

ENVIRONMENTAL CRISES AND THE METABOLIC RIFT IN WORLD-HISTORICAL PERSPECTIVE

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This article proposes a new theoretical framework to study the dialectic of capital and nature over the longue duree of world capitalism. The author proposes that today's global ecological crisis has its roots in the transition to capitalism during the long sixteenth century. The emergence of capitalism marked not only a decisive shift in the arenas of politics, economy, and society, but a fundamental reorganization of world ecology, characterized by a "metabolic rift," a progressively deepening rupture in the nutrient cycling between the country and the city. Building upon the historical political economy of Marx, Foster, Arrighi, and Wallerstein, the author proposes a new research agenda organized around the concept of systemic cycles of agro-ecological transformation. This agenda aims at discerning the ways in which capitalism's relationship to nature developed discontinuously over time as recurrent ecological crises have formed a decisive moment of world capitalist crisis, forcing successive waves of restructuring over long historical time..

"Human society is unthinkable without its environment."

—Nikolai Bukharin (1925, p. 104)

A general consensus has emerged over the past quarter century—the planet faces serious ecological problems (many would say crisis) that will lead to serious social problems (some would say social crisis) and quite possibly the extinction of part or all of humanity. Naturally, there is room for sharp disagreement within this broad consensus, with some contending that the ecological problem stems from imperfect markets, others stressing the need for regulated markets, and still others arguing that only an ecologically centered socialism will suffice. Obviously, the dialectic of economy and ecology is central here, and for this reason, the ecological debate overlaps in many ways with the globalization debate. As ozone depletion and other ecological problems manifest at a planetary scale with ever greater intensity, these two debates will increasingly become fused. The world-historical import of these debates will loom ever larger as the possibilities for a spatial fix (Harvey, 1999) of capitalism's social and ecological contradictions are foreclosed, the inevitable result of the system's headlong rush toward the commodification of everything, invading heretofore unexploited and underexploited sociocultural and ecological niches.

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What these debates lack is a coherent theoretical framework that comprehends the historical dialectic of capital and nature over the *longue duree*. I propose that the global ecological crisis of the 21st century has its roots in the transition to capitalism during the long 16th century (from 1450 to 1640). The emergence of a capitalist world-economy in the early modern era marked not only a decisive shift in the arenas of politics, economy, and society but also a fundamental reorganization of world ecology. In brief, the localized ecological problems of the feudal era gave rise to the globalizing problem of the metabolic rift (following Foster, 1999a). Developed in preliminary form by Marx and reconstructed recently by Foster, the concept of metabolic rift illuminates the rupture in nutrient cycling between the country and the city in historical capitalism. With the transition to capitalism, a new division of labor between town and country took shape—on a world scale and within regions—whereby the products of the countryside (especially, but not only in the peripheries) flowed into the cities, which were under no obligation to return the waste products to the point of production. Nutrients were pumped out of one ecosystem in the periphery and transferred to another in the core. In essence, the land was progressively mined until its relative exhaustion fettered profitability. At this point, economic contraction forced capital to seek out and develop new ways of exploiting territories hitherto beyond the reach of the law of value. This process of geographical expansion and social innovation inaugurated a new phase of capitalist development (Arrighi, 1994; Arrighi & Moore, in press; J. W. Moore, 1999, 2000; J. W. Moore & Gildea, 1999).

From this perspective, we can analyze how successive reorganizations of world ecology in the modern era have been specifically capitalist processes, rooted in the logic of capital itself, rather than in the market, industrial technology, imperial expansion, or irresponsible, profit-hungry firms as such. Such an analysis requires both theoretical reconstruction and empirical study. In this article, I focus on reconstructing theory in the interests of developing a new research agenda that places the nature-society dialectic at the center of studies of capitalist development. As such, this article deliberately poses many questions it does not answer.

The task of theoretical reconstruction is effected in three steps. First, I discuss Marx's concept of metabolic rift, which illuminates the historical ecology of the specifically capitalist division of labor between town and country. Second, I suggest that the concept of metabolic rift can be supplemented by a rereading of Wallerstein's (1974) *The Modern World-System I*. Although lacking a systematic account of ecological factors in the emergence of capitalism, I contend that Wallerstein's account and method shed more light on the ecological moment of the transition than is commonly acknowledged. Finally, I argue for a synthesis of classical Marxist and world-systems concepts to conceptualize the historical reality of successive reorganizations of world ecology in the capitalist era. Fusing concepts developed by Marx, Wallerstein, and Giovanni Arrighi, I propose that each phase of world capitalist development is at once cause and consequence of a fundamental reorganization of world ecology. These successive reorganizations of world ecology I call *systemic cycles of agro-ecological transformation*. By introducing this latter concept, I hope to bring into focus two interconnected processes: (a) the world-historical ecology of capitalist restructuring that has underpinned the renewal of accumulation in successive long centuries of capitalist development and (b) and the ways in which such agro-ecological restructuring has been the primary factor behind the simultaneous waves of capital's global expansion and its intensified exploitation of nature.

MARX: THE TOWN-COUNTRY DIVISION OF LABOR AS A METABOLIC RIFT

The best starting point for reconstructing a world-historical theory of ecological transformation under capitalism is found in Marx's concept of metabolic rift. For Marx and Engels (1970), the theory of metabolic rift centers on the ecological moment of the antagonistic relation between town and country under capitalism. With the transition to capitalism, the nutrient cycling of local ecosystems was radically disrupted as the latter were integrated into the new division of labor, and localized relations gave way to progressively globalized or world-historical relations between the country and the city (Marx & Engels, 1970, pp. 54-58).

To be sure, the division of labor between town and country is longstanding. Indeed, it is the essence and driving antagonism of the social division of labor in general. "One might well say that the whole economic history of society is summed up in the movement of this antithesis" (Marx, 1977, p. 472; see also Marx, 1976, p. 179; Marx & Engels, 1970, pp. 68-69). The peculiarity of capitalism is the dominance of the cities. In precapitalist civilizations, the city was "ruralised," whereas capitalism effects "the urbanisation of the countryside" (Marx, 1973, p. 479). This antagonism grows apace with the development of capitalism. "The contrast between town and country . . . has been brought to its extreme point by present-day capitalist society. . . . Far from being able to abolish this antithesis, capitalist society on the contrary is compelled to intensify it day by day" (Engels, 1979, p. 51, as cited in Burkett, 1995, p. 119).

This is not to say that capitalism simply sprang forth from the cities once the conditions in the countryside had ripened. Marx's view was more dialectical, illuminating the recursive interrelations between primitive accumulation in the sphere of commerce and finance and in the sphere of agriculture. If *capital*—and to a certain extent, capitalist production—emerged primarily from the cities, it is fair to say that *capitalism* as a world-system emerged to the extent that city-based capital remade the countryside through the direct investment of capital and world market formation, as a consequence of which states and agrarian social classes underwent a profound transformation as they became ensnared in the net of commodity production.¹ Urban-based capital remade the social structure and ecology of the countryside, causing the latter to decisively condition the social structure and ecology of the cities and the emergent world-system as a whole.

Marx characterized primitive accumulation as a many-sided phenomenon irreducible to either local or global processes. In Marx's hands, primitive accumulation is what geographers call a *multi-scalar* process (N. Brenner, 1999); that is, primitive accumulation was a social process that operated simultaneously at multiple geographical scales, ranging from the peasant holding and manorial estate to national-scale developments such as the creation of national debts to global-scale processes such as the African slave trade. The original accumulation of capital was located in the world market and financial markets, whereas the original "accumulation of men" (Halpern, 1991, p. 6), that is, the production of new social relations and a new division of labor, occurred principally in rural areas. There are, then, at least two moments of original accumulation, one located in the world market and the other located in agrarian regions.² During the period of transition, the form and degree of capitalist agrarian transformation in any particular locale was ultimately dependent on the first moment. Indeed, a crucial distinction between feudalism and capitalism is the liberation of capital, not only peasant producers, from the land.³ Hence, the course of capitalist development is characterized by the progressive

“victory of the commercial town over the countryside” (Marx & Engels, 1970, p. 78), whereby “agriculture more and more becomes merely a branch of industry, and is entirely dominated by capital” (Marx, 1973, p. 107). The second moment, subsequently, becomes crucial to the continued expansion of capital, which requires far-reaching and ongoing transformations of the division of labor to (re)combine fresh supplies of land and labor in the reorganization of capitalist production.⁴

As a consequence, the transformation of agrarian social relations and the natural environment through primitive accumulation was central to the new town-country division of labor under capitalism (Marx, 1977, pp. 873-940). The subordination of rural producers to the law of value, under which they were literally forced to sell to survive, meant two things. First, a surplus population of dispossessed peasants was available to sustain urban population and production, which otherwise would have dwindled.⁵ Second, agriculture itself became urbanized, that is, subjected to the capitalist imperative to increase productivity. As agrarian producers were forced to increase productivity through agricultural specialization, these producers’ households experienced significant transformation.⁶ Domestic handicraft production for use and local exchange was undermined on one hand by the imperatives of specialization and on the other by the spread of the putting-out system of textile manufacture, followed by the influx of cheap manufactures flowing into the countryside from the cities.^{7,8} This process moved forward by various combinations of primitive accumulation and market coercion in roughly cyclical fashion, which at the level of the world-economy “spur[red] on rapid increases in emigration and the colonization of foreign lands, which [we]re thereby converted into settlements for growing the raw material of the mother country.” On this basis, a

new and international division of labour springs up, one suited to the requirements of the main industrial countries, and 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 [italics added]. This revolution is linked with far-reaching changes in agriculture. (Marx, 1977, pp. 579-580; see also p. 860)

Although this process clearly accelerated and widened in scope dramatically during the long 19th century, which is what caught Marx’s attention in *Capital I*, there is a solid historical basis for locating this dynamic much earlier.

The new capitalist division of labor between town and country entailed a thoroughgoing rupture with the old ecological relations of production. In particular, the nutrient cycling of the old agrarian systems was disrupted as agricultural produce was increasingly directed to feed the surplus population, which now resided in increasingly distant locations. Agriculture became increasingly “delocalized” (Pelto & Pelto, 1985, pp. 309-310) in the early modern world-economy.⁹ Although the resulting metabolic rift operated at multiple scales, that is to say that there were “layers within layers” (to borrow a phrase from Wallerstein, 1974, pp. 119, 188) at the level of the world-system, it forced capital to push the ecological contradictions to a progressively wider sphere:

Large landed property reduces the agricultural population to an ever decreasing minimum and confronts it with an ever growing industrial population crammed together in large towns; in this way it produces conditions that provoke 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*

soil, which is carried by trade far beyond the bounds of a single country [italics added]. (Marx, 1981, p. 949; see also Marx, 1977, p. 860)

It is not only world trade but also capitalist production developed on the basis of the town-country division of labor that feeds back into agriculture:

Large-scale industry and industrially pursued 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 for exhausting the soil. (Marx, 1981, p. 950)

Thus, the simultaneous degradation of the worker and the soil is systematically connected by capitalism:

Capitalist production 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 [sic] natural conditions for the lasting fertility of the soil. . . . In modern agriculture, as in urban industry, the increase in the productivity and the mobility of labour is purchased at the cost of laying waste and debilitating labour-power itself. Moreover, all progress in capitalist agriculture is a progress in the art, not only of robbing the workers, but of robbing the soil; all progress in increasing the fertility of the soil for a given time is a progress towards ruining the more long-lasting sources of that fertility. . . . Capitalist production, therefore, only develops the techniques and the degree of combination of the social process of production by simultaneously undermining the original sources of all wealth—the soil and the workers. (Marx, 1977, pp. 637-638)

This metabolic rift shaped and was shaped by successive restructurings of the world capitalist division of labor, which extended capitalist power to new regions and tightened the grip of the law of value on areas long since subordinated to the capitalist market. The theory of metabolic rift, then, refers to a systemic process, what Braudel (1979/1984) calls a *secular trend*. The metabolic rift becomes progressively wider (and deeper?) over time. From this perspective, the history of capitalism can be conceptualized as a “series of successive, historical breaks in nutrient cycling” (Foster, 1999a, p. 399; see also Foster & Magdoff, 1998).

Whereas John Bellamy Foster locates the origins of the metabolic rift in the 19th century during the second agricultural revolution (Thompson, 1968), I suggest a different periodization. In the first place, I would extend the logic of his analysis to locate its origins much earlier, in the long 16th century.¹⁰ In this sense, we are talking about a metabolic rift that is specific to the capitalist epoch as a whole. Other historical systems certainly experienced environmental contradictions and crises—the ancient Mesopotamian city-states, the Roman Empire in the first few centuries A.D., the Mayans in the 9th century, and as we shall see, feudal Europe (Foster, 1994, pp. 36-39; Ponting, 1991, pp. 37-87). These tributary world-systems differed, however, in two important ways—they took much more time to develop an ecological crisis, and lacking the global expansionary imperative of capital, these systems generated ecological crises that were localizing rather than globalizing.

To leave our analysis at this level of abstraction, however, would explain little about the turbulent epoch of world history that resulted from the transition to capitalism. I would like to take as a starting point Foster's (1999a) idea of "successive, historical breaks in nutrient cycling" (p. 399). The historical specificity of the metabolic rift associated with the 19th century's second agricultural revolution is undeniable. Under the pressures of widespread and rapid industrialization, the rift widened and deepened considerably, manifesting in the increasingly serious problem of soil exhaustion, the primary ecological crisis of the early 19th century (Foster, 1999a). Yet, locating the origins of the rift in this period gives undue emphasis to 19th-century industrialization and its extension to agriculture as the prime mover of ecological degradation in historical capitalism. Rather than the prime mover, industrialization in this era was but a singular manifestation of capital's historical logic; earlier waves of industrialization had certainly occurred (see Carus-Wilson, 1941; Gimpel, 1976; Nef, 1964). More to the point, agriculture was subordinated to capital long before the 19th century, and certain agricultural sectors were even highly capital intensive. In the case of the plantation system—above all, the sugar plantation—we have a system of agrarian enterprise that was not only capitalist from the 16th century but also highly industrial. Early modern sugar plantations were among the most technically and organizationally advanced industrial enterprises in the capitalist world (Mintz, 1986; J. W. Moore, in press).

Thus, I think there is a metabolic rift in general and a succession of metabolic rifts specific to each successive phase of world capitalist development. One way of looking at the historical development of the metabolic rift in the capitalist era is to see it as a vector of change. A strong case can be made that there was a qualitative shift in nature-society relations with the transition to capitalism sometime around 1492. Most of the time, this vector moved slowly, only to accelerate sharply during periods of crisis and restructuring, which roughly corresponded with periods of geographical expansion until the 20th century. The basic tendency in each phase of capitalist development and its associated metabolic rift is toward increasingly intensive agriculture and increasingly intensive extraction. As long as fresh land existed beyond the reach of capital, the social and environmental contradictions and costs of the intensified exploitation of nature could be attenuated and postponed. By the 20th century, however, geographical expansion was no longer a possibility. Thence began capital's most serious challenge to the biosphere, with a new wave of intensification, such as the so-called green revolution, and an exponential rise in the production of waste.¹¹ Lacking fresh land, capital now colonizes already exploited territory and, in so doing, generates contradictions that temporarily avoid or attenuate contemporary accumulation crises yet bring the day of reckoning ever closer to the present.

In this way, we can use Marx to link the contemporary crises with such a seemingly far-removed historical issue as the transition from feudalism to capitalism. Pushing back the origins of the metabolic rift to the era of capitalist development before the Industrial Revolution is certainly consonant with Marx's (1977) perspective, which dates "the capitalist era . . . from the sixteenth century" (p. 876). It is also consistent with Foster's (1994) earlier study of capitalism and nature in *The Vulnerable Planet*, which is such a powerful book precisely because it is explanatory and descriptive of capitalism's tendency to destroy biodiversity in the drive for ceaseless capital accumulation.¹² Thus, *The Vulnerable Planet* stands in sharp contrast to Clive Ponting's (1991) *A Green History of the World*, which covers the same empirical terrain. Ponting provides a richly detailed account of the environmental consequences of European expansion. Unfortunately, this account is almost entirely

descriptive. Although Foster's book is *popular*, intended for a broad activist audience without sacrificing a Marxist critique of capital, Ponting's work is *populist*, essentially identifying industrialization rather than capitalism as the problem. Given the latter's reluctance to analyze capitalism as a historical system—there is, for example, no index entry for *capitalism* in *A Green History of the World*—Ponting's account ultimately succumbs to an industrial fetishism that attributes global ecological devastation to the so-called second great transition, the Industrial Revolution (Ponting, 1991, pp. 267-298, derived from Cipolla, 1978, pp. 17-34). This is no mere scholastic quibble. For if the problem is industrialization, as Ponting and many others would have it, then the solution is essentially technocratic—we must build environmentally sustainable factories, transportation systems, and so forth, but fundamental social transformation is unnecessary. However, if as Foster argues, the problem is capital and capitalism, then the looming planetary ecological crisis is part and parcel of a crisis of capitalism, and therefore, environmental justice necessitates social revolution.

FROM MARX TO WALLERSTEIN: AGRICULTURE, NATURE, AND THE EMERGENCE OF THE MODERN WORLD-SYSTEM

Whereas Marx supplies the concept of metabolic rift, Wallerstein offers a historical-geographical framework capable of comprehending the emergence of capitalism and the ecology of capitalism as a world-historical process. Like the concept of metabolic rift, the idea of the world-system appears throughout Marx's corpus, albeit never in systematic or explicit form.¹³ For Wallerstein, the story of the emergence of capitalism is the story of the reorganization of agriculture and agrarian class relations within a pan-European world-economy and its extension to the Americas. Frequently criticized as circulationist, a careful reading of *The Modern World-System I* (Wallerstein, 1974) reveals something quite different, indeed something much closer to Marx's even-handed approach to the dialectics of market, nature, and production.¹⁴ From this perspective, *The Modern World-System I* is a careful study of how world market formation shaped and was shaped by regional patterns of class conflict and associated modes of agricultural production, which were undergoing profound transformations precisely because the limits to the growth of the feudal system had been reached.

Wallerstein (1974) characterizes the crisis of feudalism as a "socio-physical conjuncture" (p. 35). The basic idea here is that the feudal system of social organization could advance only so far before encountering insuperable limits. A system based on the political extraction of surplus offered few incentives for increased productivity, especially by limiting the surplus available for investment in agricultural improvement. Economic expansion was therefore contingent on geographical expansion. Seigniorial revenues increased as long as the population continued to grow, which meant that the amount of land under cultivation expanded too, all other things being equal. This was indeed the case between the 11th and early 14th centuries. By 1300, it appears that the limits to expansion had been reached for two main reasons: (a) The feudal organization of agriculture had begun to exhaust its land and labor power in the European heartland, and (b) the expansion of settlement had brought more and more people onto less and less productive land at the geographical margins of the system.¹⁵ The margin of survival for European peasant agriculture was always razor thin, and overpopulation and overexploitation in the heartland and overextension at the margins rendered the feudal system of social organization highly vulnerable to what Eric Jones (1987) calls *disaster shocks*. As

shocks go, the 14th-century shift toward a colder climate was relatively mild. The intensification of cultivation and the expansion of settlement onto marginal zones over the previous centuries, however, rendered medieval agriculture increasingly dependent on favorable weather. The changing climate, along with epidemic disease (as we shall see momentarily), contributed to feudalism's "cumulative woes," thereby pushing the system to the breaking point (Wallerstein, 1974, pp. 34-35).

The decisive moment in the crisis of feudalism was the coming of the Black Death in 1348. The apocalyptic effects of the plague can be traced to "the chronic factor of resource strain involved in the feudal system of social organization" (Wallerstein, 1974, p. 35). Above all the ensuing crisis was one of declining seigniorial revenues, owing to the demographic decline and the resulting enhanced bargaining position of the peasantry. The crisis of the seigniors led in short order to the crises of the political institutions of Europe, especially the states and the church. This was also a moment of crisis for capitalists based in the city-states, who faced declining returns on trade and manufacturing. The conjuncture of these multiple crises would play a key role in the resolution of feudal crisis, which as we know resulted in the transition to capitalism rather than to another tributary system.

Wallerstein's analysis of the transition pivots on the relationship between class structure and the land-labor ratio. Here Braudel's (1979/1981) influence is particularly strong (e.g., p. 62). Where population density and urbanization remained relatively high, as in western Europe, the peasantry's power was augmented proportionately, and the predominant agricultural organization moved away from manorial production and toward medium-sized farms, favoring the rise of the yeoman farmer and intensive agriculture. Where population density and urbanization was relatively low, as in eastern Europe and the Americas, extensive agriculture developed on the basis of "coerced cash-crop labor." This difference was the result at once of the differential possibilities for "effective resistance," owing to varying population densities, and of the differential commercial opportunities presented by the relative availability of land: "If there is plenty of land, one can make do with relatively inefficient means of production. One can engage in extensive agriculture. One can use slaves or coerced cash-crop laborers [serfs]" (Wallerstein, 1974, pp. 100-101, 104, 112).

Wallerstein's innovation was to move beyond Dobb's (1963, pp. 50-70) claim—later reproduced by Robert Brenner (1977, 1985a, 1985b) and Anderson (1974)—that these were autonomous processes in eastern and western Europe. The intensification of western European agriculture and the spread of extensive, cash-crop agriculture in eastern Europe and the Americas were complementary processes. The spread of coercive modes of labor control in the new peripheries—especially slavery in the Atlantic and the second serfdom in eastern Europe—was possible to the extent that a significantly larger world cereals market emerged in the 14th and 15th centuries. However, this larger market could develop only on the basis of industrialization and agricultural innovation in the emergent core regions such as Flanders, which became able to concentrate high value-added agriculture (cattle breeding, horticulture, etc.)—not to mention industry—but could capitalize on this ability only insofar as reliable grain supplies could be obtained.¹⁶ Moreover, industrial expansion required horse power, which meant that arable land had to be converted to pasturage, which meant that workers had to be fed with imported grain, largely from the Baltic. The rising core demand for grain, in turn, sent prices and profits upward, thereby locking the peripheral Baltic into the expanding division of labor (Wallerstein, 1974, pp. 75-76). "Hence, the process of agricultural innovation fed rather than foreclosed the necessity of expansion" (Wallerstein, 1974, pp. 42-43).

Geographical expansion was not only necessary but also practical because the possibilities for inner expansion were limited.¹⁷ However, inner expansion was limited not by population but by social structure¹⁸:

There was physical room for the population, even the growing population. *Indeed that was part of the very problem that led to expansion* [italics added]. The physical room was one element in the strength of the peasantry vis-a-vis the nobility, and hence one factor in the decline of seigniorial revenues, in the crisis of feudalism. . . . What the nobility (and the bourgeoisie) needed . . . was a more tractable labor force. The size of the population was not the issue; it was the social relations that governed the interaction between the upper and lower classes. . . . Europe needed a larger land base to support the expansion of its economy, one which could compensate for the critical decline in seigniorial revenues and which could cut short the nascent and potentially very violent class war which the crisis of feudalism implied. (Wallerstein, 1974, pp. 48, 51)

Transatlantic expansion was the path of least resistance, given the reality of overlapping crises, pushing together interests that had hitherto been at odds. We might ask why European expansion in the 12th and 13th centuries differed so markedly from European expansion in the long 16th century. The answer lies in the structural convergence of interests in favor of inner expansion rather than outer expansion in the first era. Before the crisis of feudalism, cooperation between the territorial states, the seigniors, and the city-state capitalists favored land-based expansion rather than overseas expansion. The territorial states strove to consolidate national domains. The seigniors in general benefited from population growth and the extension of cultivation, as well as modestly growing markets for agricultural produce and the inflow of luxury goods from the East. Whatever surplus population developed within the aristocracy could be channeled toward the period's various expansionary movements.¹⁹ The city-state capitalists benefited from the rising agricultural surplus, which not only fed aristocratic consumption of high-value luxury goods but also made possible the further growth of towns and therefore a modest expansion of the town-country division of labor. They also benefited from the Crusades, both as suppliers of war materiel and as intermediaries in the new trade relationships with the East that developed out of the European invasion.

With the crisis of feudalism, however, the interests of the states, the seigniors, and the city-states converged to favor outer rather than inner expansion.

The only solution that would extract western Europe from decimation and stagnation would be one that would expand the economic pie to be shared, a solution which required, given the technology of the time, an expansion of the land area and population base to exploit. (Wallerstein, 1974, p. 24)

Wallerstein shows that the creation of a capitalist world-economy was the outcome of a conjuncture during which the interests of these three major groups converged to favor overseas expansion. The territorial states, which had made great strides between the 11th and 14th centuries—owing to increased revenues from internal expansion and the politico-military unification that resulted from the Crusades—now suffered greatly from the economic contraction, which began even before the Black Death. “These stronger states began to relapse again into symbolic shells when the great downturn came after 1250” (Wallerstein, 1992, p. 604). The powerful states could try to conquer smaller states, but given the rather widespread diffusion of advanced military technology and techniques and the equally widespread

access to the mobile capital needed to wage war, the possibilities for profitable war were continually frustrated from the mid-14th century. England could not conquer France, France could not conquer Italy, Castile could not conquer Portugal (indeed, it could barely hold together its own rickety nation within Iberia) or England, and perhaps most significantly, the Hapsburgs could not conquer Europe. Moreover, the rising costs of war meant increased borrowing, which ultimately strengthened city-state capital vis-à-vis the territorial states. Indeed, “many of the wars of the fourteenth and fifteenth centuries checked, or even set back, the process of state-building” (Strayer, 1970, p. 59, as cited in Wallerstein, 1992, p. 604).

The seigniors faced a deepening crisis in the wake of the Black Death. The upward readjustment of land-labor ratios effected several crucial changes in the balance of social forces, particularly in western Europe. First, the economic contraction in the countryside, which began in the later 13th century, spurred a growing challenge from below. Peasant revolts grew more frequent and extended their theater of operations from the village to larger regions (Wallerstein, 1974, p. 24; see also Hilton, 1973). Second, once population contraction set in, at first slowly and then rapidly with the coming of the Black Death, revenues declined. Third, declining population led to increased competition between the seigniors for peasant labor.

Inner expansion was hardly a possibility given the widespread abandonment of villages and cultivated land. Moreover, whatever internal expansion occurred was very largely an expansion of pasturage rather than arable land, a move that militated against a rapid population recovery (Wallerstein, 1974, p. 22, 35-36). Sheep farming especially not only required fewer hands relative to agriculture, it also yoked the seigniors to the world market, who were, as a consequence, inclined to support measures that favored the further expansion of that market.²⁰ The result was not only a “partial ‘decerealization’ of Europe in favour of animal husbandry” (Helleiner, 1967, pp. 68-69, as cited in Wallerstein, 1974, p. 36, note 78) but also an extension of the worldwide division of labor, a bias in favor of further expansion. It was no mere coincidence that Castile, itself one of the two great sheep-farming areas of Europe, not only led the conquest of the New World but also established sheep farming almost immediately on arrival. “Sheep ate men, in middle America just as in England” (Wallerstein, 1974, p. 188; see also Melville, 1993). In addition, it was not only men who were eaten by sheep and other livestock introduced by the Europeans. Another important victim of European livestock was Indian cultivation and the surrounding ground cover, an important contributing factor to the Indian’s great demographic collapse of the 16th century (Wallerstein, 1974, pp. 89-90).

Meanwhile, owing to the crisis of seigniorial power and the persistence of relatively high urbanization after the Black Death, the western European peasantry was able to “defend its gain[s] much more forcefully than ever before” (Mukhia, 1981, p. 283, as quoted in Wallerstein, 1992, p. 602), squeezing the seigniors, who in turn squeezed the states, who were forced to recognize the former’s voice in policy making. The opportunities of the seigniors within western Europe were at once limited and augmented by the formation of powerful territorial states. State fiscal policies of debasement and increasingly effective taxation systems undermined feudal arrangements in the countryside by devaluing fixed rents and extracting surplus from the peasantry. However, by creating various assemblies and selling state offices, new opportunities were opened for the seigniors to advance their interests through the state. Ultimately, then, the seigniors could expand their revenues only so far as their territorial states prospered, and during the crisis of feudalism, such prosperity was limited to the extent that inner expansion was privileged over outer

expansion. Thus, an uneasy compromise prevailed, which was ultimately resolved in favor of territorial state power and overseas expansion.

Finally, we come to the city-state capitalists. If anything, Wallerstein's treatment of the crisis of feudalism favors agrarian-class structure and state formation and underestimates the allegedly privileged domain of circulation—long-distance trade and the merchant bourgeoisie. Here we are forced to draw on Arrighi's study of city-state capitalism in the late medieval period to augment Wallerstein's analysis (Arrighi, 1994, 1996).

The growth of city-state capital between the 11th and 14th centuries was conditioned on the overall expansion of trade throughout Afro-Eurasia. However, these Afro-Eurasian trade networks collapsed in the wake of the Black Death. Trade did not cease, but the economic contraction meant that the divisions of labor developed within the Italian city-states and between the relatively commercialized Mediterranean and the relatively industrialized North Sea world-economies broke down. Competition between the city-state capitalists became cutthroat. The upshot of the growing conflict between Italian city-states was the victory of Venice in the eastern Mediterranean. Genoa was pushed out to the Atlantic, where it developed increasingly dense commercial and financial networks in Iberia and the North Sea world-economy. Of decisive importance was the decision of Genoese capital to enter into a relationship of political exchange with the Iberians, especially Castile, whereby the Genoese would supply the capital and the Iberians would supply the guns, the protection services for capital. Naturally, the Genoese favored overseas expansion, primarily because they sought to break Venice's monopoly on the spice trade. However, expansion was costly business, and it could be profitable on a capitalist basis only when military costs were borne by the territorial states. This the states could do because their power rested not on profit maximization but on revenue maximization. Because the possibilities for revenue maximization by inner expansion were blocked by the nascent balance-of-power system in Europe, the best bet looked like overseas expansion (Arrighi, 1994, 1996).

It bears repeating that these social forces, in the final analysis, pursued expansion so vigorously because the crisis of feudalism had empowered the peasantry and urban "semiproletariat" (Wallerstein, 1974, pp. 24-26, 52, 103-104; 1992).

Thus, the convergence of interests in favor of overseas expansion favored the transition to capitalism. By itself, however, expansion tells us relatively little about the capitalist reorganization of Europe's resource base. In the first place, the process of European expansion was also a process of consolidation, which brought together the existing North Sea and Mediterranean world-economies into a relatively unified capitalist world-system. Even without significant agricultural innovation, the enlarged scale of the new world-economy greatly enlarged the total surplus and resource base. With this expansion, a kind of critical mass of population, resources, and infrastructure had been achieved.

Crucially, because we are talking about a capitalist world-economy, there was set in motion a trend toward unprecedented core-periphery polarization that was also a radical reorganization of "world ecology" (Wallerstein, 1974, p. 44). Above all, this meant that not only the economic surplus but also the ecological surplus entailed by the expansion of Europe's resource base (from the Baltic, from the Americas) was "unequally consumed" (Wallerstein, 1974, p. 42). That is, the capitalist world's resource base was not only *absolutely* larger than its predecessor world-economies thanks to the kinds of inequalities and incentives built in to capitalist development, it was also *relatively* larger, much larger.

In sum, Wallerstein sees European expansion arising from the ascendant logic of capital accumulation under conditions of resource strain. "What western Europeans needed in the fourteenth and fifteenth centuries was food (more calories and a better distribution of food values) and fuel" (Wallerstein, 1974, p. 42). The drive for fuel and food—especially wood, wheat, and sugar—reinforced the uneven development of world capitalism; in the case of western and eastern Europe, it transformed the latter's small differences into large and durable inequality (Wallerstein, 1974, pp. 98-99, 111-112, 121-122, 129), and it created new peripheries in the Atlantic islands and the Americas.

This development of an unequal world division of labor, in turn, created new capitalist efficiencies of specialization between agriculture and pasturage and between agrarian activities and industrial activities. Predictably, these processes encouraged capitalist monoculture and the prioritization of short-run profits over sustainability. In England, Wallerstein (1974) argues, "The orientation of these town bourgeois was toward short-run profit . . . which had the effect of desolating the land over the following [16th] century" (p. 107). England's invasion and subsequent colonization of Ireland after 1600 contained a crucial ecological dimension. Ireland's "woods were used up to supply England with timber." Whereas one eighth of the Emerald Isle was under forest cover in 1600, it had "virtually disappeared by 1700" (Wallerstein, 1974, p. 281). In Spain, the forests receded under the pressure of a rising sheep population that was a direct response to growing world market demand (Wallerstein, 1974, p. 193).

Following Braudel (1949/1972, 1979/1981), Wallerstein (1974) speaks of a "wood famine" (p. 45, note 109). Throughout the first two volumes of *The Modern World-System*, he devotes importance to wood products, which he describes variously as "the other great basic need" (next to food) and, along with sugar, as the "continuing 'growth' crop" of the early modern world-economy (Wallerstein, 1974, pp. 44-45; 1980, pp. 161-162). This growing demand led inexorably to the "slow but steady deforestation of western Europe, Italy, and Spain, as well as Mediterranean islands. Oak became especially scarce." Dwindling timber supplies in the core and semiperiphery of the early modern world-economy led to the expansion of what we might call *cash-crop forestry* in the Baltic region, which by "the sixteenth century . . . had begun to export wood in large quantities to Holland, England, and the Iberian peninsula" (Wallerstein, 1974, p. 45). Moreover, European expansion in the Indian Ocean led to the incorporation of "India's teak forests . . . into the European world-economy as suppliers of timber for ships built in the dockyards at Goa" (Wallerstein, 1974, p. 337).

Undoubtedly, the most important instance of the new tendency toward monoculture was the rise of sugar as one of the leading export crops of the emergent world-economy.²¹ In the case of sugar, we have a "very lucrative and demanding product, pushing out wheat but then exhausting the soil, so that it required ever new lands (not to speak of the manpower exhausted by its cultivators)" (Wallerstein, 1974, p. 44; see also p. 89). I think this parenthetical reference is especially important. For Wallerstein, writing very much in the spirit of Marx (1977, pp. 283, 636-638), the transformation of nature is a labor process, and therefore, the degradation of nature is the degradation of the worker. This degradation of the worker could occur both at the point of production and through the instrument of world trade. Hence, the ecologically driven westward movement of sugar, first to the Atlantic islands and thence to the Americas, led to the emergence of a new, capitalist and racialized slave regime based on African laborers. But why Africans as the new slaves? Because in Africa, capitalists found a nearby area where it could extract slaves without concern

for its negative economic impact on the region. Moreover, the relatively low cost of slave labor was suited perfectly for sugar production, whose low skill requirements were matched by equally high mortality rates, high even by the standards of New World slavery (Wallerstein, 1974, pp. 86-90). The only really curious omission in this discussion of monoculture and the environment is a failure to discuss the ecology of wheat, the other great export crop of the 16th century. Although it was certainly not exhaustive of soil fertility to the same degree as sugar was, we might observe, with Braudel (1979/1981), that “wheat’s unpardonable fault was its low yield; it did not provide for its people adequately” (p. 120) and that it “devours the soil and forces it to rest regularly,” an ecological reality that “implied and permitted the raising of livestock” (Braudel, 1977/1977, p. 11)—itself a major factor in ecological transformation and one that sets Europe’s environmental history apart from, *inter alia*, China.

Whereas Wallerstein emphasizes the relations of class, state, and market, Braudel’s influence (see especially 1949/1972, 1949/1973, 1979/1981) pushed him to consider ecological factors to a far greater extent than many other students of historical capitalism. To his credit, Wallerstein adheres to a Marxist rather than Braudelian conceptualization of capitalism.²² This interpretation runs contrary to a popular caricature of world-systems analysis, which equates the world-system with the world market (R. Brenner, 1977; Stern, 1988). At best, this line of critique is guilty of a rather casual and one-sided reading of *The Modern World-System*. If anything, Wallerstein’s class analysis gives excessive weight to the dialectic of state and class rather than class and market (see especially, Wallerstein, 1974, pp. 132-162, 224-297). Even in these discussions, social classes’ position in the state and the character of the state itself are mediated by social forces at the point of production almost as much as by the world market. Wallerstein’s productionism is even more apparent in his discussion of the rise and demise of the United Provinces, the United Kingdom, and the United States as successive world hegemonic powers. In this scheme of things, Wallerstein prioritizes agro-industrial efficiencies as the propulsive mechanism behind hegemonic ascent (Wallerstein, 1980, pp. 36-71; 1984, pp. 37-46; for a critique, see Arrighi & Silver, 1999).

Even if we acknowledge that Wallerstein bends the stick too far in the direction of markets (Tomich, 1997)—no doubt in reaction to the hegemonic discourse of national developmentalism, Marxist and non-Marxist alike, in the 1950s and 1960s—this hardly makes him a neo-Smithian (i.e., non-Marxist); indeed, logically speaking, it is hardly more meritorious to emphasize production over circulation than the other way around. For all its brilliance and logical coherence, Robert Brenner’s (1977, 1985a, 1985b) proposed framework has served to close off from further inquiry some important social questions, such as the history and continuing role of imperialism and underdevelopment.²³ In contrast, Wallerstein’s approach, although it is partially imprisoned in older debates—such as the one initiated by Paul Sweezy and Maurice Dobb in the 1950s (see Hilton, 1976)—has opened a new research agenda that promises to transcend the increasingly sterile debate between production and circulation (see Tomich, 1976, 1997).

This reading of *The Modern World-System* suggests a retooled world-historical framework capable of illuminating the ways in which world market formation, the geographical expansion of capital, and the transformation and reorganization of world (or world-systemic) ecology interacted at multiple geographical scales—not only at the scale of the world-economy but also equally as a force behind uneven regional development and socioecological change at the point of production. Unfortunately, Wallerstein never develops these ideas systematically for historical

and analytical reasons. In the first place, *The Modern World-System* was written during a period of intense social unrest worldwide and a period when Marxist thinking about nature and capitalism had barely begun. The planetary ecological crises of global warming, species extinction, epidemic disease, and genetic pollution that appeared in the headlines every day during the 1990s were not so conspicuous three decades earlier. Moreover, the “profound split among left academics” during this period kept apart those academic currents that emphasized the environment and those that emphasized social justice, interests that were perceived by many at the time in exclusionary terms (Roberts & Grimes, 1999, p. 60). Given these limits, the extent to which Wallerstein considers the ecological dimensions of feudal crisis—and the ecological transformations fundamental to the origins of capitalism—is striking.

Yet, Wallerstein’s analytical strategy ultimately inhibited a systematic elaboration of a world-historical theory of capitalism and nature. Obviously, such an elaboration was not Wallerstein’s goal in *The Modern World-System*. Wallerstein does not develop a systematic account of capitalist environmental transformation because, like Robert Brenner (1977, 1985a, 1985b) and in contrast to Braudel (1977/1977, 1979/1982, 1979/1984) and Arrighi (1994), his analytical strategy prioritizes agrarian capitalism over its urban forms.²⁴ The emphasis on agrarian capitalism is for the most part right on target. Unless agriculture could be drawn into the orbit of capital accumulation and subjected to the competitive pressures of the law of value, capitalism could not develop, much less get started. Rather than simply reassert the importance of agriculture or city life in the emergence of capitalism, we should refocus our attention on the emergence of a new division of labor between town and country. As long as we adhere to an agrarian capitalism approach, our analysis of the modern world is necessarily one-sided. Paradoxically, getting away from the agrarian capitalism thesis actually gets us closer to an understanding of the agro-ecological realities of any given historical period by focusing our attention on the dialectic (antagonism) of town and country in the modern era and its metabolic rift.

TOWARD A WORLD-HISTORICAL ANALYSIS OF CAPITALISM AND NATURE: SYSTEMIC CYCLES OF AGRO-ECOLOGICAL TRANSFORMATION IN HISTORICAL CAPITALISM

Together, Marx’s concept of the metabolic rift and Wallerstein’s account of the transition to capitalism provide a useful starting point for the study of capitalism and nature. These ideas focus our attention on the historical specificity of the town-country division of labor and its metabolic rift as a fundamental ecogeographical feature of capitalism as a world-system that contained a powerfully globalizing spatial logic. However, once the ball gets rolling for historical capitalism, how do we account for its successive transformations of world ecology in the intervening six centuries? In highly compressed form, I will sketch in broad strokes the outline of an explanatory framework for the whole of modern world environmental history. At this point, I should reemphasize that my intent is to lay out what Marx called a *guiding thread* for subsequent investigations and to suggest hopefully new ways that social researchers can think about the dialectic of nature and society in the modern world.

My thesis is that the environmental transformations following the 14th-century crisis constituted a world ecological revolution (adapted from Merchant, 1989) that was central to the emergence of the world capitalist system in the long 16th century.

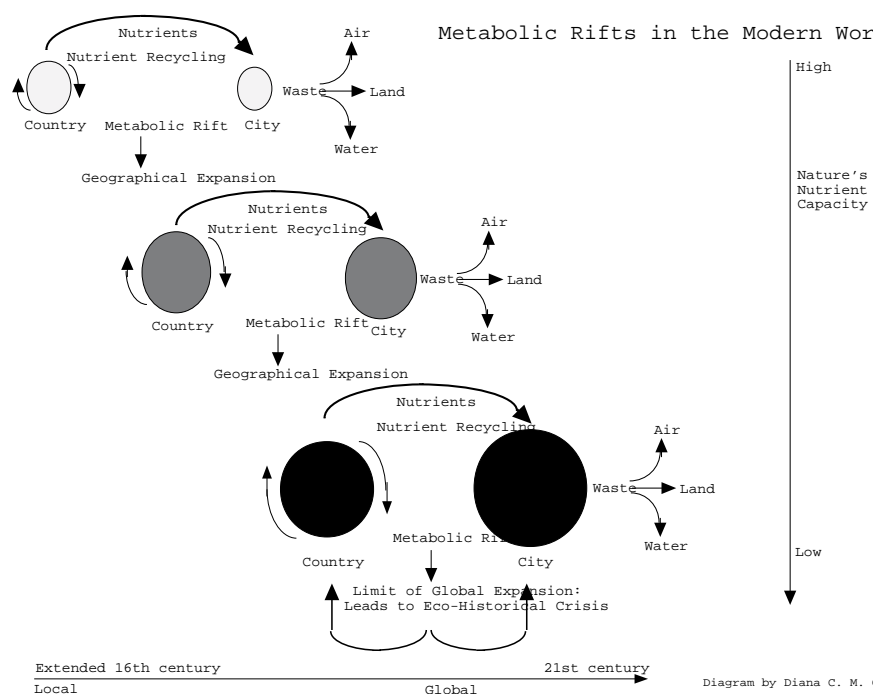


FIGURE 1: Metabolic Rifts in the Modern World-System

Note: Diagram by Diana C. M. Gildea.

This world ecological revolution was the first of many. In the centuries that followed, capital would face repeated accumulation crises on a world scale, which led to successive restructurings of the institutional and geographical configuration of the system. As Arrighi and his colleagues have argued, each new phase of capitalist development—which they call *systemic cycles of accumulation*—was marked by organizational revolutions in business organization, the emergence of new world hegemonies capable of organizing and leading the system, and new class structures (Arrighi, 1994; Arrighi et al., 1999).²⁵ What has been missed in this formulation—and the stages-of-capitalism literature in general—is the centrality of agro-ecological transformation in these successive restructurings of the system, including the present epoch of so-called globalization. Building on Arrighi's conceptual framework, I suggest that these successive phases of agro-ecological restructuring are best conceptualized as *systemic cycles of agro-ecological transformation* (see Figure 1). Each new phase of capitalist development ushers in a new, more intensive and more globalized exploitation of nature by capital.

Why this should be so has a lot to do with the nature of capitalist agriculture and the disequilibrium of capital accumulation on a world scale.

The impact of the metabolic rift has been exacerbated by the tendency of capitalist agriculture "toward the radical simplification of the natural ecological order," best represented by monocultural production (Worster, 1990, p. 1101; see also Haila & Levins, 1992, chapter 5). In practice, such simplification meant that from the early modern era, there was "a division of labor not only between agricultural tasks and industrial tasks, but among agricultural tasks as well," especially between

cereals agriculture and pasturage (Wallerstein, 1974, p. 84). We might add another crucial division between agriculture and pasturage on one side and, on the other side, mining activities that devastated mountain ecosystems and poisoned the rivers and soil below (Dore, 1991; Dunaway, 1996).

The result has been a progressive widening and deepening of the metabolic rift not only between town and country but also between country and country. By facilitating such regional specialization, the vastly greater scale of the capitalist world-economy's markets and its agrarian division of labor magnified the disruptive ecological effects of the town-country division. Certainly, monocultures long predate capitalism. With the transition to capitalism, however, such monocultures become incomparably more intensive, larger in scale, and more durable over time. The development of a world division of labor comprising most of Europe and the Americas—one that was shaped, reshaped, and progressively expanded under the impetus of a highly competitive world market and interstate system—made possible, indeed necessitated, a degree of monocultural specialization that was impossible in earlier systems. Far from being evenly distributed, these new monocultures were concentrated in the periphery (Wallerstein, 1974, p. 102; e.g., pp. 15-129); indeed, they were the prime agents of peripheralization.

Under conditions of generalized commodity production and the imperative of ceaseless capital accumulation, specialization destabilized local ecosystems. Local ecosystems that might otherwise have regenerated in time were not allowed to do so. Destabilization in turn led to falling productivity and profitability and thence the renewed search for fresh land, often found outside the existing boundaries of the capitalist world-economy. As goes the search for fresh land, so goes the quest for new labor. As Karl Polanyi (1957) argued some 50 years ago, capital's inner logic is to commodify the land and labor that provides the foundation for continued accumulation, thereby undermining the human and natural foundations of the system. From the perspective of capital, the best solution was expanding geographically and, secondarily, restructuring the labor systems and agro-ecological relations within the system's existing boundaries.

Hence, the opening of the world scale metabolic rift in the 16th century meant that capitalism could not survive as a *closed-cycle system*, to borrow a phrase from ecology. Whereas closed-cycle systems "continuously recycle their own nutrients," capitalism is a "flow system" that is "depend[ent] upon an external nutrient supply that . . . [it] cannot . . . produce" (Fischer-Kowalski & Haberl, 1993, p. 416). Capitalism is not only dependent on an external nutrient supply. More to the point, given the imperative of ceaseless growth, capitalism's dependence on external resources rises over time, requiring ever larger energy inputs to reproduce itself. As a result, the system experiences a geometrically increasing energy density that today is fast approaching natural limits, as capital hogs an ever larger share of the world's energy for itself, leaving an ever smaller share for the planet's other residents.²⁶ As long as the capitalist world-economy did not encompass the entire globe, these natural limits could be overcome by geographical expansion and, to a lesser extent, by a shift to capital-intensive agriculture, although the possibility of the latter ultimately depended on the success of the former.

From this perspective, Rosa Luxemburg's (1970) insights on the indispensable function of the "non-capitalist environment" (p. 417) for capital accumulation, and the former's gradual penetration and destruction by capital and imperial states, can be applied to the historical relation between capital and nature.²⁷ "The accumulation of capital *is a kind of metabolism* [italics added] between capitalist economy and those pre-capitalist methods of production without which it cannot go on and

which, in this light, it corrodes and assimilates” (Luxemburg, 1970, p. 416). The same argument that Luxemburg applies to noncapitalist social organizations can be applied to ecosystems hitherto beyond the direct reach of capital.²⁸ In this way, the imperative of capitalist spatial expansion—one of the few imperatives actually grasped by contemporaries in the early modern era (Hopkins & Wallerstein, 1977)—can be seen to contain a profoundly ecological dimension. Indeed, ecological degradation may be said to have been the primary force behind the cyclical geographical expansion of the world-economy from the 15th to the 19th century, when the entire globe was finally drawn into capital’s orbit.

This means that the ecological transformations that constituted a decisive moment of “primary” accumulation (Marx, 1977, pp. 873-940) did not end with the collapse of feudalism. Rather, these transformations were primary in a double sense—a moment of primary accumulation *and* the first moment of a long-run trend, which has manifested in a succession of systemic cycles of agro-ecological transformation.²⁹

Systemic Cycles of Agro-Ecological Transformation

Each systemic cycle of accumulation is characterized by a phase of material expansion, followed by a phase of financialization when the previously hegemonic territorial and business organizations are challenged and eventually displaced by a new world hegemony and a new group of capitalists who innovate by leading an organizational revolution (Arrighi, 1994).

Just as the phase of material expansion marking the beginning of each new systemic cycle is created by a new organizing center of politico-military and economic power, so the conditions for material expansion must be rooted in a new, geographically broader and technically more intense mode of capitalist ecological exploitation. During these overlapping periods of crisis and reorganization, the system’s relationship with the environment assumes special importance. In such periods,

The internal structure of the system (its internal equilibrium) must change together with the relation existing between the system and its environment. The latter relation is the decisive factor . . . for the character of the equilibrium between society and nature determines the fundamental course of the motion of society. (Bukharin, 1925, p. 79)

As in commerce and manufacturing, each fundamental reorganization of world ecology yields increasing returns during the phase of systemwide material expansion (see Figure 2). In this context, increasing returns can be accomplished in two main ways.³⁰ Production can be reorganized to maximize the marketable surplus by minimizing the consumption of the direct producers. This was often the case in the early modern world, among European peasants and American slaves (Wallerstein, 1974, pp. 44).³¹ Alternatively, production can be reorganized in a more typically capitalist manner by increasing productivity, which is measured by units of land, labor, or capital inputs and achieved through various technical and social innovations. Naturally, in any historical epoch, we see some combination of these two means of increasing the agricultural surplus. It seems to be the case, however, that over the centuries, the first mode has been gradually eclipsed by the second. Moreover, it is probable that the first strategy regains prominence during periods of transition from one phase of capitalist development to the next, as the normal operation of the market breaks down. During such crisis periods, renewed capital accumula-

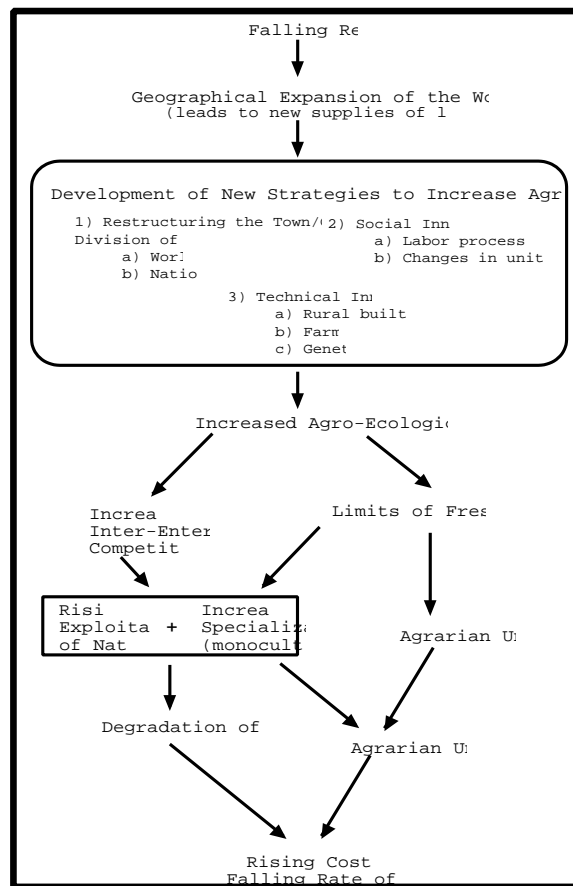


FIGURE 2: General Schematic for Systemic Cycles of Agro-Ecological Transformation
 Note: Diagram by Diana C. M. Gildea.

tion by means of the market is possible only once the social relations of particular societies and the world-system as a whole are reorganized by means of state power. The mistake is to see these as exclusive strategies, one being noncapitalist and the other being capitalist. Regardless of the strategy, each reorganization of agricultural production and extraction, to the extent that it achieves an increase in the marketable surplus, is a precondition of renewed capital accumulation. We might consider, for example, how the creation of plantations and the plantation complex in the early modern era was a necessary condition for the material expansion represented by the growth of the slave trade, shipbuilding, and, eventually, the so-called Industrial Revolution (Blackburn, 1997; Curtin, 1990; Mintz, 1986).

As each material expansion breaks down under the pressure of escalating interenterprise competition, planters, farmers, and other agricultural commodity producers (including miners) intensify the exploitation of the environment, leading to diminishing returns. Fresh supplies of land are needed, and fresh supplies of workers are required to work the new land. The bulk of the capital necessary to reorganize production, largely through the establishment of new production sites, is supplied by the rising hegemon. For example, in the early 17th century, Dutch capi-

tal was behind the development of the West Indies sugar plantations (Edel, 1969), shifting the center of sugar production away from Brazil; alternatively, after the mid-20th century, U.S. agribusiness opted for a vigorous strategy of transnational expansion that was a key component behind the green revolution. New, more technically and socially advanced forms of agricultural enterprise, such as the plantation or the capital-intensive family farm, become possible on these virgin lands—that is, lands free, or relatively so, from previous capitalist exploitation.³² Thus, each new arrangement of agro-ecological production constitutes an indispensable pillar of each new systemic cycle.

During the early phases of each new systemwide material expansion, capitalists develop new, more intensive modes of agro-ecological exploitation. This establishes, in a fundamental way, the conditions for renewed material expansion in commerce and manufacturing. As interenterprise competition increases over the course of the systemwide expansion, so the capitalist exploitation of nature increases. Escalating ecological exploitation leads to rising costs, which over time necessitates a fundamental reorganization of world ecology, not to mention the world-economy as a whole. Each reorganization is not merely organizational and technical, it is crucially a new phase of the geographical expansion of the world-economy, which is accompanied by the deepening subordination of agriculture to the law of value in regions where capitalism has long held sway. Moreover, such periods of expansion were invariably moments of primitive accumulation on a world scale, which is not so much ongoing as cyclical. In the New World, such primitive accumulation was typified by frontier expansion (see J. W. Moore, 1997b, 2000b), whereas in Africa and Asia, it assumed a more classical form—the production of a class of producers, with nothing to sell but their labor power, and a (colonial and comprador) class of capitalists. The dialectical relation between these two arenas of primitive accumulation is found in the central importance of the New World for the emergence of capitalism, which in turn developed European military power and business organization to the point at which it could incorporate Asia, which contained the world's greatest concentrations of wealth (Frank, 1998).

Each successive reorganization of world ecology serves a double purpose: (a) The reorganization of agro-ecology increases demand for the means of production (slaves, fertilizers, tractors, genetically engineered crop varieties, etc.), which permits raising the output of primary products in a more cost-effective way than previously possible, thereby cutting costs for industrial and commercial capital and allowing for a new phase of material expansion; (b) through the process of primitive accumulation, each reorganization leads to widespread deruralization and the creation of a massive reserve army of labor that ultimately lowers costs and provides capitalists with new opportunities for the reorganization of industry. The newly and greatly enlarged reserve army is, in turn, fed more cheaply (cutting capital's wage bill even further) by the new organization of agriculture on a world scale. The process then begins again, each time generating social and ecological contradictions that are increasingly powerful and disruptive.

Thus, each new systemic cycle of accumulation marks a world transformation of the ecological relations of production on multiple geographical scales. I suggest that there are eight primary transformations. These transformations play out differently across the different zones of the world-economy—developments in the core differ from developments in the periphery and semiperiphery, and changes and conflicts in areas long experienced with capitalism are different from those in regions that only recently have been incorporated in the system. Moreover, not every systemic cycle is accompanied by a fundamental shift in all categories. First, as noted,

the world-economy's division of labor has been extended until it encompassed the entire globe by the early 20th century. Second, the town-country division of labor was reorganized at the scale of the world-economy and the states. Vast regions of the globe were reorganized to provide agricultural and other primary products to core states. The trend toward specialization and monoculture was consequently reinforced over time. Third, the agricultural unit of production changed. For instance, proprietary plantations gave way to corporate plantations in the late 19th century (Beckford, 1972; J. W. Moore, 1999). Fourth, the dominant form of labor organization and labor process changed. Fifth, the rural built environment was transformed, particularly through the construction of irrigation projects, railroads, and so forth. Sixth, the kinds of farm inputs changed. Seventh, the global organization and control over genetic stock shifted to place more power in the hands of core states and capital. Finally, each systemic cycle of agro-ecological transformation has been shaped by intense agrarian resistance from below.

I propose that there are five systemic cycles of agro-ecological transformation.

1350s to 1580s. During the transition from feudalism to capitalism, the rising tide of rural and urban unrest led Europe's states and landlords to turn toward the world market and its geographical expansion. Between 1535 and 1680, European control extended "from about three million square kilometers to about seven" (Chaunu, 1959, p. 148, as cited in Wallerstein, 1974, p. 68).³³ In the northwestern European core, subsistence producers gave way to a class of capitalist farmers, gradually shifting toward more productive agriculture techniques such as the three-course rotation and convertible husbandry (R. Brenner, 1985a; Slicher van Bath, 1963). In the new peripheries of eastern Europe and the Americas (including the Atlantic islands), new agricultural enterprises emerged: the eastern European manor, based on the second serfdom, and the American plantation, based on African slavery (Kay, 1975; Malowist, 1959; Wallerstein, 1974). In both enterprises, monocultural specialization was the norm. In the Americas, the European invasion initiated not only epidemic disease of apocalyptic proportions but also a Columbian exchange of flora and fauna (Crosby, 1972, 1986).

1590s to 1750s. A new period of agro-ecological restructuring began at the end of the 16th century. The world-economy expanded to include significant parts of North America and the West Indies; although in contrast to the previous and subsequent systemic cycles, this period is marked by consolidation (Arrighi, 1994). In the first half of the 17th century, agrarian unrest increased dramatically, comprising a key moment of the political upheavals of the eras, which included the Dutch and English revolutions, the Fronde in France, and the revolt in Catalonia (Mousnier, 1970; Wallerstein, 1980). Probably the most important agro-ecological development in this era is the maturation of the plantation complex, with its extension to the West Indies and the southern colonies in British North America. With the flowering of the plantation system, the African slave trade became a major arena of capital accumulation (Blackburn, 1997; Curtin, 1990; Williams, 1944). Also in the Americas, with the discovery of mercury deposits at Huancavelica in 1563, there occurred a "quantum leap in the [mining] industry's environmental impact" (Dore, 1991, p. 15). The mining center of Potosi became one of the largest cities in the European world-economy, growing to 350,000 by the close of the 16th century. In Southeast Asia, the Dutch moved to control not only the spice trade but also the spice production, laying waste to competing centers of production and asserting their hegemony over the remaining centers (Furber, 1976).

1760s to 1870s. Beginning in the mid-18th century, a new wave of capitalist agrarian transformation swept over the core, and the world-economy again expanded dramatically, producing major transformations of agrarian life in the new peripheries. Between 1815 and 1878, Europeans expanded direct colonial rule from 55% of the globe to 67% (Fieldhouse, 1966, p. 178).³⁴ The first half of this period, from the 1760s to the early 1800s, was characterized by the so-called world revolution of the West, which comprised numerous agrarian revolutions throughout the expanding world-economy: the French, Haitian, and American Revolutions; the Tupac Amaru revolt in Peru; the Pugachev uprising in Russia; and lesser movements elsewhere (J. W. Moore, 1997c; Palmer, 1954; Silver & Slater, 1999; Wallerstein, 1989, pp. 193-256). In England, the rate of enclosures accelerated in the 1760s; in France, the so-called aristocratic reaction before the revolution was in fact a bourgeois offensive to impose a capitalist logic on the countryside; and in the United States, the triumph of the Southern planters and the Northern mercantile bourgeoisie in the American Revolution led to the capitalist transformation of agriculture that eliminated subsistence-oriented agriculture everywhere but the frontier (Braudel, 1979/1982, pp. 293-296; Mantoux, 1961; J. W. Moore, 1997b; Post, 1995; Wallerstein, 1989, pp. 41-42, e.g. chapter 1 passim). In the new peripheries, we see more of the same. In India, beginning in the 1760s, the British rulers imposed a “burden of taxation on agricultural producers [that] reached unprecedented heights” (Arrighi et al., 1999, pp. 111, 113). The resulting “squeeze” on the direct producers “led to a superexploitation of land and other natural resources, which tended to destroy the productiveness of nature” (Bagchi, 1982, p. 84). Finally, vast new semiperipheries were set into play—Russia and the White settler zones of the United States, Australia, Canada, and others were drawn into the world market as major agricultural exporters. During the apogee of British hegemony in the mid-19th century (from 1840 to 1870), world cultivated land increased 50% and the volume of world agricultural trade grew by 450% (Hobsbawm, 1975, p. 196; Ponting, 1991, p. 224). This was made possible by developments in the built environment: Transportation infrastructure expanded dramatically with railroads and the steamship. Toward the end of this period, the first steps toward the mechanization of agriculture began, particularly in the United States and the West Indies (Post, 1995; Tomich, 1991, 1994). The first era of slavery was being phased out with Britain’s emancipation of the slaves in its colonies in the early 1830s, but a second slavery had already begun in areas controlled by Britain’s rivals—Spanish Cuba, Portuguese Brazil, and the American South (Tomich, 1988). Finally, the British became not only the commercial and financial clearinghouse and workshop of the world but also the global organizing center of botanical imperialism (Broswimmer, 1991). In fact, a decisive aspect of Britain’s colonial strategy was the appropriation of the world’s genetic stock. For instance, the Opium War was not just about opium, it was also about breaking China’s monopoly in the tea trade. In 1848, Robert Fortune moved some 2,000 tea plants and 17,000 seeds from China to India. By the end of the century, the English were drinking tea grown in India, not China (Juma, 1989, p. 49).

1870s to 1940s. The era stretching from the late 19th century to the Second World War witnessed the industrialization of agriculture to an unprecedented extent. The momentum of geographical expansion set in motion by the rise of British hegemony was reinforced rather than slowed by the decline of British hegemony during the Great Depression of the later 19th century (circa 1873-1896). European control of the globe extended from 67% to 84.4% between 1878 and 1914

(Fieldhouse, 1966, p. 178). Once again, the scale and scope of agrarian unrest increased dramatically, leading to social revolutions in Mexico and Russia and increasingly powerful anticolonial movements in the new peripheries, especially in Africa and Asia (J. W. Moore, 1999).

In contrast to the era of British hegemony, this period was characterized by the formation not just of protected national economies—this being one of the major factors in Britain's decline—but also of national agricultures in the core (Friedmann & McMichael, 1989). The United States led the way, organizing a dynamic interregional division of labor in which farm households became more specialized and relied increasingly on heavy capital inputs such as reapers and threshers. Because of specialization, farmers consumed an ever larger amount of producer goods, and because time was increasingly scarce, farmers consumed progressively more consumer goods (Friedmann, 1978). The precondition for such specialization was the completion of the process of primitive accumulation begun during the previous epoch. Family farms in the core were no longer subsistence producers who marketed their surplus but were commodity producers who had no choice but to sell to survive (J. W. Moore & Gildea, in press; Post, 1995). In the periphery, subsistence-oriented producers were drawn into commodity production in varying ways—sometimes becoming sharecroppers, sometimes rural proletarians, or sometimes (but rarely) petty commodity producers. By the early 20th century, these transformations in the periphery produced not only deepening social contradictions and growing peasant unrest but also equally an ecological crisis (Wolf, 1969). Probably the most significant change in the structure of peripheral agricultural enterprises was the shift from the proprietary plantation to the corporation plantation, which was mainly in the Americas. This was made possible in part by the process of primitive accumulation in Asia, which freed a large number of former producers to become contract laborers in the Americas (Northrup, 1995). Such coreward immigration was hardly confined to Asians; agrarian transformation throughout Europe created a huge surplus population, many of whom migrated to North America. Finally, the reorganization of world ecology involved for the first time a massive reorganization of the rural built environment. This was especially evident in efforts to control water, particularly in the American West, India, and Egypt, and railroad construction (see J. W. Moore, 1999).

1950s to the present. It may well be the case that the era of agro-ecological transformation that began after the Second World War is coming to an end. It is too soon to tell. With the opportunities for geographical expansion foreclosed, capital shifted from an expansionist strategy to an intensification strategy. This has been the era of the so-called green revolution. This effort faced formidable barriers, however, in the social contradictions of the previous era, which generated powerful peasant movements and a series of epochal peasant wars, including China, Cuba, Algeria, Vietnam, and others (Wolf, 1969). Hence, the progress of the green revolution has only now begun to reach its totalizing maturity. This revolution has been the latest (and possible last) phase of primitive accumulation on a world scale; it has been all the more intense because there are no more frontiers. At the core of the green revolution was the production of high-yielding variety seeds. In reality, the production of and control over genetically engineered seeds have been only one part of a broader strategy pursued by the United States and its transnationalizing agribusinesses. This strategy aims at commodifying “a whole range of . . . [farm] inputs: fertilizers and pesticides, irrigation equipment, tractors,” and so forth (Pelizzon & Casparis, 1996, p. 129; George, 1977). The result has been an

intensification of the highly unequal “global division of labor associated with colonialism” (McMichael, 1998, p. 100). Whereas Europe’s per capita wealth was 40 times greater than China’s or India’s in 1940, it was 70 times wealthier by 1990 (Dore, 1992, p. 73). In core and peripheral societies alike, although with much greater force in the latter, the worldwide turn toward export agriculture in the 1970s “destabilized family farming.” Particularly in the periphery, agricultural regions have been transformed into “agro-export ‘platforms’” characterized by

a widespread subordination of producing regions to global production and consumption relations organized by transnational food companies. . . . Under these conditions, agriculture becomes less and less a foundational institution of societies and states, and more and more a tenuous component of corporate global sourcing strategies. . . . Further, the corporate strategy of incorporating regions into global production and consumption relations simultaneously undermines the institutional bases of national farm sectors, in the North as well as the South. (McMichael, 1998, pp. 102, 104)

The logic of the green revolution is generating increasingly serious ecological and social contradictions. For example, in 1995, U.S. farmers spent \$40 billion in pesticides “to save approximately \$16 billion in U.S. crops.” Essentially, the green revolution has destroyed these food crops’ immune systems (Altieri, 1998, p. 64; Perfecto, 1992). Socially, the direct and indirect impact of the green revolution—through primitive accumulation in the countryside and the growth of third-world megacities—is fast leading to serious social problems in both the core and periphery. By the 1990s, some 75 million people moved from the periphery to the core each year (Barnet & Cavanagh, 1994, p. 296). In the periphery, the growth of megacities provides the context for serious urban disorder, which is interestingly enough a major issue behind the green revolution (Pelizzon & Casparis, 1996, p. 129). An equally serious threat to capital, but more promising of ecological sanity, is the emergence of a new peasantry, particularly in Latin America, that has developed on the basis of the new agrarian class relations brought into existence in the postwar era (Petras, 1997).

CONCLUSION

Much historical detail and theoretical rigor have been lost in the foregoing sketch. Nevertheless, I think we can draw some important conclusions. First, the history of capitalism is not simply the logic of capital, or the dialectic of states and capital, writ large (cf. Arrighi, 1994). This would be a most one-sided history in which land and labor appear as objects to be reshaped according to the needs of capital (Herod, 1997; Lebowitz, 1992a, 1992b). Rather than suggest any definitive answer to the questions posed by the complex and ever-shifting dialectics of capital, state, labor, and nature, I suggest that a synthesis of the concepts of the metabolic rift, the world-system, and systemic cycles of accumulation offers a new vantage point from which to view the interconnections between agro-ecological restructuring, class struggles, and capital accumulation since the long 16th century. This is so because capitalist agriculture as an ecosocial process involves not only economic and ecological transformation on a global and local scale but also equally has far-reaching implications for class structure, class struggle, and national political regimes (B. Moore, 1996; Wolf, 1969).

What this article brings into focus is the historical geography of capital's "global expansionary logic" (Meszaros, 1995, p. 6) manifest in the new, antagonistic, and inherently unstable division of labor between town and country under capitalism. As a condition of its very existence, this new division of labor was based on a metabolic rift that, precisely because of its unsustainability, was fundamentally globalizing in nature. That is, because of its metabolic rift, capitalism has been unable to sustain itself as a closed system, in which nutrients are recycled, but rather only as a flow system, requiring ever greater external inputs to survive. As a result, the system is compelled to seek out fresh land beyond its boundaries. Fresh land, however, is worthless without fresh labor. Consequently, each expansion of the world economy has been accompanied not only by an expansion of the system's potential natural resource base but also equally by a new phase of primitive accumulation, which is not only an economic and ecological process but also equally a moment of intense class struggle. These fresh supplies of land and labor, in turn, are worthless without a reconstruction and expansion of the system's built environment, especially its transportation networks, its control of water and genetic stock, and its urban forms and agrarian settlement patterns—in sum, a reorganization and geographical extension of the town-country division of labor. This process of agro-ecological restructuring and spatial expansion is cyclical rather than continuous because each new sociospatial organization of accumulation, and agro-ecological relations in particular, at first liberates and then imprisons accumulation. The benefits of ecological exploitation on a progressively wider and deeper scale were and remain self-limiting, as nature exacts its revenge. Until the 20th century, the imprisoning contradictions of the accumulation process—in their social, economic, and ecological forms—could be escaped through geographical expansion. With the possibilities of the spatial fix foreclosed, however, capital turned toward inner expansion, among other things commodifying and therefore simplifying the world's genetic stock. Meanwhile, such inner expansion on a now global scale has been possible because capital has used the planet as a sink for its exponentially growing volume of waste. In so doing, it has generated ecological contradictions of an unprecedented nature. By locating the origins of modern ecological degradation in the 16th century, I suggest that the ecological contradictions of the present are not essentially rooted in industrialization or corporate depredation but are found rather in the logic of capital itself.

NOTES

1. Marx (1971) wrote, "The urban labour of the Middle Ages already constitutes a great advance and serves as a preparatory school for the capitalist mode of production, as regards the continuity and steadiness of labour" (p. 434).

2. Marx (1968) wrote,

With regard to the *accumulation of capital in the towns during the Middle Ages*, Adam Smith very correctly notes . . . that it was principally due to the exploitation of the country (by trade as well as by manufacture). (There were in addition the users and even haute finance; in short, the money merchants.) (p. 232)

3. Marx and Engels (1970) wrote,

The separation of town and country can also be understood as the separation of capital and landed property, as the beginning of the existence and development of

capital independent of landed property—the beginning of property having its basis only in labour and exchange. (p. 69)

4. Marx (1973) wrote,

The value of the old industry is preserved by the creation of the fund for a new one in which the relation of capital and labour posits itself in a *new* form. Hence the exploration of all of nature in order to discover new, useful qualities in things; universal exchange of the products of all alien climates and lands; new (artificial) preparation of natural objects. . . . The exploration of the earth in all directions, to discover new things of use as well as new useful qualities of the old; such as new qualities of them as raw materials etc.; the development, hence, of the natural sciences to their highest point . . . is likewise a condition of production founded on capital. This creation of new branches of production . . . [is a decisive moment of] the development of a constantly expanding and more comprehensive system of different kinds of labour, different kinds of production, to which a constantly expanding and constantly enriched system of needs of corresponds. . . . Just as production founded on capital creates universal industriousness on one side—i.e. surplus labour, value-creating labour—so does it create on the other side a system of general exploitation of the natural and human qualities. . . . Thus capital creates the bourgeois society, and the universal appropriation of nature as well as of the social bond itself by the members of the society. Hence the great civilizing influence of capital; its production of a state of society in comparison to which all earlier ones appear as mere *local developments* of humanity. . . . For the first time, nature becomes purely an object for humankind, purely a matter of utility; ceases to be recognized as power in itself; and the theoretical discovery of its autonomous laws appears merely as a ruse so as to subjugate it under human needs, whether as an object of consumption or as a means of production. *In accord with this tendency, capital drives beyond national barriers and prejudices* [italics added]. . . . It is destructive of all of this, and constantly revolutionizes it, tearing down all the barriers which hem in the development of production, the expansion of needs, the all-sided development of the forces of production, and the exploitation and exchange of natural and mental forces. (pp. 409-410)

5. Braudel wrote, “The urban proletariat cannot maintain itself, let alone increase without the help of continuous immigration” (Braudel, 1949/1972, p. 334; 1981, pp. 490-491).

6. For the early modern era, our best evidence for agricultural specialization is derived from regional-level trends (e.g., see Wallerstein, 1974, pp. 84-129).

7. Although a full discussion of this matter would take us too far afield, it is notable that despite its growing strength, urban-based capital conquers manufacturing first in the countryside (Wallerstein, 1974, pp. 81-82).

Consider Marx’s (1964) observations:

The original historical forms in which capital appears at first sporadically or *locally, side by side* with the old modes of production, but gradually bursting them asunder, make up *manufacture* in the proper sense of the word (not yet manufacture). This arises, where there is mass-production for export—hence of the *basis of large-scale maritime and overland trade*, and in the centers of such trade, as in the Italian cities, Constantinople, the Flemish, Dutch cities, . . . etc. Manufacture does not initially capture the so-called *urban crafts*, but the *rural subsidiary occupations*, spinning and weaving, the sort of work which least requires craft skill, technical training. Apart from those great emporia . . . manufacture first establishes itself not in the cities but in the countryside, in villages lacking g[u]ilds, etc. (p. 116)

8. Luxemburg (1970) wrote,

It is a recurrent phenomenon in the development of capitalist production that one branch of industry after the other is singled out, isolated from agriculture and concentrated in factories for mass production. . . . Capital must get the peasants to buy its commodities and will therefore begin by restricting peasant economy to a single sphere—that of agriculture. (pp. 395-396)

Identifying the same process, Marx (1968) observed, “This is why in the Middle Ages, the towns prohibited the spread of as many professions as possible to the countryside, not merely for the purpose of preventing competition . . . but in order to create markets for themselves” (p. 269).

9. Pelto and Pelto (1985) wrote,

By “delocalization” . . . we refer to processes in which food varieties, production methods, and consumption patterns are disseminated throughout the world in an ever-increasing and intensifying network of socio-economic and political interdependency. . . . Delocalization means that an increasing portion of the daily diet comes from distant places usually through commercial channels. (pp. 309-310)

10. This extension of Foster’s logic is consistent with his *The Vulnerable Planet* (1994), in which he argues that the emergence of capitalism in the 16th century was the beginning of a profound and negative change in nature-society relations (see Foster, 1994, pp. 35-36, 40-41).

11. Far from a result of inefficiency or shortsightedness, the production of waste is in fact a basic feature of the monopoly capitalist order that coalesced in the advanced capitalist countries in the later 19th century and has since spread to all regions of the world-economy (see Dowd, 1989; Foster, 1994, pp. 14-33, 108-124).

12. The formulations in this paragraph were developed jointly with Diana Gildea (see J. W. Moore & Gildea, 1999).

13. Frequently characterized as a deviation from Marxism, it bears repeating that “the idea of a world-system was there and not there at the same time, from the beginning, in Marxist thought” (Wallerstein, 1991, p. 590).

14. Marx (1973) wrote,

The conclusion we reach is not that production, distribution, exchange and consumption are identical, *but that they all form the members of a totality* [italics added], distinctions within a unity. Production predominates not only over itself, in the antithetical definition of production, but over the other moments as well. . . . A definite production thus determines a definite consumption, distribution, and exchange as well as *definite relations between these different moments*. Admittedly, however, *in its one-sided form*, production is itself determined by the other moments. For example, if the market, i.e., the sphere of exchange, expands, then production grows in quantity and the divisions between its different branches become deeper. A change in distribution changes production, e.g. concentration of capital, different distribution of the population between town and country, etc. Finally, the needs of consumption determine production. *Mutual interaction takes place between the different moments. This is the case with every organic whole* [italics added]. (pp. 99-100)

On the basis of the above passage from the *The Grundrisse*, Dale Tomich (1997) argues that “neither production nor exchange may be privileged as the singular authentic domain of social historical development.” Instead, he suggests an alternative framework wherein

production may be theoretically constructed as a *general historical relation* that presupposes distribution, exchange, and consumption. . . . In this formulation, . . . production and exchange are understood as relations that presuppose, condition, and are formative of one another as distinct parts of a whole. . . . The relevant unit of analysis is defined by the extent of the interrelated processes of production, distribution, exchange, and consumption. *As a general category*, production is defined through its relation to the other moments of this process; its coherence, scope, and significance are defined within this conceptual field. If production is to be treated as determinant, it is determinant with regard to the totality of these relations. (pp. 299-301, italics added)

In a related but more geographical line of argument, Richard Peet (1980) observes,

If we need to introduce exchange relations as at least a major component in the transition [from feudalism to capitalism], . . . these relations should be integral to our understanding of modes of production in the first place. A mode of production, then, should be seen as a mode of social *and* spatial organization. Spatial organization includes the territorial division of labour, trade relations, and the geographical transfer of surplus value. *Spatial organization* is predicated on the forces and social relations of production . . . but also has a relative autonomy . . . *that is, it changes in part under its own dynamic.* (p. 73)

In my view, Tomich's and Peet's arguments get far closer to both the spirit and the letter of Marx's writings on the transition to capitalism and capitalist development than, say, the approach of Robert Brenner.

15. Kosminsky (1955) wrote, "The growth of feudal exploitation began to exhaust peasant agriculture and at the same time whittle down the productive forces of feudal society, destroying the conditions for reproduction of the labor force" (p. 32, as cited in Wallerstein, 1974, p. 24, note 27).

16. Tilly (1975) wrote,

That one or two percent [of Europe's total consumption provided by Baltic grain] was nevertheless exceptionally important, both because of the prosperity it brought to such seafarers as the Dutch and because it represented the margin of survival for capital cities like Lisbon. (p. 416)

17. Throughout this article, I will use the terms *inner expansion* and *outer expansion*, following Hopkins and Wallerstein (1977):

The literature on agricultural history has indicated a clear pattern over time of "inner" expansion, in the sense that not all the areas physically located inside the outer boundaries of the world-economy had necessarily been from the outset involved in the social economy. There were "subsistence redoubts." It is clear that, as a process, the incorporation of areas at the outer edges and the areas that were redoubts inside it were the same phenomenon economically, even if it had a different definition juridically and perhaps different prerequisites politically. (p. 125)

As Chase-Dunn and Hall (1997) have demonstrated, all social systems pulsate; that is, they expand and contract, both in the territorial extent of their power and in the density of that power. I suggest an amendment to the Hopkins and Wallerstein (1977) distinction between inner and outer expansion. The term *inner expansion* refers to a dynamic of systemic geographical expansion that is primarily land based, especially internal colonization. The term

outer expansion refers to systemic expansion that is primarily accomplished through the development and extension of sea power.

18. Indeed, Europe's population in 1500 was about the same as in 1300 (McEvedy & Jones, 1978, p. 18; Slicher van Bath, 1963).

19. These expansionary movements included

the gradual reconquest of Spain from the Moors, the recuperation by Christian Europe of the Balearic Islands, Sardinia, and Corsica, the Norman conquest of Southern Italy and Sicily . . . the Crusades, with its addition first of Cyprus, Palestine and Syria, then of Crete and the Aegean Islands. In Northwestern Europe, there was English expansion into Wales, Scotland, and Ireland. And in eastern Europe, Germans and Scandinavians penetrated the lands of, conquered, and converted to Christianity Balts and Slavs. (Wallerstein, 1974, p. 38)

20. Here again we can see Marx's influence at work behind Wallerstein's account of the transition to capitalism. See Marx's discussion of sheep farming and primitive accumulation in the first volume of *Capital* (Marx, 1977, pp. 878-881, 891-893).

21. It is important to note that the trend toward monoculture was most evident in the periphery. "The trend in the *core* was towards variety and specialization [in high value-added crops]" (Wallerstein, 1974, p. 102).

22. Braudel's definition of capitalism centers on the self-expansion of capital rather than any transformation of productive relations as such. For Braudel (1977/1977, 1979/1981, 1979/1982, 1979/1984), capitalism is constituted by the most profitable activities in a given world-economy, usually long-distance trade and finance, although since the early 19th century, this includes industrial production as well. As such, capitalism is distinct from the zone of the market economy, constituted by low-profit, regularized market exchanges, and the zone of everyday life, constituted by such quotidian processes as agronomy, households, city life, and so forth (see Tilly, 1984, pp. 65-74; for further discussion, see J. W. Moore, 1997a). In contrast, Marx (1973, 1977) emphasized the historical specificity of the relationship between capital and the transformation of social relations, a relationship that Braudel would argue is quite weak and not essential to capitalism.

23. Indeed, reading R. Brenner's (1998) recent account of global capitalism in the post-World War II era, there is barely a mention of the periphery, not to mention the class struggle (for a critique, see Foster, 1999b).

24. Wallerstein (1974) wrote, "The emergence on an industrial sector was important, but what made this possible was the transformation of agricultural activity from feudal to capitalist forms" (p. 126).

25. We may interpret Marx's general formula of capital (M-C-M [money to commodity to money]) as depicting not just the logic of individual capitalist investments but also a recurrent pattern of historical capitalism as a world-system. The central aspect of this pattern is the alternation of epochs of material expansion (i.e., M-C [money to commodity] phases of capital accumulation) with phases of financial rebirth and expansion (i.e., C-M [commodity to money] phases). In phases of material expansion, money capital sets in motion an increasing mass of commodities (commoditized labor power and gifts of nature included), and in phases of financial expansion, an increasing mass of money capital sets itself free from its commodity form and accumulation proceeds through financial deals (as in Marx's abridged formula of M-M [money to money]). Taken together, the two epochs or phases constitute a full systemic cycle of accumulation (M-C-M). Starting from these premises, we can identify four systemic cycles of accumulation: (a) a Genoese-Iberian cycle, stretching from the 15th through the early 17th centuries; (b) a Dutch cycle, stretching from the late 16th through the late 18th centuries; (c) a British cycle, stretching from the mid-18th through the early 20th centuries; and (d) a U.S. cycle, stretching from the late 19th through the current phase of financial expansion. Each cycle is named after (and defined by) the particular complex of governmental and business agencies that led the world capitalist system, first toward the material and then toward the financial expansions that jointly constitute the cycle. The strate-

gies and structures through which these leading agencies have promoted, organized, and regulated the expansion or the restructuring of the capitalist world-economy is what we shall understand by the regime of accumulation on a world scale. The main purpose of the concept of the systemic cycle is to describe and elucidate the formation, consolidation, and disintegration of the successive regimes through which the world capitalist system has expanded from its late-medieval regional embryo to its present global dimension (Arrighi & Moore, in press).

26. Fischer-Kowalski and Haberl (1993) explain, "Energy density means the amount of energy taken in and being transformed by the system per calculation unit (space or organism)" (p. 416).

27. Like Marx, Luxemburg (1970) did not face directly the issue of formidable ecological barriers to expanded accumulation. Nevertheless, consider her observation on the importance of natural resources:

Thus, if [the advanced capitalist nations] were dependent exclusively on elements of production obtainable with such narrow limits, its present level and indeed its development in general would have been impossible. From the very beginning, the forms and laws of capitalist production aim to comprise the entire globe as a store of productive forces. Capital, impelled to appropriate productive forces for purposes of exploitation, ransacks the whole globe, it procures its means of production from all corners of the earth, seizing them, if necessary by force, from all levels of civilization and from all forms of society. The problem of the material elements of capitalist accumulation, far from being solved by the material form of the surplus value that has been produced, takes on quite a different aspect. It becomes necessary for capital progressively to dispose ever more fully of the whole globe, to acquire an unlimited choice of means of production, with regard to both quality and quantity, so as to find productive employment for the surplus value it has realised. . . . The process of accumulation, elastic and spasmodic as it is, requires inevitably free access to ever new areas of raw materials in case of need, both when imports from old sources fail or when social demand suddenly increases. (p. 358)

28. Here we should make a distinction between capital's capacity to transform the natural environment as part of reorganizing production processes and its capacity to transform the environment by using it as a space to dispose of wastes. So, for instance, the mining center is a site of capital's direct transformation of nature, whereas the polluted stream that results may be a site of indirect transformation. Obviously, over the course of capitalist development, the latter process has become more problematic as it comes into conflict with working-class communities and even competing capitalist interests.

29. Foster (1992) has formulated this latter trend as the

absolute general law of environmental degradation. . . . This contradiction can be expressed as a tendency toward the amassing of wealth at one pole and the accumulation of conditions of resource-depletion, pollution, species and habitat destruction, urban congestion, overpopulation and a deteriorating . . . life-environment . . . at the other. (pp. 78-79)

This absolute general law of environmental degradation, which parallels and "derives its momentum" from the "first" contradiction between capital and labor, "increasingly constitutes the most obvious threat not only to capitalism . . . but to the life of the planet as a whole" (Foster, 1992, pp. 77-78). The very transformations that were a condition of capitalism's genesis have, through the long-run development of this general law, become one of the principal barriers to systemic survival in the present. The limit to capital, as Marx observed (1967, p. 250), is capital itself. This is not to suggest that capital does not face natural limits to

its expansion (see, inter alia, Mann, 1990). Rather, we are arguing that when viewed from the perspective of the *longue duree* of the modern world, the natural limits that capital faces in the contemporary global ecological crisis are primarily limits of its own making.

30. For the moment, this discussion abstracts the introduction of new plants and new plant varieties. Certainly, the introduction of such crops as the potato and maize, with their high yields and low labor requirements, was a major and highly fortuitous boon to the emergent capitalist world-economy. Moreover, capitalist efforts to control and manipulate nature, from the botanical gardens of the great European powers that date from the 17th century to present-day genetic engineering, represent another dimension of this surplus-maximizing strategy.

31. African slaves and other workers drawn from *outside* the boundaries of the world-economy—or from enclaves of subsistence production within it (we might think of Irish indentured servants)—were particularly effective for realizing this strategy because capital did not bear the costs of reproducing, in this case, African societies. The process of raising productive adult workers from infancy is an expensive one, and it is one that capital seeks to avoid. This was one of the principal reasons why capital could work slaves (and indentured servants) to death. When capital was forced to absorb the full costs of the social reproduction of such workers, as in the U.S. antebellum South, slave mortality declined sharply relative to previous epochs.

32. Accounting for the obstacles “to the penetration of agriculture by capital” in settled agricultural regions, Kloppenborg (1988) observes,

Amassing contiguous acreages for large-scale production can be accomplished only through the cannibalization of smaller ownership units, a process that can be lengthy and difficult. Moreover, outright purchase of farm land is an expensive proposition that effectively freezes the mobility of large amounts of capital and ties it to a highly uncertain market. (p. 28)

On the frontier (which of course no longer exists), the situation was vastly different: Land was not exactly free, but the costs of clearing it for use by capital was largely borne by states and settlers. See also J. W. Moore (1997b, in press) on the importance of settler colonialism as a mechanism for preparing frontier lands for exploitation by capital.

33. Chaunu’s periodization conceals the discontinuity between two phases of geographical expansion, one beginning in the 1450s and lasting until the 1520s and the other beginning in the 1620s and lasting until the 1660s (Hopkins et al., 1977, p. 125).

34. Magdoff (1978) contends that “much” of this 55% was “merely claimed.” He estimates that “effective control existed over a little less than 35 percent” (p. 29). In his view, the period from 1763 to 1875 is primarily a phase of consolidation—rather than extension—of capitalist control.

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