

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



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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 trans-disciplinary, 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 pre-industrial 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-Alcôol 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, indigenesness, 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 disproportionately 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