondoa District sunflower was sold for 3,000–6,000 Tanzanian shillings (TSh) per bag in 2005. A year later the price was 4,000–13,000 TSh, while in 2007 the price per bag reached 35,000 TSh in Kondoa Town by late December.

This dramatic increase in price goes together with an interesting change of attitudes in the country. Industrially produced cooking fats have for years been standard for most families, but no longer. The quality of cooking oil is a topic that engages almost everyone in Kondoa, as elsewhere in the country. Farmers are critical of fats "that clog your blood" and "give high blood pressure". They prefer cooking oil pressed from seeds produced on their own farms, or at least bought from someone known to them. A common opinion is that industrially produced fats "are fit for making soap but dangerous to eat". Also, people living on narrow margins tried to use sunflower oil (or safflower oil if available), although the price has skyrocketed in recent years. How this widespread change of opinion came about is worthy of a study in its own right. Those I asked, both in Kondoa, at the headquarters of the Ministry of Agriculture and at the

University of Dar es Salaam, insisted that there had not been major government propaganda on the issue, but that the message spread from mouth to mouth. In Kondoa, in its promotion meetings for safflower, the Company had emphasised the health aspect along with the economic benefits of the crop. It seems that this argument had caught an interested audience.

The Kwamtoro experience

Kwamtoro ward is a sparsely populated part of the district, least of all known for farming achievements. Instead, it has a legacy of hunting and honey production. The majority population, the Sandawe, speak a language with click sounds, related to the Khoisan languages of southern Africa. This affinity is further evidenced by the ancient rock paintings found in the area (Fozzard 1966; Kohl-Larsen and Kohl-Larsen 1958; Lewis-Williams 1986; ten Raa 1974), which are similar in style to those of southern Africa.

The major crops grown are millet, sorghum, maize, pumpkins, pigeon peas, cassava and sunflower. Fields are on average small in this area as land preparation is commonly done by hand with hoes. Charcoal and timber are important products, as is honey and beeswax. The road to Kondoa Town, some 60 km away, is of poor quality, impassable during rains and passes through tsetse-infested forest, making Kwamtoro an isolated part of the district. Wild meat remains part of the diet for many households.

The area would seem an unlikely choice for an industrial crop, but land is available, the climate is suitable, and the growing of safflower began here in the 2005–2006 season. The chairman of the association of safflower growers in Kwamtoro, Ramadhani Saidi Kwenda, on a business trip to Singida had encountered the profitable and drought-resistant crop. He approached the Company and served as a facilitator for its activities in Kwamtoro.

The Company requires that farmers organise themselves into groups to facilitate mechanised ploughing and harvesting. Groups of up to 20 farmers clear land for the new crop. So far, every farmer wanting to open a new field has been granted land by the village government. The *mbuga* plots are vast compared to the number of people living in the area. This is particularly so in one of the five villages of the ward, Ndoroboni (which means “of tsetse fly” in Swahili). It was founded around 1976 to counter problems with tsetse flies (Madulu 2001: 13), while the Kwamtoro area more generally experienced tsetse-clearing campaigns during the 1950s (Kikula and Mung’gong’o 1993: 24, 33). People from different parts of Sandawe country were at the time mobilised to come and clear forest harbouring the fly near the main village of Kwamtoro, which was becoming uninhabitable because of the fly. Today, clearings again characterise life around Kwamtoro as more and more land is allocated to safflower.

Farmers in Kwamtoro perceive themselves as being at the mercy of the Company. They have no prior experience of mechanised farming to fall back on, and the market value of safflower is not known to them, nor the exact prices of farm inputs provided by the Company. They feel that they have to accept the conditions offered. Agribusiness interventions are by their very nature a top-down exercise. What is to happen, who is to be included and on what terms is decided by the investor and by national institutions. When local communities are invited to participate, this follows a "harmony model of power" (Mohan and Stokke 2000: 249). No restructuring of economic or political relations are assumed. If a mutually beneficial situation were to develop, this would require that all partners in the process had reasonable access to information and were able to make informed decisions. This is not the case in Kwamtoro. Here relationships are clearly asymmetrical.

Farmers received only rudimentary growing instructions from the Company and proceeded on a trial-and-error basis. They noted that they lacked knowledge of the characteristics of different varieties of the crop, and of how it performs under different weather conditions or over longer periods of time. An obvious conclusion is that professional agronomic advice is much needed, as is support during negotiations with the Company, if disappointments are to be avoided. As already noted, however, the District Agricultural Office has as yet acquired no competence on safflower.

Some farmers worry that the Company will not send tractors and combine harvesters at appropriate times. It is essential that the seeds be harvested when the oil content is at its maximum, and before seeds risk falling to the ground. Kwamtoro farmers realise that they are far from the centres where the machinery is based, and that the acreage they cultivate is small by comparison. They may not be the ones given priority in times of shortage.

Nevertheless, the number of Kwamtoro farmers growing safflower has increased dramatically. After two years there were 53 groups recognised by the association of growers at Kwamtoro (registered with approved minutes from meetings) and a further 13 groups that have listed themselves but await formal recognition. In all, 687 farmers were growing safflower by December 2007. Given that Kwamtoro ward in total had 1,761 households (in December 2007), this is an impressive figure after only two seasons. Furthermore, of these 687 households, well over 400 were headed by women. This high percentage is somewhat specific to Kwamtoro; although women are active in income-generating activities all over Kondoa District, their share is particularly high in Kwamtoro. They are active in all parts of the process, except forest clearing, for which they hire men. As in many parts of sub-Saharan Africa, women dominate farming both for subsistence and for sale, but what is emphasised here is that they formalise their role as they list themselves as being responsible for the family enterprise.

When asked why female farmers take the lead in Kwamtoro, both men and women mentioned cultural traditions as an explanation. There is a legacy of hunting in the area and many men retain the habit of being away from home for shorter or longer periods – not only to hunt, but also for other activities. Kwamtoro men are, for instance, prominent among charcoal providers for Dodoma Town. Men could not be relied upon to be present at any specific time, both men and women argued, and therefore women registered themselves with the association to make things run smoothly. Another factor prompting women to grow a cash crop was said to be widespread drinking among men, which forced their wives to assume responsibility not only for the day-to-day care of the family's needs, but also for larger expenses. Since Kondoa District generally is dominated by Muslims, while they constitute a minority at Kwamtoro, it is to be expected that drinking may be more prominent in the latter ward, and hence the need for women to register themselves as independent growers is more acute. At least this was how informants in Kwamtoro perceived the situation.

Economics of safflower cultivation

Table 19.1 provides a budget of approximate production costs and estimated incomes. It suggests that it is profitable to grow safflower. Alternative crops such as maize or sunflower may produce a better return if sold later in the season. Simsim is also an attractive option.

Although Table 19.1 indicates that it pays to grow safflower, many farmers worry that they may not recover their costs if the harvest is too small. For the 2007–2008 season they therefore asked to have the price increased from 250 TSh per kilogram to 400 TSh per kilogram. They received 300 TSh, an increase that corresponded to about three times the annual inflation.

One major difference with growing safflower compared to other crops is that the price is fixed in the contract between the growers and the Company. Payment is made at the time of harvest. In 2007 the safflower price was 25,000 TSh per bag. This is much better than sunflower at the time of harvest, when sunflower may in fact be sold at a loss.

Table 19.1 Comparative economics for safflower and competing crops

	Maize	*Sunflower*	*Safflower*
Land preparation	20,000	20,000	20,000
Seeds	5,000–9,000	1,500	3,600
Planting	6,000–8,000	6,000–8,000	4,000
Weeding	6,000–12,000	6,000–10,000	8,000
Fertiliser, pesticides	–	6,000	6,500
Bird-scaring	0–4,000	2,000–4,000	–
Harvesting	4,000–10,000	4,000–10,000	–
Crushing	2,000–3,000	10,000	–
Transport from farm	0–2,500	0–2,500	–
Expenses (bags, ropes)	3,000	2,000	–
Production costs	*60,000*	*66,000*	*42,100*
Yield	600 kg	450 kg	480 kg
Income at harvest	72,000	69,300	120,000
Balance	*12,000*	*–3,300*	*77,900*
Income December 2007	120,000	207,700	–
Balance	*60,000*	*141,700*	–

Note: costs/income per acre, Kwamtoro village, 2007, round sums.

By late December 2007, however, the price for sunflower in Kwamtoro reached 25,000 TSh for a bag weighing around 65 kg, which means that sunflower was then more profitable than safflower. A further option is to press a bag of sunflower seed to get 20 litres of oil, which sells for 45,000 TSh. In that case a small additional income can also be gained from the residues, which are used as livestock feed.

Simsim fetched an even higher price at 65,000 TSh per bag, but the crop requires very fertile land, and considerable work goes into producing a bag of simsim.

Thus, although there are other crops which, under optimal conditions, bring in more money than safflower, the latter is still an attractive option because of the moderate production costs and because it is grown on land otherwise not commonly used for farming. Most important, however, is the fact that money is secured at harvest: many Kwamtoro farmers cannot afford to store crops and sell after a couple of months. Pest attacks during storage is also a factor to consider.

Being paid per kilogram is a definite advantage compared to other crops that are bought per bag, which gives rise to difficult negotiations with traders. The traders often demand that bags are "properly filled", which means that additional grains should be added to make the sack "full". The problem of "*lumbeza*" (to add extra weight to a full sack) has for years been a major problem for farmers in many parts of Tanzania and considerably reduced their incomes. Buyers have only accepted their own sacks, where the top part is extended by another third or even more, while the price remained that of a normal bag. The practice is prohibited by law but discussions of what constitutes a full sack still occur at farmgate trading.

Making it without the Company

Mohammed Omari Lamlawa Moshi has an altogether different take on safflower growing compared to other farmers in the District. At 70 years of age, after a long career as a chemist and as an executive manager in both government agencies and private companies, he finds himself opening up new fields of activities. Together with his adult son Yai he runs the Lamlawa Agricultural Processing Company at Kiteo in Pahi Ward, Kondoa District. This is on the dry, hot plains below the Irangi escarpment. Here he has built a couple of simple structures containing a flour mill, an oil press, welding equipment, a mechanic's workshop and also a *mgahawa* run by his wife, i.e. a place where passers-by can get tea, soft drinks, and food. He says: "We live simple. I earn 2,000–3,000 TSh a day [approximately US$2.5] as neighbours come here to have their cell phones charged on our solar outfit. It is very little, but I also need very little."

This was said with a subtle smile by someone who has travelled the world, holds a degree from West Virginia University, and owns property in Arusha and Morogoro. To the visitor it rings true – because of the quiet, agreeable atmosphere on the compound – but at the same time as a gross understatement as the place is also the home of a tractor ploughing several hundred acres of land out on the plains. There Mzee Moshi grows not only safflower, sunflower and simsim, but also millets, groundnuts and several more crops. His priority, however, is oil seed crops.

> I first read about safflower in an agricultural magazine, the *SACCAR Newsletter* [published by the Southern African Centre for Cooperation in Agriculture and Natural Resources Research and Training, Botswana]. In that article I learnt the chemistry of safflower, and I saw that it was high in oil content and that the plant thrives in dry conditions. That impressed on me. I started to look for seeds. That was back in 1998. We planted four acres as a trial, broadcasting the seeds and harrowing them into the soil. We harvested by hand, using gloves and protective clothes. We just pulled the pods off. We only got a bag and a half because of the poor husbandry. But I had seen that the crop could do well in this environment and my interest was sustained. However, I do not want to be dependent on Quality Food Products in Arusha. That is not my way of doing things. Therefore we have only grown as much as we can harvest and process ourselves. I press my own oil here, for our own use and to sell locally. We have nothing in stock now. All we had is gone. Definitely, we could expand! I am ready to pack safflower oil for the domestic market using my own trademark. I do not aim at exports. I could not possibly compete with Quality Food Products. That is not what I have in mind. But there definitely is a local market for safflower oil. You will see me developing this step by step during the next few years.

Mzee Moshi shares characteristics with many African farmer innovators (Reij and Waters-Bayer 2001). About three-quarters are men, they commonly organise their enterprises as family undertakings, they are strong personalities, of mature age, relatively rich, prepared to give their innovations time to mature, have been exposed to other areas and are full-time farmers. "Instead of diversifying into off-farm activities, they have chosen to diversify their agricultural activities" (ibid.: 82). Another study, based on a survey of 505 farmers in three East African localities, produced a somewhat different picture. Here the focus was more on the farming system than on the innovators. Nielsen (2001: 96–100) found that almost all farmers do various small innovations in their work every year and that access to off-farm income contributed to innovations.

The empowerment ideology

Mzee Moshi is making it on his own. Few Kondoa farmers have that option. Why did the District Agricultural Office not take a more active role with regard to safflower? The answer is found in recent changes in the country's development policies. The time when the state and CCM, the ruling party, resolutely led development is long gone. The *ujamaa* ideology, the Arusha Declaration, and the "villagisation" policy of the 1970s, i.e. the radical land reform which concentrated people into development villages, were replaced by the structural adjustment policies of the IMF and the World Bank, initially resisted by Tanzania, but eventually implemented. Today we have multi-party elections, a devalued currency, a liberalised economy and a drastically reduced infrastructure for rural development. Land has become a commodity. The former nationalist agenda has been replaced by openness to foreign investments. In the IFC/World Bank report *Doing Business 2007*, Tanzania appeared among the ten most successful "reformers". The doyen of social comment in Tanzania, Issa Shivji, notes that the leading classes no longer seek legitimacy from their people but from donors and international financial institutions (Shivji 2006: 11). From such quarters also comes the reorientation of the development policy to "participation" and "empowerment from below", which may appear as a paradox.

In theory, when a district establishes its plans for the coming year the procedure has started months before in the villages, where the real planning is supposed to take place. The district plan should be an aggregate of what has been thought and decided in villages, wards and divisions. But in practice what happens is that some villagers participate in meetings where they are consulted rather than "holding the stick", as Robert Chambers (1997) once formulated it. At the district level, of course, officers continue to hold internal meetings as before, follow instructions from the Ministry, and are careful to register the opinions of the District Commissioner as well as those of senior officers at the regional level. As Jules Pretty (1995) has observed, planners fear people's participation as much as they need it after decades of collapsed development efforts. It is rare that local communities in any real sense take part in decision-making, monitoring and evaluation processes.

Nevertheless, it is also true that things have changed. We now have an ideology of "good governance", and the previous authoritarian atmosphere is largely gone, as also is to a large extent the staff. Successive years with budget cuts have had an impact; for instance, the agricultural service of a division that used to be manned by some five members of staff today only has one person remaining, and she/he neither has independent transport nor power to intervene. New policies and lack of resources have led to a situation where many local officers no longer hope to be able to influence developments as entrepreneurial individuals make use of the area's land, water and forest resources. According to the neoliberal agenda the lives of people would naturally improve as the state withdrew. For some it did.

It is this new situation that paved the way for a private company to by-pass the Agricultural Office. The responsibilities for environmental protection and development policies at the district level have become diffuse. Public offices, NGOs, private companies and international agencies all contribute and in the process they cross each other's boundaries and it becomes increasingly difficult to distinguish who is responsible for what. In theory, the Kondoa Agricultural Office could decide to become actively engaged in safflower if farmers actively requested support from the office in their dealings with the Company. However, this is not likely to happen, because the resources for new activities are just not there and because the new political climate stipulates that commercial interests are to be promoted and not just regulated.

Whatever the case, precious time has already been lost. Large areas have been cleared. Facts have been established on the ground before the district authorities have had time to reflect over how desirable this is. The Company has already set the agenda.

Conclusions

Safflower has high market value and the overseas demand is increasing. Both farmers in Kondoa and the District Agricultural Office harbour great expectations that safflower cultivation will bring substantial incomes to some parts of the district. Climatic conditions are favourable and suitable land is available in abundance, according to both villagers and the staff at the district headquarters. However, farmers worry about becoming dependent on the Company. The level of mechanisation in safflower growing makes it difficult for small-scale farmers to take command over the work on their fields. Harvesting is a major obstacle. If simple machinery for harvesting, crushing the pods and separating the grains could be developed, this would help small-scale farmers to start thinking along similar lines as Mzee Moshi does, envisaging possibilities to sell their own oil.

Clearly there is scope for the District Agricultural Office to become more active with agronomic advice, but also to support farmers in their dealings with the Company, to link up with colleagues in other districts where safflower is grown and to explore additional possibilities to market the crop. Farmers would feel more confident with the new crop if the District Agricultural Office staff were firmly on their side. In its absence the Company has become the dominant actor regarding safflower. When no independent fact-gathering on safflower is undertaken, not to mention proper research, farmers take risks as they adopt the new crop on an ad hoc basis.

This account of how safflower was introduced to Kondoa District is not reported as an administrative failure but as a reflection of the country's political reorientation and how a new regime in rural development has yet to find its institutions. The fact that the Kondoa Agricultural Office so comfortably entrusted a private company with the commanding role when a new crop was introduced into the district's farming landscape demonstrates how neoliberalism has become hegemonic both as a mode of thought and as political-economic practice. This is how we now understand the world (Harvey 2006: 145). In such a world, concepts like "popular participation" and "empowerment from below" take on qualities of Orwellian Newspeak.

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20 Land-claims

Racialized environmental struggles in Latin America

Susan Paulson

Since the European conquest of Latin America, mechanisms and justifications for unequal access to and control over natural resources have developed in tandem with racial ideologies and institutions. Conceiving race and racism as socio-cultural systems that evolve historically with and through the organization of human–environment relations, this chapter considers cases in which racism supported the expropriation of land from subordinate populations for purposes of colonial profit or national/capital development, together with recent cases in which resignified racial visions have been mobilized by non-dominant groups in struggles to "reclaim" land. Differential rights to and powers over land, and differential visions for land use, have been key in the construction of diverse racial identities, and in accompanying senses of entitlement, agency and political possibility.

A volume on ecology and power offers opportunities to provoke and contribute to more powerful and empowering conceptualizations of race and environment. This chapter brings insights from selected studies on land claims in Latin American contexts to conversations about relations among environmental formations, racial systems and political subjectivities.

Conceptualizing and seeing race

Drastically differing conceptualizations of race and racism are among factors that make it notoriously difficult to study, talk or write about race. The *American Anthropological Association Statement on Race* opens with the observation that, "In the United States both scholars and the general public have been conditioned to viewing human races as natural and separate divisions within the human species based on visible physical differences" (Smedley 1998), a view that locates the phenomena largely in human bodies. In contrast, critical scholars see race and racism as historically contingent socio-cultural institutions pervasively intertwined with colonialism, modernity and nationalism (Wade 2010; Omi and Winant 1986, 2009). Although discrimination and segregation of subordinated groups are commonly recognized as tangible evidence of racism, scholars increasingly identify the establishment of whiteness/Europeanness, with its incumbent privileges, as the common core of multiform and complex systems of racial categorization (Bonilla-Silva 2007; Rothenberg 2007; Weismantel 2001).

In this chapter I understand race and racism as socio-cultural and ideological systems that are different from (although always intersecting with) other forms of differentiation and ethnocentrism in two ways. First, race and racism are *historically specific phenomena* that developed and evolved in conjunction with European conquest of distant colonies and the rise of capitalism and modern nation-states starting in the sixteenth century, then evolved in diverse contexts. Second, racial ideologies are rooted in *biological* understandings of human difference that were consolidated through the logic and language of natural science in the nineteenth and twentieth centuries.

A less widely recognized aspect of race, and one which is vitally important here, is the extent to which the development of racial ideologies and systems has been driven by the appropriation and exploitation by White/European-identified people of land and other natural resources (minerals, forests, human bodies) that had been lived in and managed by other people. In an excellent discussion of recent research in Latin America, geographer Juanita Sundberg (2008) demonstrates ways in which racial thinking has worked with and through the natural environment to establish and justify unequal social relations at multiple and intersecting scales, and asks why so few scholars have paid attention to these vital articulations. Limitations stem on one side from the fact that "scholarship on race in Latin America has largely neglected the natural environment and how dominant visions of nature and appropriate human–land relations articulate with and inform racial hierarchies" (Sundberg 2008: 572), while limitations arise on the other side from the static way studies of natural-resource struggles have conceptualized race:

> This research sheds little light on how race articulates in and through environmental formations and vice versa … social groups are assigned coherent or taken-for-granted identities like "indigenous people" or "such and such ethnic group" *prior to* their entry into the politico-ecological relations in question.
>
> (Sundberg 2008: 572)

When environmental scholars as well as environmental justice movements take racial categories as givens, it is hard to advance Peter Wade's (2010: 43) idea that "race is not about biology, but about a constant movement between nature and culture, mediated by classifications of Others, based on histories of western colonialism and postcolonialism."

I address these conceptual limitations by thinking about racial expressions and experiences in Latin America that differ from more globally dominant ones. In the United States, racial identifications have often been portrayed as permanent essences of individual bodies, literally inscribed on birth certificates and medical records, and viewed as distinct from class and geographic identifications, which are seen as more contingent. In many Latin American contexts, in contrast, racial identification operates more flexibly and dynamically as bodies move through diverse biophysical and social environments and perform differently-coded practices, notably in relation to land. Telles (2004), for example, describes a Brazil where race is shifting and context-specific, and documents dimensions and mechanisms of discrimination often overlooked in more rigid schemes. Recognizing the extent to which ethnic and racial thinking and institutions intertwine and overlap, I follow other Latin Americanists in describing certain phenomena as "ethnoracial."

Insights that local conceptualizations bring to relations of race, land and power are evidenced in ecological anthropologist Benjamin Orlove's (1998: 207) study of racial distinction between two populations whose members are not discretely marked by inherited physical characteristics: "The racial identities of Indians and mestizos in a highland Peruvian region are closely associated with their relative positions to the earth. The agricultural Indians are closer to the earth and town-dwelling mestizos are further from it." Processes through which land-use practices are slowly built into one's body and then coded as racial characteristics are tangibly exemplified in feet, an important ethnoracial index across the Andes. Orlove writes that "mestizos tend toward footwear that prevents contact with the earth and that displays this lack of contact through its shininess; the Indians have footwear more open to the earth, when they wear shoes at all" (1998: 215). Thus an Indian life of toil in rough tire-tread sandals leads to flat, hardened, dirt-caked soles, which become biophysical evidence of non-whiteness.

In sum, contextual and flexible experiences and expressions of race in Latin America illuminate explorations of ways in which human bodies and environments influence each other with racialized meaning and power, and ways in which systems we call race, class, gender and urban–rural distinctions intersect and mutually constitute each other (Collaredo-Mansfeld 1998; Godoy *et al.* 2010; Wade 2008, 2010; Weismantel 2001). These analyses help us build understandings of ways in which dynamics of ecology and power constitute, and are influenced by, racial geographies and identities.

Colonial land-grab and the emergence of race

Starting in the sixteenth century, Europeans and their descendants practiced in Latin America what we now call "land-grab": they used force to take control of extensions of land in order to expand territorial holdings and broaden political-economic power. These land-grabs and related labor-grabs were racialized in various ways. Wolfe (2011) argues that territorial expropriation was foundational to the colonial formations into which Europeans incorporated American Indians, whereas colonizers' relations with transported Africans centered more on expropriation of labor; he interprets miscegenation policies as promoting assimilation to reduce an indigenous population with rival claims to the land, and strategies of racial exclusion and hypodescent as serving to enlarge enslaved labor forces. In a wide variety of arrangements, people of African and Native American descent were drawn into working the land in unprecedented ways: producing luxury foodstuffs and mining precious metals exported for landowners' profits.

Sundberg (2008: 573) writes that "the colonial system clearly privileged Europeans, who assumed rightful ownership of the bodies and labor of Indios as well as natural resources. This group also presumed to define 'appropriate' land use" and cites Jonathan Amith's (2005) book on transformation of space in southwestern Mexico during the late colonial period. Amith documents struggles over land, labor and capital that impacted geographic patterns, demonstrating that colonists' strategies to appropriate native lands involved racializing distinctions between what they represent as their own productive, rational, economic exploitation of land and the inferior and lazy land management practices on traditional agroforestry plots.

However, this is only part of the picture; in parts of Mexico and elsewhere, colonial legislation protected collective land rights of indigenous groups, allowing colonists to benefit by claiming tribute from those labeled "Indians" in exchange for the privilege of territorial autonomy, which allowed many indigenous communities to maintain significant degrees of cultural and political autonomy, notably in the realm of environmental management.

Racialized biopolitics intensified during the nineteenth century as neocolonial projects carved into these communal lands, harnessing local resources and bodies to produce profit for distant interests, in systems engineered and justified by increasingly powerful scientific arguments. Historian Sarah Chambers (2003) describes how elite appropriation of communal lands in Arequipa, Peru, during the first half of the nineteenth century contributed to a dis-identification with indigeneity, a trend which progressed until a dramatic about-turn in the late twentieth century. As it became increasingly difficult to pay racially based tribute, and less beneficial to identify as indigenous, people stopped doing so. "With the principal advantage of being an Indio disappearing, some individuals petitioned to have their identity legally changed to Spanish" (Chambers 2003: 35, cited in Sundberg 2008).

Building modern nations

Latin American leaders building modern nations advanced various strategies to create homogenous citizenry, ranging from biological "whitening" through policies to attract European immigrants (especially successful in Argentina) to cultural "whitening" through the promotion of European-identified clothing, language, education, religion and, of course, land management. Forced reorganization of land use was justified by notions that "backward" ethnoracial traits (notably traditional forms of land management) bind certain groups to primitive tradition and therefore underdevelopment.

Bolivia's 1952 revolution, mass enfranchisement and ensuing reform policies were explicitly couched as efforts to overcome racial exclusion and marginalization seen as barriers to modern development. These initiatives can be interpreted in (at least) two distinct ways: as working to make racism disappear, and as working to make racially marked communities disappear. Land reform helped do away with racial exploitation in hacienda arrangements that kept Indian peons in labor bondage, and it helped privatize communal holdings fundamental to many indigenous communities. While mid-twentieth century intellectuals and politicians described projects to promote improved bodily, homemaking and farming habits as relieving natives of their "backward" ways, Brooke Larson (2005) identifies them as efforts to transform Bolivia's unruly and heterogeneous Indians into uniform farm families. And while decisions to purge the word '*indio*' from all official communications and to promote class-based discourse and institutions in the place of ethnoracial ones can be read as attempts to eliminate racial discrimination, they can also be seen as a push to eliminate indigenous identification altogether.

In the mid-twentieth century, actors in various positions throughout Latin America predicted that indigenous identification would fade away as modern development created national citizens. Not only had governments tried hard to develop non-indigenous modern citizens, but after centuries in which individuals labeled "Indian" and "African" were legally, economically and socially discriminated, people found all kinds of ways to evade these identities. Many observers – from scholars to political leaders to *National Geographic* magazine – declared that "Indians were disappearing." Observing Bolivian life in the 1980s, anthropologist Thomas Abercrombie (1992: 96) wrote that,

> given their advantage in force, it is not surprising that aspects of the colonizers' value systems have become hegemonic, so that the stigma attached long ago by Europeans to "Indianness" has worked its way into "Indian" self-consciousness as well. Consequently, self-proclaimed Indians are exceedingly scarce.

Donna Van Cott (2003: 755) calculates that throughout the twentieth century, although the majority of the Bolivian population spoke indigenous languages as their mother tongue, no more than 2.7 percent of the populace ever voted for indigenous-identified political parties in a national election. The following section traces aspects of radical changes leading up to the 2005 election of indigenous-identified Evo Morales as president of Bolivia.

Reindigenized and reafricanized lands: "territories plus culture"

Struggles to reverse or resist colonial and neoliberal land-grabs have played a major role in the remarkable ascendancy of new forms of racial thinking and action working to empower actors and mobilize solidarity. For the past 20 years, Latin America has been shaken by environmental conflicts in which people engaged in struggles over land and natural resources explicitly identify themselves with African and/or indigenous heritage.

The 500th anniversary of the "discovery" of the Americas was celebrated with extraordinary protests for indigenous territory and dignity. In 1992, thousands of Amazonian residents walked to Quito, then camped for weeks in front of the governmental palace to demand legal recognition of ancestral territories of Quichua, Shiwiar and Achuar Nations. Lowland participants bore traditional spears, masks and head-dresses marking their Amazonian identity, and thousands of Andean Indians, heretofore organized in separate networks, joined the march and supported what would become an allied movement. In the following years, Ecuadorian protestors used their indigenously marked bodies to block bridges and roads, paralyzing the nation in protests over a Hydrocarbon Law and an Agrarian Development Law that tried to abolish communal holdings. The same year, Bolivians marched from the lowlands demanding rights to ancestral territories, and in 1994 indigenous women marched for sovereignty over their bodies, crops and fields in the Chapare, a militarized coca-growing region. In 2000 indigenous organizations joined with other sectors to drive out transnational investors in Cochabamba's famous "Water Wars," and in 2005 to abort a major sale of natural gas, forcing the resignation of two national presidents along the way. In the Peruvian Amazon nearly 1,000 Achuar arrived in boats and headdresses to occupy four oil wells in 2006. Faces streaked with paint and carrying hunting guns and ceremonial spears, they formed a peaceful blockade that shut down most of the region's oil production for two weeks.

Meanwhile, in Brazil, remarkable changes in political and legal conditions opened unprecedented possibilities for poor Brazilians to acquire land, and reconfigured relations between racial identity and land claims. With impressive economic growth and vast territorial resources, Brazil has garnered increasing political power in global arenas. Within the nation, however, formidable inequalities in the distribution of power correspond with poverty rates, human development indices, and income levels demonstrating that "the magnitudes of racial differences in Brazil are striking and highly statistically significant" (Gradín 2009: 1428), while land distribution is highly uneven across racialized groups (Avalos *et al.* 2008). Among diverse realms in which efforts are being made to achieve great racial justice, legislation on land redistribution is particularly relevant. Different parts of Brazil's 1988 constitution outlined routes to access land by landless, indigenous and African slave descendants – for example, the provision that "survivors of quilombo communities occupying their lands are recognized as definitive owners, and the State shall issue them titles to the land" (Linhares 2004: 818).

In contexts where identities and relations are shaped concurrently by race, class and location, various groups of people are engaging in struggles for land that involve self-identification and public labeling with explicit race or class categories. This process is demonstrated by cases of three rural communities in northeast Brazil who, until the 1980s, had been similar in their self-identification as mixed-race Brazilians. Then, in parallel processes relating to different legal mechanisms for land redistribution, one group embraced indigenous identity, a second emphasized descendancy from African slaves and a third connected with the class-based landless movement.

Following a long history of displacement, disease, religious conversion and sexual relations with Portuguese colonists and others, descendants of slaves and multiple indigenous groups were absorbed into rural missions or larger working populations throughout Brazil. Anthropologist Jan Hoffman French (2004: 663) observes that “until the 1970s, it was assumed that descendants of the indigenous inhabitants of the Brazilian Northeast had been assimilated into the local peasantry.” Indeed, the 2007 national census (IBGE 2008) shows that 63 percent of the residents of the northeastern state of Bahia identify as mixed race, 21 percent as white, leaving less than 16 percent to identify as black and less than 1 percent as indigenous.

In French’s (2004: 663) chronicle of “a successful struggle for indigenous identity and access to land by a group of mixed-race, visibly African-descended rural workers,” she argues that

> the upsurge of indigenous self-identification, illustrated by the people who would become the Xocó, is not just about (or not necessarily at all about) Indianness but is more fundamentally about political subjectivities forged in the struggle for land that, when tied to claims of indigenous identity, result in communities of likeness.
>
> (2004: 664)

Agreeing basically with French’s argument, I do think these land claims are on some levels about “Indianness,” or perhaps more accurately, being Indian in these contexts is about certain connections to the land, at least for actors like Apolonio, the former leader of Xocó Indians, who told French (2009: 123), “[when I learned I was an Indian] the emotional impact was very powerful, *because I was born and raised on the land*. Being a day labourer without education *working the land*, when suddenly I came to know that I was a person belonging to a community that had a past and that now we have a history” (my emphasis).

In a later study, French described how 90 families of landless rural workers became a modern-day *quilombo* (settlement of escaped slaves), gained title to more than 5,000 acres that had belonged to their former employers, and began to associate themselves with representations of an imagined African past:

> Motivated by new legal rights, access to land, and the possibility of improvements in their standard of living, residents of Mocambo had embarked on a campaign in 1993 to gain quilombo recognition (achieved in 1997), even though it would mean identification with a much-derided category associated with oppression and slavery – “negro.”
>
> (French 2006: 341)

These cases cast light on things I have seen and heard over the past decade during yearly visits with a squatter community living among remnants of the Atlantic Forest along Brazil’s northeastern coast. The cluster of homes known as K25 (located 25 km from Itubera along a dirt road) has for some 50–60 years been inhabited by landless people who work on nearby plantations. In 1997 a group of families invaded sections of abandoned/uncultivated land nearby and collaboratively navigated Brazil’s agrarian reform system to secure tentative claims to their plots (Paulson and DeVore 2006; Paulson forthcoming).

Hundreds of thousands of Brazilians have gained access to land in similar ways over the last two decades, thanks to processes of organization and solidarity surrounding the class-based identity "landless." Brazil's Landless Workers Movement, in Portuguese *Movimento dos Trabalhadores Rurais Sem Terra* (MST), is the largest social movement in Latin America, with an estimated 1.5 million members. In addition to pushing for more redistributive reforms and organizing large-scale invasions of "unproductive" property, the movement has inspired a wide range of squatter settlements and identities, ranging from well-organized cooperative agricultural enterprises to scenes of disorganized hunger and desolation.

What role do class and ethnoracial identifications play in these land claims? Residents of K25 do not seem to organize themselves into named racial categories, yet, like the Xocó "Indian" quoted above, residents' conversations about land and labor are rich with racial meanings. Following numerous similar conversations with Luiz, who worked for decades as a plantation laborer before squatting on a plot of land that he now owns and cultivates, I wrote down some observations he made in 2009:

> When I worked on the plantation I was a slave (*eu era um escravo*). I did not have control over my body or my labor. I had to work morning to night like a black man. Now that I work my own land I am free.

Like his neighbors, Luiz experiences control of land as vital to his current identification as "free man," and lack of land as constitutive of his former identification as "slave" or "black man." By calling up images of slavery vs. freedom, subjugation vs. sovereignty, hunger vs. satiety, Luiz and his neighbors connect bodily sensations of labor in the fields and food in the belly to a cultural/historical field of racialized land–labor relations (Paulson forthcoming).

The astounding emergence of collective ethnoracial identities and related land claims in Latin America has been influenced, and has influenced, an eruption of global concerns and discourses about land conservation, about biodiversity, and about cultural or ethnic diversity (Escobar and Paulson 2005). In a long-term study in the Pacific rainforest of Colombia, Arturo Escobar (2008) follows the emergence of racial identification and environmental activism among people who now identify as Afro-Colombians, highlighting their articulation of an alternative conceptualization of biodiversity as "territory plus culture," understood in this context as dynamic cultural/natural spaces and life corridors associated with riverine production systems.

Rudi Colloredo-Mansfeld (1998: 188) observed that

> the co-existence of racial beliefs with ethnic activism impacts Ecuador's native political movements, and indeed, has parallels to similar movements in Chiapas and elsewhere in Latin America. The mass indigenous mobilizations this decade have used indigenous culture as a political resource to press claims for land and challenge the values of national society.

In light of the twentieth-century initiatives discussed above that targeted racial differences and local land management practices as impediments to modern development, I argue, together with French (2009: 123), that certain assertions of ethnoracial identity and solidarity seem to be advancing goals of equity in Latin American development and natural resource management.

Power, race and ecology at the dawn of the twenty-first century

Yet agreement on this point is far from universal, as clashes continue to escalate between groups with different power bases, whose land claims are racialized in newer and in older ways. First, not everyone is enthusiastic about the new wave of political mobilization in which indigenous and afro identities develop in tandem with struggles for land and environmental justice. The title of a widely circulated 2006 article by Mario Vargas Llosa (2010 Nobel Prize winner in literature) warns: “A new racism has emerged in the region: Indians against whites. With Evo Morales, Ollanta Humala y Hugo Chavez, race has become ideology.” Although I share his concern about any use of racial thinking in political agency and action, I do wonder what Vargas Llosa thought race was *before* contemporary movements turned it into an ideology?

Second, assaults on non-dominant and racially identified land management practices continue, in some contexts intensifying, in the context of privatization of natural resources, expansion of corporate agriculture and capitalist exploitation of so-called “empty” lands. Describing a violent clash in the Peruvian Amazon in 2009, Barrera-Hernández (2009) reports that President Alan García used a Peru–United States free-trade agreement popular among urban voters as a pretext to implement an agenda aimed at opening a vast area of the Peruvian Amazon to development, making it easier for private investors to acquire and exploit lands inhabited by indigenous populations. Months of bitter conflict resulted in confrontations leading to over 50 deaths. Ironically, initiatives to conserve Latin American lands have also exercised racial discrimination (Sundberg 2004; Escobar 1997).

Today, some camps characterize racially identified populations as barriers to modern land development or to conservation, while others see them as inspirations for sustainable development and land management. From above-mentioned colonial characterizations of native land management as derelict and unproductive (Amith 2005) to contemporary judgment of certain indigenous land practices as not useful for larger society (Mentore 2007: 65), indigenous people have long been cast as closer to nature in ways that exclude or marginalize them from modern development of the territory. In parallel processes, environmental movements and indigenous movements alike have mobilized strategic essentialisms, representing indigenous people as “natural” land-managers, inherently close to nature, with which they live in harmony.

Conclusion

Claims for land have been racialized in many ways over the previous 500 years, making race a formidable force in shaping Latin American landscapes and identities. Ideologies and technologies of race emerged amid European colonial efforts to organize and justify the appropriation of land and other resources, and evolved via efforts to develop modern nations with homogenous European-like citizens, and to expand production of wealth under neoliberal political economic regimes. At the dawn of the twenty-first century, as diverse actors employ their bodies in land occupations, road blocks and cross-country marches, demanding sovereignty over land and related resources, they revitalize and re-signify racial categories in opposition to colonial and national ordering of territory, and in conscious rejection of dominant approaches and policies.

These examples, selected from a range of geographical and historical contexts, illustrate some of the ways in which access to and control of land has been organized and justified through racial thinking and mechanisms, and how access and relations to land has shaped racial identities. I present this material with the goal of prompting some rethinking of notions of race and environment in order to better grasp mutually constructive relationships among them.

It is important to emphasize that the concepts and practices of race explored in this chapter represent only some of the approaches at play in Latin America. In Brazil, for example, some traction has been gained recently by initiatives to push a type of racial self-labeling in which people with any African ancestry should self-identify as "*negro*" in the interests of political solidarity and affirmative action (Pagano 2006). In his aptly titled article, *Girl, You are Not Morena. We are Negras!*, Michael Baran (2007: 383) recounts that

> in 2003, teachers at the municipal high school in Belmonte, Brazil, began presenting students with a radically different ideology about racial categorization: an essentialized ideology that defines anyone not "purely" *branco* (white) as *negro* (black). This system of categorization conflicts with popular belief in a mixed-race *moreno* identity.

Without pretending to assess the range of identity politics and strategic essentialisms expressed across the Americas, or the range of scholarship examining these phenomena, I venture to warn that trends toward labeling that fix race in discrete bodies tend to draw attention away from mutually influencing relationships between race and environment. That is exactly why, over more than a century, scholarship about race and scholarship about land have had little to say to each other. This chapter makes the case that notions of race and racism that are social and historical rather than individual and genetic, and that encompass political economic and ecological actions and relations, empower us to be more conscious of how we make race and landscapes via our historical choices and actions, including the concepts we use to research and write.

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21 Smoke

Cooking, coughing and collective action in Kenya

Anne Jerneck and Lennart Olsson

It is dark and smoky inside. She is squatting on the mud floor, stirring the porridge in the pot over an open fire encased by three stones. As a young mother she spends hours every day in her windowless kitchen preparing the ingredients and cooking all the meals for the household while tending to the baby strapped on her back. Silently they endure the smoke. It irritates their eyes and creeps into their lungs while the mother cooks, day after day.

Owing to its small lungs, the little child needs to breathe faster than her mother, thus risking more extensive inflammation from inhaling the smoky air, which may cause serious damage to its immune system (Warwick and Doig 2004) or even a fatal acute lower respiratory infection such as pneumonia (WHO 2002). Obviously, the smoke from cooking and heating causes huge individual discomfort and suffering, posing a severe public health problem, not least for infants and children who, in absorbing more pollutants and retaining them longer, risk their lives (Budds *et al.* 2001). In 1984, respiratory disease was the main cause of death in many countries. In 2010 the main killer in low-income countries was a communicable disease like HIV, malaria or diarrhoea (WHO 2010b), but every year between 1.6 and 1.8 million people die of respiratory diseases caused by indoor air pollution (IAP) from cooking over open fires. The majority of the victims are women and children (WHO 2002).

This chapter, based on several field visits in 12 villages in western Kenya between 2007 and 2010 (Olsson and Jerneck 2010), suggests means of combating IAP triggered by smoke from cooking stoves in sub-Saharan Africa. We relate a neglected disease to the wider context and search for solutions that offer natural and social benefits as well as synergies at local to global scales. In so doing we view power as entailing agency, intentionality and direction, following a definition of power as ‘the ability of actors to mobilize resources to achieve a certain goal’ (Avelino and Rotmans 2009).

Across the global South, most people who are poor, and even some who are not so poor, cook over open fires, often indoors and on a simple stove in the shape of three stones. Combustion of solid fuels for cooking over an open fire takes place in often poorly ventilated kitchens, mainly in rural households but also in some urban and peri-urban areas, where it creates complex interactions between indoor and outdoor pollutants that affect the stove users as well as other city-dwellers.

Although the proportion is difficult to estimate, roughly every second or third household in the world uses solid fuels like wood, dung, coal and agricultural residues for everyday cooking and heating. In addition, it is estimated that a further 200 million people will rely on biomass for cooking and heating by 2030 (Warwick and Doig 2004). If you belong to that half of the global population who cooks comfortably on gas or electricity, it may be hard to imagine that the other half uses low-grade fuels on simple stoves associated with dire health hazards.

Despite the discomfort and health hazards caused by indoor cooking, it may still be preferred to outdoor cooking because it offers privacy and safety, including protection from animals, dirt and theft, as well as shelter from wind, rain, cold, heat and a scorching sun. Cooks need a special place for cooking, sheltered from problems other than smoke.

Diffusion of modern technology contributes to transforming production, services and social relations, but the kitchen domain located at the very heart of the reproductive sphere is in many parts of the global South ruled by an ancient order. This is women's space, where technological change is slow or neglected, as observed by Boserup (1970), who saw few sparks of innovation and improvement in areas dominated by female labour and responsibility.

This illustrates how technology is linked not only to micro-processes in women's everyday lives, but also to social processes in the community and society at large. Gendered reproductive work, like hazardous smoky indoor cooking, must therefore be studied as embedded in deeper social relations and structures, including gender regimes, gendered labour divisions and other hidden forms of dominance within and beyond the local and regional context (Lim and Tinker 1990). The personal and private spheres must thus be examined in relation to the public sphere (Elson 2000).

Responses to suffering

The fight against smoke has been long and varied, with motives for technology improvement ranging from increased energy efficiency and decreased deforestation to the alleviation of women's workload and the reduction of greenhouse gas emissions. As regards energy saving, women, being the managers of heavy and time-consuming biomass collection, have developed fuel-efficient cooking practices (Clancy *et al.* 2003). Regarding health, researchers reported already in the 1970s and 1980s that cooking over open fire yields high emissions of certain respirable particulates and dangerous pollutants, causing chronic obstructive lung diseases like bronchitis (Reid *et al.* 1986). Recently, research and development initiatives have focused specifically on health hazards for women and children who are exposed to dangerous gases, particles and compounds, which may cause diseases such as asthma, cataracts, chronic obstructive pulmonary disease, lung cancer, pneumonia and tuberculosis, as well as lower birth weight for infants (Smith *et al.* 2000; Ezzati and Kammen 2002; WHO 2002).

In India in the 1940s, Gandhi initiated dissemination programmes for cooking stoves with flue pipes that would reduce the smoke from indoor cooking over open fire. In the 1970s, concerns about deforestation and the excessive time rural people spent on fuel gathering triggered programmes for more fuel-efficient cooking stoves, mainly in South Asia (Eckholm 1975). In the 1980s this was followed by more scientifically based programmes that attempted to measure both smokiness and energy efficiency with the support of international aid organizations that intervened mainly in Asian countries, including China, India, Nepal and Sri Lanka (Reid *et al.* 1986). In the 1990s, the World Bank recognized that improved stoves can generate economic, environmental and social benefits (Barnes *et al.* 1994).

Given the prevailing gendered division between productive and reproductive labour, it can be argued that the provision of improved cooking stoves and smoke-free kitchens would constitute a synergy between several Millennium Development Goals (MDGs), ranging from reduced infant mortality and enhanced gender equality to forest preservation, environmental sustainability and emissions reductions (Warwick and Doig 2004). A successful technological shift in cooking equipment would address five of the eight MDGs directly by lowering the health hazards for children and mothers, improving gender equality, reducing deforestation and mitigating global climate change (MDG 3–7). Indirectly, it is argued (ibid.), it would also promote the MDGs on poverty reduction (MDG 1) and primary education (MDG 2), when women's and children's time spent on firewood collection is redirected towards school attendance (for children) and income generation and food-securing activities (for women).

For various reasons, very little progress is being made in sub-Saharan Africa towards any lasting improvement of the widespread indoor cooking practices, despite the health hazards associated with IAP and the benefits of broad initiatives that address the multiple problems of traditional stoves, including high disease burden, heavy workload, low fuel efficiency, rapid deforestation and high aggregated emissions. Given the many synergies, it is thus difficult to explain why smoke-free kitchens are not more readily available.

Social injustice

Other measurable inequalities aside, such as variation in life expectancy or income, the consequences of cooking divides the world into the rich versus the poor, who rely on outdated technology. Among the poor, there is a further division of men versus women and children, who are exposed to the smoky air in poorly ventilated kitchens for several hours a day (WHO 2002). We therefore argue that the intersectional inequality of IAP – linked to age, class, gender and place – is an easily identifiable, measurable, spatially localized and thus highly visible social injustice. On the other hand, cooking, including manual biomass collection, is generally performed by unpaid women and children in the informal economy and thus falls outside national accounts of labour and energy, which makes it an invisible activity with high risks of attracting neglected diseases (Warwick and Doig 2004).

If up to two million people die every year from respiratory diseases caused by indoor air pollution from cooking over open fire, a majority of which are women and children, deaths from IAP represent a clear illustration of structural and environmental injustice. Despite the magnitude of the health issue of IAP and its consequential injustices, it receives very little global attention in terms of policy, funding, interventions and implementation. In fact, indoor air pollution is one of the most neglected problems in the global South, even though it is persistent and kills twice as many people annually as malaria (WHO 2010). While the international community reacts strongly to global health challenges caused by the three big epidemic diseases of HIV/AIDS, malaria and tuberculosis, as well as to the social and gendered risk of maternal mortality – as seen in the joint initiative on reproductive health by the UNDP, UNFPA, WB and WHO (WHO 2009) – there is no global initiative to address IAP.

The inability to deal with IAP is thus perhaps the biggest global and gendered health failure ever, comparable only to the 500,000 annual maternal deaths (Ronsmans and Graham 2006). The concerns of health-hazardous indoor cooking over open fire entails three types of inequality (Jerneck *et al.* 2010): (1) international inequality, as it afflicts the global South; (2) intersectional inequality, as it is overwhelmingly performed by rural women; and (3) intergenerational inequality, as it entails huge risks for the infants and children whose mothers (performing another gendered reproductive task) mind their offspring while cooking.

New players

It is obvious that IAP from indoor cooking over open fire is associated with a severe health hazard causing a high disease burden, disability, economic stress, premature deaths and intersectional inequalities. Accordingly, IAP ought to be a global health priority. Although there has been a surge lately in the funding for neglected diseases (Moran 2005), the only comprehensive study on funding for such diseases reports that the three big epidemics of HIV/AIDS, malaria and tuberculosis receive 80 per cent of all global funding for neglected diseases with funding dominated by the US Institute of Health (42 per cent) and the Bill and Melinda Gates Foundation (18 per cent). A scrutiny of global health policies further indicates strong shifts from state actors to private actors (Ollila 2005; Prah-Ruger 2007), from health agencies to financial actors (Koivusalo 1999), from comprehensive health care to a focus on specific diseases (Ollila 2005) and finally an increasing dominance of the United States as a major player in global health policy and funding, drawing on both public and private funds (Kickbusch 2002).

While the United States may thus be a dominant player in global health, the WHO has the global mandate to act as the leading international organization in the field. The importance of the WHO arises not only from its large funding volume, but also from its normative role and global reach, supposed to cover all aspects of human physical and mental health (Stuckler *et al.* 2008). Yet, the allocation of WHO funds tells an interesting story about global health priorities. The WHO has two main funding streams, the regular funding from member countries and the extra-budgetary funding from various countries and organizations. The allocation of the regular funds is determined collectively by the WHO general assembly, while the allocation of the extra-budgetary funds is determined by donor preferences. As seen in Table 21.1, there is an important difference in how the regular as compared to the extra-budgetary funds are used. The allocation of the regular budget is already off-balance compared to the global burden of disease, but the allocation of extra-budgetary funds is extremely skewed towards communicable diseases and specific disease-control programmes, making the overall balance unacceptable (Lopez 2008). The fact that the extra-budget funding in the fiscal year 2008–2009 was three times larger (US$2.95 billion) than the regular budget (US$0.95 billion) (WHO 2010a) aggravates the situation.

Taken together, the conditions determining the sourcing and the allocation of global health funds clearly indicate, and perhaps partly explain, the lack of global initiatives for tackling IAP as a driver of the disease burden caused by smoke from cooking.

The changing funding arrangements can be seen as indicative of a shift away from the high ambition to offer comprehensive public health care towards a narrow focus on curing particular diseases in line with the interest of large private corporations. From a corporate perspective, it can be argued that the sale of pharmaceuticals for curing diseases is potentially much more profitable than preventing ill-health, when millions, even billions, of people become potential customers in the expanding global pharmaceutical market. This condition is probably an important driver behind the mentioned shifts in global health policies and may partly explain why the prevention of respiratory diseases caused by IAP is not a global health policy priority.

In the case of smoke, there are no easily identifiable commercial benefits from preventing respiratory diseases through the promotion of smokeless cooking.

Table 21.1 The WHO allocation of funds in relation to the global burden of disease

	Global burden of disease expressed as percentage of disability-adjusted life years	*WHO funding, regular budget (2006–2007) (%)*	*WHO funding, extra-budgetary (2006–2007) (%)*
Communicable diseases	41	68	91
Non-communicable diseases (including respiratory diseases due to smoke)	47	31	8
Injuries	12	1	1

Source: (WHO 2010a).

Smoke is primarily an issue in rural and semi-urban areas where people who are poor spend little money in the market. In the absence of a large corporate beneficiary who could reap the benefits of developing or distributing improved cooking stoves, global initiatives such as those for HIV/AIDS, malaria and tuberculosis are unlikely to emerge. This calls for alternative approaches, especially in places where women have less access to credit, information, land and other resources than men, which causes inherent gender inequalities in the market.

Local synergies

On an aggregated level the carbon emissions from indoor cooking warm the atmosphere at regional and global scales (Ramanathan and Carmichael 2008). Synergetic solutions should therefore engage with local issues of ill-health, deforestation and poverty while mitigating global climate change, thus seeking individual/local as well as public/global benefits (Olsson and Jerneck 2010).

From the local outlook of poor peasant farmers, switching to another technology based on a cleaner and higher-quality fuel is unfortunately not a real option, owing to high market prices of the necessary equipment, let alone costly fuels (liquid gas, kerosene) or electricity. A more affordable option is to offer improved cooking stoves equipped with a flue pipe that removes the smoke from the kitchen while creating ancillary benefits such as increased energy efficiency along with reductions in everything from deforestation to the discomforts and dangers of inhaling smoke and collecting firewood. The provision of smoke-free kitchens to poor households could thus potentially create profound synergies across social, natural and economic domains (Olsson and Jerneck 2010).

With regard to the social domain, the reduced amount of time needed for firewood collection would lead to increasing opportunities for children and youth to attend school or engage in other activities. For adults, the time saved could be used for personal development, skills, leisure or community interaction. Regarding environmental benefits, a lower demand for wood fuel would decrease deforestation and increase biodiversity. Where crop residues or animal dung is used as fuel for cooking, there would be increased crop yields, since these substances can be used as fertilizers. Improved vegetation status in turn reduces vulnerability to extreme climate events, such as floods, and can lead to increased sequestration of carbon in ecosystems. Increased fuel efficiency would also imply reduced emissions of greenhouse gases, an issue that is often overlooked, as people who are poor are rarely recognized as significant emitters of greenhouse gases. Regarding the economic domain, more time can be spent on other livelihood tasks such as tending to agriculture and creating new income opportunities. Importantly, the impairment of women's working ability would be reduced, as would expenditures on clinical visits, check-ups (including expensive lung X-rays) and medicine. On the other hand, there is of course a risk that a time-saving new technology may exert additional demands on women to perform other labour-intensive tasks (Beneira 2003).

Global synergies

Smoke in the form of black carbon (soot) ranks as the second or third most important contributor to climate change, with a global warming potential several magnitudes stronger than CO_2 (Bond and Sun 2005). As an aerosol, smoke also has global climate impacts as well as important regional climate effects on precipitation (Rotstayn and Lohmann 2002) and temperature in the form of heat waves (Stott *et al.* 2004; Tressol *et al.* 2008). In addition, smoke may influence regional air quality and cause health problems. Reducing the emissions of smoke would have immediate effects on both global and regional climate patterns, in contrast to reducing CO_2 emissions, which takes many decades before it has any effect (Grieshop *et al.* 2009). Synergetic benefits of smoke reduction can thus be seen at the global and regional level.

The international climate change regime contains a number of mechanisms for the provision of clean energy, particularly the Clean Development Mechanism (CDM). Paradoxically, however, the CDM covers no such straightforward activity as the provision of smoke-free cooking stoves for the poorest of the poor. This is unfortunate, because people who are poor emit, in total, substantial amounts of greenhouse gases through wood combustion (Olsson and Jerneck 2010). Wood fuel is a renewable source of energy, but whenever the consumption of wood is greater than the regrowth of trees and bushes, there is a net emission of greenhouse gases.

This means that people, mainly women, who cook over open fire can play an important role in altering the emissions by shifting from being passive victims to using their transformative agency to become active participants in fighting global climate change (Olsson and Jerneck 2010). For poor peasant farmers, an improved cooking stove is a relatively inexpensive investment, implying very little sacrifice in terms of reduced consumption, but guaranteeing several positive local changes as well as globally reduced greenhouse gas emissions.

Collective action

Globalization is increasing expectations on social equality (Beck 2010). This reinforces the obligation to forcefully address the smoke problem and its dire consequences. While waiting for top-down initiatives and policies in global health that can tackle IAP as a serious disease affecting mainly the poorest of the poor, we refer here to an example of how small communities in western Kenya can be engaged in collective action for treating aspects of the smoke problem through the design, manufacture and distribution of smoke-free kitchens (Olsson and Jerneck 2010).

The initiative draws on the skills of community members and is designed as an attempt to create a local community of practice (Wenger *et al.* 2007) in the form of a business chain based on cooperation and trust among committed members. In this chain a potter crafts the clay stoves, a tin-smith assembles the flue pipes through riveting and a community entrepreneur provides credits in a revolving fund as well as facilitation in the form of demonstrating the new technology and installing and transporting new equipment to customers and users. While the literature underlines that lasting solutions for smokeless kitchens depend upon 'the active participation of those at risk, poor women' (Warwick and Doig 2004), we underline that sustainable and gender-sensitive solutions need to involve both men and women as active participants. In addition, and as far as households are gendered spaces where men and women have structurally conflicting interests, intra-household gender relations including gender coding of work and responsibilities need to be considered (Sen 1995).

From an intersectional perspective, people experience multifaceted realities and identities even in a context where everyone is exposed to the same double pressure of poverty and environmental change. It is therefore wise to avoid universalizing experiences based on gender. Yet, the collection of water and firewood for the preparation and cooking of food constitute a suite of reproductive tasks shared by many women and children across the global South. This gendered division of labour is deeply historically inscribed in social organization and gender regimes (Elson 1991). Empirically, it is enacted when women carry out sequences of gender-coded activities in reproductive work flowing from conventional roles in the local context.

A gender-sensitive approach to IAP would underline the social injustice of a gendered division of labour that ascribes most unpaid reproductive work to women. It would also highlight the gendered inequality in life expectancy and life opportunities caused by women's higher exposure to dangerous particles in smoky kitchens as well as the social incapacity to replace traditional with improved cooking stoves, despite the availability of alternative technologies. Importantly, it would also seek gender-informed solutions to the problem despite possible initial resistance.

Stoves and symbolic circles in Kenya

In our experiments in Kenya we found social change to be more profound and consistent when we involved women and men as well as female and male skills in interventions for improved stoves and smokeless kitchens (Olsson and Jerneck 2010). Both men and women discussed the design and construction of improved stoves and took part in the production, distribution, installation and demonstration. In order to explicitly involve men in our experiments we reclassified the kitchen from a cooking area into an experimental arena for smokeless cooking on improved stoves with flue pipes. By performing their conventional labour repertoire as carpenters and masons building the kitchen, and as tinsmiths for riveting and installing the new cooking stoves with flue pipes, men were involved in, and acknowledged the very conditions of, cooking.

The shared experience of constructing and introducing improved stoves and smokeless kitchens in a gender-mixed community of practice created a certain ambiguity in relation to cooking and indoor air pollution that built on, but also challenged, traditional gender identities. Finally, both men and women began to value and understand the long-term implications of a smoke-free cooking environment. A new ‘symbolic circle’ (Strauss 1959) could thus be drawn around the generally female reproductive task of cooking over open fire and the mainly female suffering of respiratory disease. Not only was the kitchen reframed, from having been viewed merely as a woman’s cooking space into a gender-neutral experimental arena, but the improved cooking stoves were reframed from mainly serving the purpose of energy and time efficiency in female food preparation towards an issue of improved health status for community members that would benefit everyone, although women and children, having suffered more, would benefit relatively more. The very reframing of production and reproduction in subsistence farming can thus, if performed as a joint activity in the community, be a forceful tool for problem definition and resolution.

In principle, interventions as part of transdisciplinary research and knowledge production show that social learning emerging from experiments may spill over into a new community of practice dealing with other challenges. Water scarcity represents such a challenge in an unequal world where one billion people have limited access to clean water for their daily needs and survival. Again, household water provision is considered to be women’s domain. Water-harvesting experiments with water tanks show that solutions can be designed locally and distributed in similar networks. When men also get involved in the design of the water-storing equipment and come to realize that a shared responsibility for water entails shared benefits, a new symbolic circle can be created also around water.

Conclusion

It is evident that smoke is a multidimensional problem with serious short- and long-term consequences for billions of people. The impact is both direct (through inhalation) and indirect (through interference with the regional and global climate). What may thus initially be considered an individual woman’s and her baby’s personal suffering should be understood as a structural problem that needs multilevel resolutions with multiple benefits.

We have showed that although the problem of dangerous indoor pollution from cooking and heating exists in many different and varied local contexts, there are simple yet general technical and social solutions. Moreover, the solutions may contribute widely shared local to global benefits like improved living conditions for people who are poor and climate change mitigation for the global community. Yet, we argue that global initiatives delivering such solutions are unlikely to emerge within the international global health regime due to its increasingly commercial orientation. Further, although the process of identifying solutions through transdisciplinary knowledge production is necessary, it is not sufficient, not even in a context of high social learning like this one, because implementation needs much encouragement and stimulation through various, not only financial, forms of support.

Consequently, we argue for scientifically informed and supported collective action in the form of communities of practice aimed at creating local markets and social arrangements that incorporate context-specific social relations, skills and preferences as a basis for installing, using and understanding the multiple benefits of smokeless kitchens. This is a way forward for promoting local to global sustainability with intersectional awareness.

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22 Sugarcane

Agrofuels and conflicting land uses in Brazil

Kenneth Hermele

Biomass energy only accounts for a small share of global energy use, about 10 per cent. Most of this is derived from firewood and charcoal. The part of the biomass that is set aside for liquid fuels is so small that it hardly shows in the statistics – 1–2 per cent of the global energy supply (FAO 2008). Nevertheless, the fast growth of agrofuel feedstocks from these low levels has been much debated in recent times, and a number of factors have pushed the issue to the forefront: a perceived need to reduce the dependence upon oil-exporting countries, the environmental concern to find a substitute for fossil fuels, and the wish to prepare for the imminent reduction of oil production.

Agrofuels as geopolitics

In 2001 global ethanol production was 19 billion litres, while in 2008 global output surpassed 60 billion litres, a three-fold increase in less than a decade (Farinelli *et al.* 2009). Behind this unprecedented increase we find basically only two producing countries, Brazil and the United States.

In the mid-1970s, the Brazilian government initiated a large-scale ethanol production programme called Pro-Álcool, to increase Brazilian energy autonomy in the face of the oil price hikes of 1973–1974. The feedstock was sugarcane, and the choice was made easy by a decline in world sugar prices. The first phase of Brazilian agrofuel policy in order to substitute ethanol for gasoline almost came to a halt in the late 1980s/early 1990s, when the price of oil fell while sugar prices simultaneously soared. As Brazilian car owners had been subsidized to purchase cars that only ran on ethanol – by 1988, 80 per cent of the car fleet was "ethanol only" – a crisis followed when ethanol became expensive and scarce (Bekunda *et al.* 2009).

This could have been the end of the ProÁlcool programme, but the impasse was resolved by still more policy support: mandatory blending was strengthened in 1993, requiring 22 per cent ethanol (E22). Flex-fuel vehicles have come to dominate the Brazilian vehicle market, currently covering about 80 per cent of the vehicle fleet, and the share will go on growing as today ten times as many flex-fuel as gasoline cars are sold. In addition, tax discounts were applied to agrofuels (making them more competitive as compared to fossil-based gasoline and diesel). Against this background, it is not surprising that approximately half of Brazil's transport needs are covered by domestic ethanol production.

The US government decided on mandatory blending of ethanol much later than in Brazil and opted for a blending requirement of only 2 per cent ethanol in 1990. More importantly, in the Renewable Fuels Standard of the Energy Policy Act of 2005, the US government mandated the use of minimum *volumes* of ethanol to be mixed with gasoline; subsequently, the US Energy Independence and Security Act of 2007 doubled the volume to a staggering 136 billion litres by 2022, twice the *global* production today. One outcome of such mandating of volumes may in fact be that the United States will be substituting the imports of feedstocks (or agrofuels) for today's imports of oil. Hence, the United States may end up exchanging one insecure source of energy for another equally insecure source.

But the interest in agrofuels is equally important to a wide array of importing countries, as blending requirements have spread (see Table 22.1).

Table 22.1 Agrofuel blending mandates 2009

Country	*Mandate*
Australia	E2 in New South Wales, increasing to E10 by 2011; E5 in Queensland by 2010
Argentina	E5 and B5 by 2010
Brazil	E22 to E25 existing and B5 by 2010
Canada	E5 by 2010 and B2 by 2012
China	E10 in nine provinces
Colombia	E10 and B10 existing
Dominican Republic	E15 and B2 by 2015
EU	E5.75 by 2010, E10 and B10 by 2020
Germany	E5.25 and B5.25 in 2009; E6.25 and B6.25 by 2014
India	E5 by 2008 and E20 by 2018; E10 in 13 states/territories
Italy	E1 and B1
Jamaica	E10 by 2009
Malaysia	B5 by 2008
Paraguay	B1 by 2007, B3 by 2008 and B5 by 2009; E18 (or higher) existing
Peru	B2 in 2009; B5 by 2011; E7.8 by 2010
Philippines	B1 and E5 by 2008; B2 and E10 by 2011
South Africa	E8–E10 and B2–B5 (proposed)
South Korea	B3 by 2012
Thailand	E10 by 2007 and B10 by 2012; 3 per cent biodiesel share by 2011
United Kingdom	E2.5/B2.5 by 2008; E5/B5 by 2010
United States	Nationally: 136 billion litres/year by 2022; E10 in Iowa, Hawaii, Missouri, and Montana; E20 in Minnesota; B5 in New Mexico; E2 and B2 in Louisiana and Washington State; 3.4 billion litres/year agrofuels by 2017 in Pennsylvania
Uruguay	E5 by 2014; B2 from 2008–2011 and B5 by 2012

Sources: REN 21 2009: Table R 12; EU 2008

Note: E = ethanol, B = biodiesel. E5 = 5 per cent ethanol blend, B2 = 2 per cent biodiesel blend.

By 2007, the production of liquid agrofuels had been concentrated to three producers: Brazil (42 per cent of global ethanol production), USA (46 per cent of ethanol and 13 per cent of biodiesel) and the EU (75 per cent of global biodiesel production, mostly in Germany) (World Bank 2008). Simultaneously with this development, global trade in agrofuels almost quintupled, from 1.5 to 7.1 billion litres from 1997 to 2007.

The crucial role of government policy

There is more to agrofuel politics than blending requirements, however, and governments intervene in a number of areas, such as production support, including favourable tax rules, and consumption subsidies, including for multi-fuel vehicles (Dufey 2006). State support also encourages domestic producers via customs duties, including tariff escalation (where raw material imports are free or only lightly protected, while the final product is taxed considerably).

In the EU, such protection of agrofuels is 2–6 times higher than the average protection of agriculture.[1] This situation is the rule in the North; a survey of importing countries' policies concludes that agrofuel exporters face tariffs that add up to 25 per cent of the price of their products in the United States, and up to over 50 per cent in the EU (Steenblik 2007: 2).

The global trade rules of the World Trade Organization have little to say in this regard, and what little there is, unfortunately, is confusing. A complicating factor is that the WTO classifies ethanol as an agricultural product, while biodiesel is considered to be an industrial good, thus applying different rules and agreements to the two agrofuels (UNCTAD 2006).

In fact, the WTO has not even managed to establish whether it considers agrofuels to be "environmental goods" or not (which may not be a bad thing, though, as will become evident when I subsequently discuss the ecological impact of agrofuels). However, if agrofuels were classified as environmental goods, the protective policies of the North will be subjected to stronger criticism, since the WTO Doha declaration already in 2003 declared that it wanted to see "the reduction or, as appropriate, elimination of tariff and non-tariff barriers to environmental goods and services" (Doha Development Agenda, Article 31 (iii); see UNCTAD 2006). The Doha agenda seems designed to constrain countries of the North from protecting their home market from the imports of competing environmental goods from the South. Brazilian exporters may be penalized by 25 per cent tariffs on the US market and by as much as 50 per cent when exporting to the EU; similarly, some countries' excise rules offer exemptions for locally produced agrofuels – but not for imports – which may constitute the most decisive support (FAO 2009; Steenblik 2007).

Illegal or not, such policies are inconsistent with the blending requirements that have been established, as those objectives will not be met without considerable imports, primarily from producing countries in Latin America and Asia. On the other hand, the level of protectionism may not be as severe as it may seem, as the EU as well as the USA have entered trade agreements with low-income and least-developed countries that exempt them from regulations that affect middle-income countries. In the case of the EU, 75 per cent of agrofuel imports take place under various preferential agreements, e.g. the Generalized System of Preferences, the Economic Partnership Agreements, the Everything But Arms Initiative; similar rules apply to US imports from the Caribbean and Central American region (Farinelli *et al.* 2009: S10–11).

Agrofuels as climate policy

Although ethanol production, as we have seen, did not originate as a tool for climate policy but rather for geopolitical reasons, agrofuels have nevertheless surfaced during the last few years as a solution to climate change, and the alleged benefits in terms of reduced greenhouse gas emissions (GHG) have certainly been one of the contributing forces for the mandatory blending requirements that have been introduced in recent years.

Initially, the impact of agrofuels was assessed by applying life cycle analyses (LCA), trying to capture the environmental impact of the production and combustion of agrofuels from field to exhaust pipe. The results were quite encouraging, but this was due to the fact that LCAs do not take all factors into consideration. Although they do include indirect use of fossil fuels – fertilizer and other fossil-based inputs utilized, as well as fuels spent in production and transportation – they disregarded the effects of land use change (LUC) as a result of the cultivation of the various feedstocks, whether maize, sugarcane, soybeans or palm oil.

Today we know that bringing such effects into the picture completely alters the result. While sugarcane ethanol is considered to be the best feedstock for agrofuels, it may still not be ecologically sound, as the view that sugarcane is "climate neutral" is based on calculations that disregard the "knock-on" effects on pastures and savannah lands from sugarcane plantations, not to speak of the cases when the sugarcane replaces forests. Thus, when counting with the LUC effects, even a feedstock as suitable as sugarcane will require quite extended periods of cultivation before it contributes to reducing GHG emissions (see Table 22.2).

There are great differences depending on the underlying assumptions, one of the most decisive being what original land use the feedstock replaces. Peat land

Table 22.2 Payback time: number of years before a feedstock's GHG balance becomes positive

Feedstock/fuel/country	*Payback grassland (years)*	*Payback forests (years)*
Palm oil/biodiesel, Malaysia	0–11	18–38
Soya/biodiesel, United States	14–96	179–481
Sugarcane/ethanol, Brazil	3–10	15–39
Wheat/ethanol, United Kingdom	20–34	80–140

Source: Renewable Fuels Agency 2008: 26.

and forest conversions lead to the highest carbon losses: carbon payback times are increased by a factor of at least three (and often much more) if forests rather than grasslands are cleared for sugarcane, palm oil or soya.

GHGs, however, are not the only ecological aspect that is worth considering when assessing agrofuels; the impact on biodiversity also varies greatly depending on LUC (see Table 22.3). Overall, evaluations here are negative for all sorts of previous land uses except abandoned lands that used to be intensively cultivated (i.e. that were used for monocultures). For the remaining cases – including extensively cultivated lands – the impact on biodiversity will remain negative for at least a century.

The environmentally most advantageous conversion to agrofuel feedstocks thus takes place on land that previously was not used, but the assumption that there are "degraded" or "abandoned" areas available to be used for agrofuel production has been questioned:

> In most cases, lands defined as "marginal", "wasteland" or "idle" are vital for the livelihoods of small-scale farmers, pastoralists, women and indigenous peoples. What governments call "marginal" lands are in fact lands that have been under communal or traditional customary use for generations.
>
> (Gaia Foundation *et al.* 2008: 1)

Conflicting land uses

In Brazil, 50 per cent of the sugarcane crop is turned into ethanol; in the United States the corresponding share of maize is 30 per cent, and in the EU 60 per cent of the rape seed cultivated is transformed into biodiesel (FAO 2008). Hence, it should be obvious that fuel production has a considerable impact on agriculture, but is it a case of competition over limited resources, or a case of peaceful co-existence? To some, there is cause for alarm, and the trade-off that exists could be formulated quite concretely: the grain required to fill up the tank of an SUV with 100 litres of ethanol represents 240 kg of maize; alternatively, this maize could have been used to feed a person for a year (World Bank 2008).

Sugarcane has not always been grown where we find today's plantations – quite the opposite: many areas in Brazil that are now dominated by sugarcane were once covered by Atlantic forest, of which today only 6–7 per cent remain (Fritz 2008; see Figure 22.1). Still, deforestation was only the first LUC caused by the growth of sugarcane; in the present phase of expansion, grazing areas are being converted to crop land, which in turn forces cattle ranchers to move into the *Cerrado* (the savannah) and even further into the Amazon rainforest. Thus, even the use of already cleared land for the production of feedstocks may lead to the opening of new lands in other areas of Brazil, or even in other countries. The process is best described as a continuous flow of LUCs, where sugarcane and soybeans tend to occupy areas previously used for pasture, while the latter may in turn displace the *Cerrado* and the rainforest (WWF 2008). The extent to which this has actually been happening, however, is a matter of debate.

Table 22.3 Biodiversity balance of land use change

Land cover converted to agrofuel feedstock	*Positive impact*	*Negative impact*
Recently abandoned land after intensive use	Immediately positive but not substantial until 2100, < +25%	
Recently abandoned land after extensive use	Mildly positive after 100 years, < +25%	Immediately negative < –25%
Abandoned partly restored lands		Immediately negative, > –25%; after 100 years still –10–25%
Grasslands extensively used		Immediately negative, > –50%; after 100 years still –25%
Natural grasslands and forests		Immediately negative, > –75%; after 100 years still –60%

Source: UNEP 2009: 71. Impact on biodiversity is measured in terms of percentage change of mean species abundance.

Figure 22.1 shows the expansion of sugarcane in Brazil during a decade of significant growth in the production of this feedstock. The conclusion here is that no *direct* deforestation took place following the introduction of sugarcane. During the period studied, the area planted with sugarcane replaced pastures and previous crops rather than occupying newly deforested lands. This conclusion, however, holds only for areas where sugarcane expansion took place, whereas effects further away may have included deforestation (Sparovek *et al.* 2009). The conclusion is supported by another study which maintains that, so far, most

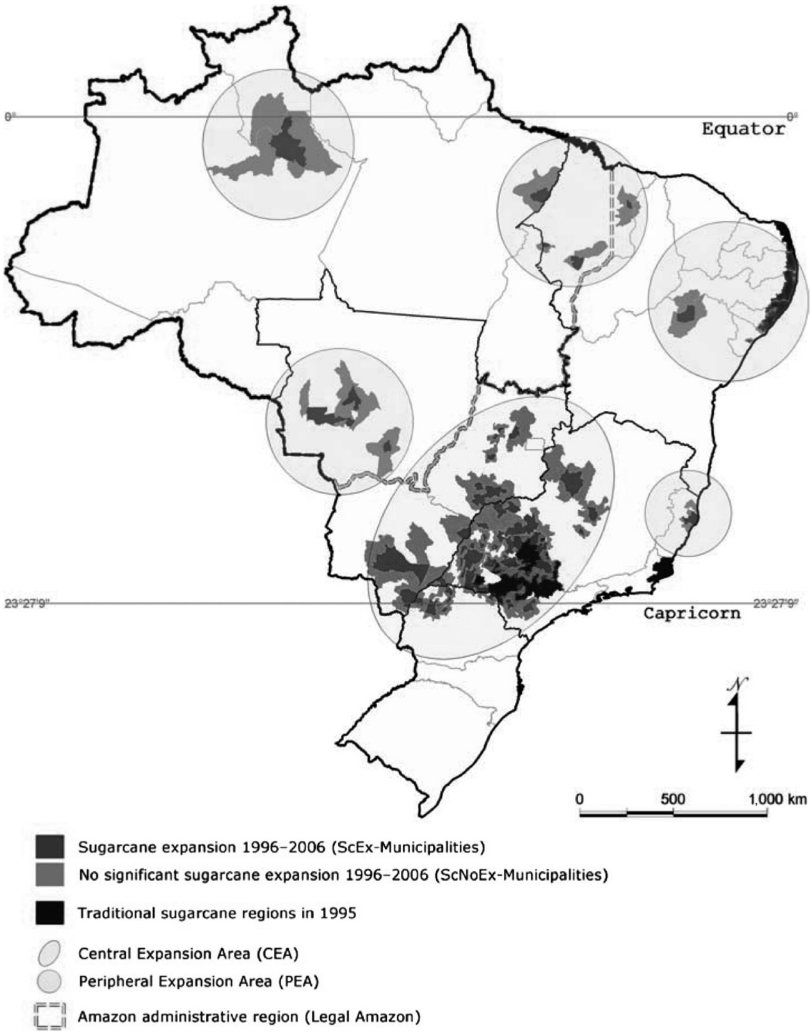

Figure 22.1 The geographical expansion of sugarcane in Brazil 1996–2006, showing central and peripheral expansion areas (source: Sparovek *et al.* 2009, reproduced with permission).

of the expansion of sugarcane production has been taking place on pasture lands (65 per cent), while 25 per cent has taken place on crop land (replacing soya, maize and citrus) (Porder *et al.* 2009). The LUC effect is thus lower than if it generally had been forests that had been cleared.

With increasing sugarcane production, it seems likely that the demand for agrofuels will require new areas to be opened up, which pushes crop lands further into the *Cerrado*, and also into the rainforest. The process can be portrayed as a flow of events, where one LUC leads to another through the unfolding of "deforestation dynamics" (see Figure 22.2).

The example here is the State of Mato Grosso, bordering on the southern parts of the Amazon. In Mato Grosso, the *Cerrado* and previous pastures have been converted into crop lands, mostly for soybean cultivation (which is used as fodder for meat production and in the food industry, but also as feedstock for biodiesel). As a consequence, GHGs are released, undoing – or at least diminishing – the positive impact that agrofuels may have had.

The social impact

The negative impact on the environment is only half the story of the cultivation of sugarcane for ethanol (see Mendonça 2005; Rede Social 2006; WWF 2008; Hall *et al.* 2009; Fearnside 2008; Sawyer 2008). Work on the plantations is

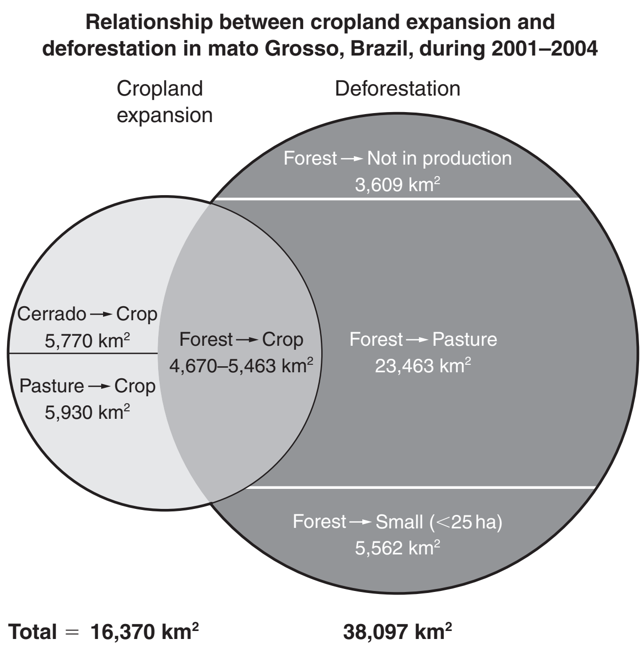

Figure 22.2 Land use change in Mato Grosso 2001–2004 (source: Morton *et al.* 2006 used with permission).

fraught with danger, and accidents are frequent. Smoke from fields set afire lead to pulmonary diseases and burns among the workers, including children. Conflicts over the right to the land are ubiquitous. During a period of 20 years, 1985–2004, close to 1,400 assassinations of workers, union leaders and lawyers have been reported; during the same period more than 7,000 workers were sent to jail for trade union or political activities.

Yet, this is only "the tip of the iceberg", in the words of the Brazilian Human Rights league, and extremely exploitative albeit less violent forms of employment are common (Rede Social 2006). The labour force is to a large extent composed of migrant workers brought to the sugarcane plantations on false premises. Workers are often indebted and have to stay on, working for salaries below what was promised. Pay is based on daily tasks, and the required workload has been pushed ever higher, from 5–8 tons per day in the 1980s to 12–15 tons today.

Against this background the following summary of the social impact of sugarcane production in Brazil, although quite negative, may in fact be too optimistic:

> Most benefits from the Brazilian ethanol market have flowed to large and highly capitalized producers in the South of the country, while workers earn low wages for unhealthy and backbreaking labour. Current trends towards increased efficiency and the replacement of labourers with mechanized harvesters suggest that even the employment benefits of sugarcane production for landless rural workers will soon be gone.
>
> (Vanwey 2009)

It is difficult to be optimistic here, and the literature is full of warnings that Brazilian agriculture – and above all the production of feedstocks for agrofuels – is heading in the wrong direction, "a 'technological package' of chemicals, mechanized agriculture, accounting procedures, massive inequality of land holdings, and an oligopoly of large grain and oilseed traders" which force the peasants in the countryside to "navigate between the Scylla of economic marginalization and the Charybdis of ecological breakdown", to quote one of the more dystopian accounts (Fisher 2007).

Small improvements can be seen, however, such as the government law to end the burning of sugarcane fields by 2021 (for mechanized harvests) or 2031 (for areas manually harvested or with inclinations higher than 12°). Actually, the Brazilian sugarcane industry realized that the time periods granted by the government were unnecessarily extended, and voluntarily offered to terminate its burning practices by 2014 and 2017, respectively (WWF 2008).

Where could we go from here?

We have seen that agrofuels are replete with drawbacks. Even the energy security argument for choosing agrofuels is open to question: although agrofuels can be counted on to reduce dependence on oil, they also entail risks. When food prices go up, or when weather conditions turn unfavourable, countries may be faced with failed harvests and rebellious populations demanding that their agro-resources be reserved for meeting domestic food needs. This happened repeatedly during the recent (2008) hike in food prices, when protests were reported in at least 43 countries, leading in some cases to the prohibition of exports.[2]

Brazil appears to be aware of the social drawbacks of agrofuel operations and has decided to stimulate the production of socially acceptable biodiesel through a programme called *Selo Combustível Social* (Social Fuel Stamp), which mandates the participation of small-scale peasant farmers in the supply chain of soybean for biodiesel, a precondition for biodiesel manufacturers to obtain government support. This may ease some of the negative aspects of agrofuel production – its focus on large-scale production units, for instance – but for agrofuels to become sustainable in a broad sense, their ecological impact must also be considered (such as biodiversity and GHG emissions), which is not the case today.

Brazil is not alone in facing this challenge; a growing number of certification schemes are being proposed, many mixing social and ecological considerations (Friberg 2008; WRI 2006; Roundtable on Sustainable Biofuels 2009). However, certification is a two-edged sword: if the terms are slack and inadequate, they will be a "seal of approval" for questionable feedstocks and operations. Consider two cases when such standards have been less than useful:

- A couple of years ago, Brazilian ethanol production was assessed in order to judge whether it conformed to the demands of a Dutch sustainability standard. Although the assessment could not say whether the production competed with food or other energy uses, it was nevertheless accepted. The same study also found the GHG balance favourable without considering LUC (Smeets *et al.* 2008).
- The International Finance Corporation (IFC), the World Bank's private lending arm, has agreed to finance land development by Brazilian conglomerate and agrofuel giant Amaggi in the states of Mato Grosso, Pará, Rondônia and Amazonas without ensuring appropriate levels of environmental and social protection, although the IFC had established safeguards that were to protect against such mistakes as a precondition for finance (CAO 2005).

Hence, certification schemes may "greenwash" rather than provide reliable rules for the approval of agrofuels. On the other hand, certification schemes are certainly better than no rules at all, since a complete lack of rules would allow a business-as-usual scenario, where all concerns – ecological as well as social – would be sacrificed in order to secure a maximum increase in the supply of agrofuels.

The Roundtable on Sustainable Biofuels (RSB) is an example of a serious attempt to establish procedures and conditions for certification. The RSB, initiated by the World Wildlife Fund, is composed of a mixture of stakeholders – private firms and international agencies as well as environmental NGOs – representing environmental concerns, indigenous peoples' rights, as well as the agrofuel industry and the buyers of agrofuels. The RSB can thus be seen as a joint venture, which gives some NGOs ground for questioning the degree of seriousness of the scheme and its relevance in terms of fostering social and ecological sustainability. The Roundtable is said by some "to provide a veneer of sustainability", and to "do more harm than good" (Shattuck 2009: 130). But even a cursory look at the proposed sustainability principles of the Roundtable discloses that this may be a premature conclusion (see Table 22.4).

The RSB's Principle 4 deals with human and labour rights. Human rights (HR) law stipulates that affected populations have a right to "free, prior and informed consent" (FPIC), a HR principle of the ILO Convention 169 (1989). Since this principle gives indigenous people the right to have a say before projects and investments are undertaken – and the right to be adequately compensated if the final decisions should go against their wishes – this HR principle is frequently disrespected (as in the case with IFC above). Thus, for example, when the Food First Information and Action Network (FIAN 2008) advised the Indian government how the certification rules of India ought to be amended in order to conform to HR law, acceptance of the FPIC principle was the first point.

The RSB, on the other hand, is well aware of this and has included the FPIC among its core conditions. In addition, the RSB will in the future include criteria for judging the consequences of the indirect LUCs that follow from the production of agrofuels; today only direct LUC is part of the proposed certification conditions (as part of Principle 3). A similar situation exists regarding GHG emissions: the RSB will decide on *one* emission target to be met in order to be certified for all the different feedstocks. However, the RSB has not yet chosen where to draw the line.

Nevertheless, certification schemes do have serious limitations. The most important one has to do with aggregation of criteria and conditions: how do you assess an agrofuel when some factors are favourable and some negative? For instance, a survey of 17 social and environmental criteria for judging Brazilian ethanol production concluded that only two criteria were problematic: biodiversity and competition with food production (Smeets *et al.* 2008). Is this to be viewed as a serious limitation of sugarcane ethanol, or should it be approved based on the fact that most of the criteria were found to be acceptable?

Another problem with the certification approach is that some principles, although important as such, have almost no chance of being approved if you take them at face value. Is it a realistic requirement that agrofuels should avoid impacting negatively on biodiversity, as stipulated by Principle 7 of the RSB? This would imply that *none* of today's feedstocks will pass the test in this regard over the next century (see Table 22.3).

Agrofuels done right?

The UNCTAD (2006) suggests a way out of this predicament by taking a stance that at first sight seems quite realistic: the real choice is not between bad and

Table 22.4 Proposed RSB sustainability principles 2009

Principle	*Sustainable biofuel operations shall…*
1 Legality	follow all applicable laws and regulations.
2 Planning, monitoring and continuous improvement	be planned, implemented and continuously improved through an open, transparent and consultative Environmental and Social Impact Assessment and an economic viability analysis.
3 Greenhouse gas emissions	contribute to climate change mitigation by significantly reducing life-cycle GHG emissions as compared to fossil fuels.
4 Human and labour rights	not violate human rights or labour rights, and shall promote decent work and well-being of workers.
5 Rural and social development	in regions of poverty contribute to the social and economic development of local, rural and indigenous people and communities.
6 Local food security	ensure the human right to adequate food and improve food security in food-insecure regions.
7 Conservation	avoid negative impacts on biodiversity, ecosystems and other conservation values.
8 Soil	implement practices that seek to reverse soil degradation and/or maintain soil health.
9 Water	maintain or enhance the quality and quantity of surface- and groundwater resources, and respect prior formal or customary water rights.
10 Air	minimize air pollution from biofuel operations along the supply chain.
11 Use of technology, inputs and management of waste	seek the use of technologies that maximize production efficiency and social and environmental performance, and minimize the risk of damages to the environment and people.
12 Land rights	respect land rights and land use rights.

Source: Roundtable on Sustainable Biofuels 2009.

perfect goods, but between bad and worse. Hence, the UNCTAD (2006) defines "environmentally preferable products" as "products that cause significantly less 'environmental harm' at some stage of their 'life cycle' than alternative products serving the same purpose."

But is this not tantamount to giving up the possibility to develop sustainable agrofuels, by lowering our ambitions so much that they simply will have no regulative power at all? Certainly, the ambitions should be higher, and "biofuels done right" – to use a phrase which is ubiquitous in the pro-ethanol and biodiesel literature – only accepts five feedstocks in order not to damage biodiversity or contribute to GHG emissions (see Tilman *et al.* 2009):

- perennial plants on degraded lands;
- crop residues;
- wood and forest residues;
- double crops and mixed cropping systems; and
- municipal and industrial wastes.

Most salient in this list is that today's favoured feedstocks – sugarcane and maize – will not qualify; in fact, the list could be read as a serious objection to the way agrofuels are developed under present conditions. Agrofuel development is taking place along pathways with "several wrong options" (Tilman *et al.* 2009), which means that the risk that agrofuels will increase GHG emissions, endanger biodiversity and push out food production is imminent and should be the overriding concern. Today, in other words, agrofuels are certainly done wrong.

Hence, a minimum demand would be that a moratorium on the use of agrofuels is instituted, as suggested by the well-placed NGO, the International Food Policy Research Institute (2008), since there is competition between food and fuel for the use of the same limited land resources. While agrofuel production is restrained, alternative fuels from waste products (biogas) could be developed. In this view, neither sugarcane nor soya cultivation should be expanded and no mandatory blending requirements for fuels should be introduced.

Notes

1 The average protection that the EU Common Agricultural Policy accords is 17 per cent (on the price of imports), but the protection for EU agrofuel imports has been calculated to be in the range of 40–100 per cent (depending on the world market price of ethanol). See Kommerskollegium (2007: 16).

2 Cohen and Garrett (2009) report violent protests in the following countries: Burkina Faso, Cameroon, Côte d'Ivoire, Egypt, Guinea, Haiti, Honduras, Indonesia, Kenya, Malaysia, Mauritania, Morocco, Mozambique, Pakistan, Russia, Senegal, Thailand, Tunisia and Yemen.

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