

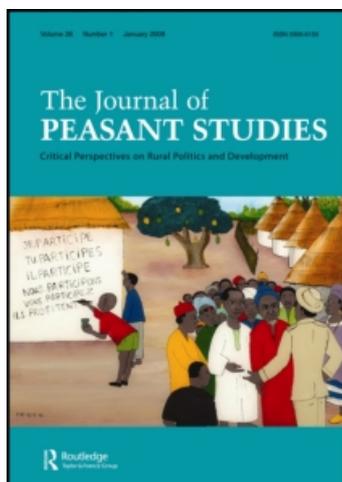
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Deepening, and repairing, the metabolic rift

Mindi Schneider and Philip McMichael

This paper critically assesses the metabolic rift as a social, ecological, and historical concept describing the disruption of natural cycles and processes and ruptures in material human-nature relations under capitalism. As a social concept, the metabolic rift presumes that metabolism is understood in relation to the labour process. This conception, however, privileges the *organisation* of labour to the exclusion of the *practice* of labour, which we argue challenges its utility for analysing contemporary socio-environmental crises. As an ecological concept, the metabolic rift is based on outmoded understandings of (agro) ecosystems and inadequately describes relations and interactions between labour and ecological processes. Historically, the metabolic rift is integral to debates about the definitions and relations of capitalism, industrialism, and modernity as historical concepts. At the same time, it gives rise to an epistemic rift, insofar as the separation of the natural and social worlds comes to be expressed in social thought and critical theory, which have one-sidedly focused on the social. We argue that a reunification of the social and the ecological, in *historical practice and in historical thought*, is the key to repairing the metabolic rift, both conceptually and practically. The food sovereignty movement in this respect is exemplary.

Keywords: metabolic rift; ecology; capitalism; farming practice; epistemic rift; agroecosystem; knowledge

The thin layer of soil covering the earth's surface represents the difference between survival and extinction for most terrestrial life.

John Duran (2002)

Introduction

Over the last decade Karl Marx's concept of the 'metabolic rift' has received increasing attention, as social scientists have incorporated ecology into theories and accounts of capitalist development and agrarian change. More recently, in the context of an international peasant mobilisation embracing the science of agroecology, the metabolic rift has become the focal point of attempts to restore forms of agriculture that are environmentally and socially sustainable. It has become so because it refers to a double separation: of agriculture from its biological foundations, and of humans from nature. Agrarian regeneration movements therefore act to reveal the impossibility of these divisions and to reverse both as the basis for a post-capitalist political ecology.

The authors are grateful to Jennifer Gardner and two anonymous reviewers for helping us develop our argument.

While we are in agreement with these developments, this essay seeks to deepen our understanding of the metabolic rift and its implications. This involves first extending the ecological dimension beyond the question of soil chemistry, particularly as Marx and contemporary authors have framed it. To do this, we argue that farming practices must figure centrally in our analyses, both because they implicate a broader set of ecological and social relations and because they provide a way to specify how humans interact with non-human nature and to what effects. Second, we situate the metabolic rift as a historical concept with epistemic consequences. The latter concerns not only how the metabolic rift affects knowledge production and reproduction in farming in particular, but also how the metabolic rift underlies the epistemic, as well as material, relations of capitalism in general. In other words, our intervention concerns a double limitation in the paradigm of the 'metabolic rift' as such – both in terms of its material scope and its epistemological status.

Origins of the 'metabolic rift'

In 1999, the *American Journal of Sociology* published John Bellamy Foster's paper, 'Marx's theory of metabolic rift: classical foundations for environmental sociology'. Colleagues called this publication the most prominent in the history of environmental sociology, and the concept of metabolic rift a 'promising focal point' for the development of the sub-discipline (Buttel *et al.* 2002, 7). In subsequent years, Foster (2000) and other scholars of environmental and global sociology (e.g. Foster and Magdoff 2000, Moore 2000, York *et al.* 2003, Clark and York 2005, Clausen and Clark 2005, Clausen 2007, Clark and Foster 2008, McMichael 2008a, Campbell 2009, Wittman 2009, and Araghi 2009) have further developed and deployed the concept. While there are differences regarding its scope – for instance Clark and York's (2005) biospheric rift and Clausen and Clark's (2005) analysis of oceanic ecosystems – arguably the principle difference in how the concept has been deployed is one of historical origins.

We take as a starting point a key disagreement between John Bellamy Foster and Jason Moore. These two authors share a general material and relational conception of the metabolic rift as both a rupture in nutrient cycling between town and country and a rupture in the metabolic relation between humans and nature under capitalism. They differ, however, with regard to the concept's periodisation. Foster situates the rift in the context of nineteenth-century industrialisation, while Moore argues that it is properly located at the transition to capitalism in the sixteenth century. These differences have important implications for how the concept is deployed in analyses of various socio-environmental problems and the kinds of solutions that are best proposed for their resolution.

For Foster (1999, 2000), the metabolic rift first occurred in the nineteenth century during what he refers to as the 'second agricultural revolution' (following Thompson 1968). During this time, from roughly 1830 to 1880, people first in Britain and shortly thereafter in North America and other parts of Europe widely perceived a crisis of declining soil fertility. These concerns were both the cause and consequence of developments in soil chemistry and plant physiology at the time, culminating in the emergence of the fertiliser industry in England in the 1840s. Prominent soil chemists drew the public's attention to the nutritional needs of crop plants and the soil's diminishing ability to supply those needs. Justus von Liebig, Germany's

leading agricultural chemist, along with agronomists in Britain, France, and the US, argued that by shipping food and fibre from the countryside to cities, soil nutrients were being lost. Whereas in 'traditional' forms of agriculture nutrients were recycled back to the soil, because modern crops were being transported long distances between the sites of production and consumption, nutrients instead ended up in urban sewage that became an important source of pollution in early industrial cities. In the 1830s, Britain began importing bones from Napoleonic battlefields and guano from Peru as a first attempt to apply the findings of the new soil chemistry to the problem of declining soil fertility. Then in 1843, J.B. Lawes, a wealthy English landowner and agronomist, opened the first fertiliser factory where he produced the first artificial (phosphate) fertiliser. As concerns grew about soil fertility (through the work of scientists), they were met with an industry that supplied materials and methods to address soil nutrient needs through the purchase of external inputs.¹

According to Foster, Marx was particularly influenced by Liebig's critique of capitalist agriculture, whereby trade 'robbed' the soil of nutrients. In his critique of capitalist ground rent, Marx extended Liebig's argument and proposed the notion of a 'rift' in the 'metabolism' between human beings and the land. In *Capital*, volume 3, he wrote,

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 which cause an irreparable rift in the interdependent process of the social metabolism, a metabolism prescribed by the natural laws of life itself. The result of this is a squandering of the vitality of the soil, which is carried by trade far beyond the bounds of a single country. (Liebig) . . . Large-scale industry and industrially pursued large-scale agriculture have the same effect. If they are originally distinguished by the fact that the former lays waste and ruins the 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 latter course of development, since the industrial system applied to agriculture also enervates the workers there, while industry and trade for their part provide agriculture with the means of exhausting the soil. (Quoted in Foster 1999, 379)²

Similarly, at the end of his discussion of 'Large-scale industry and agriculture' in *Capital*, volume 1, Marx wrote,

Capitalist production collects the population together in great centres, and causes the urban population to achieve an ever-growing preponderance. This has two results. On the one hand it concentrates the historical motive force of society; on the other hand, it disturbs the metabolic interaction between man and earth, i.e. it prevents the return to the soil of its constituent elements consumed by man in the form of food and clothing; hence it hinders the operation of the eternal natural condition for the lasting fertility of the soil . . . But by destroying the circumstances surrounding that metabolism . . . it compels its systematic restoration as a regulative law of social production, and in a form adequate to the full development of the human race . . . All progress in capitalist

¹Foster does not comment on the ways in which developments in soil science and the fertiliser industry were translated into practice. It would be interesting to explore the social relations involved in the production, reproduction, and application of these new forms of knowledge, particularly the role of the state and the fertiliser industrialists.

²The International Publishers edition of *Capital* omits use of the term 'metabolism'. A similar meaning is implied in 'an irreparable break in the coherence of social interchange prescribed by the natural laws of life' (Marx 1967, 813).

agriculture is a progress in the art, not only of robbing the worker, but of robbing the soil; all progress in increasing the fertility of the soil for a given time is a progress toward 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 worker. (Quoted in Foster 1999, 379)

Foster argues that Marx introduced the ‘metabolic rift’ in these passages to explain what was happening as a result of the capitalist town-country (‘social’) division of labour and the increasing alienation of human beings from nature as a result of industrialisation and its extension to agriculture.

The key points in Foster’s reconstruction of Marx’s concept are as follows. First, the social division of labour created an ‘irreparable’ rift in the metabolism between humans and nature. Second, large-scale agriculture and long-distance trade intensified the rift. Third, the corollary to the problem of declining soil fertility in the countryside was the accumulation of human waste pollution in towns. Marx’s use of *metabolism* as the ‘material exchange between man and nature’ is central. According to Foster, the concept referred to both the actual metabolic interaction between society and nature through human labour, and in a wider sense, to the social relations brought into being and constantly reproduced in alienated form under capitalism (1999, 381, footnote 5).

Jason Moore takes issue with Foster’s periodisation of Marx’s metabolic rift and with his emphasis on industrialisation as the primary cause of soil nutrient depletion.³ Instead, Moore reframes the origins of the metabolic rift in the sixteenth century, arguing that the concept is specific to capitalism as a whole, not just to its industrial form. He maintains the material and social thrust of the concept as Foster developed it, but extends the concept by theorising ‘a succession of metabolic rifts specific to each phase of world capitalist development’ (Moore 2000, 128). Foster’s metabolic rift during the second agricultural revolution in the nineteenth century is, for Moore, just one historically specific manifestation of historical capitalism’s general metabolic rift.

These different periodisations have implications for how the relationship between primitive accumulation and the metabolic rift is understood. On the one hand, Clark and Foster (2008) argue that both concepts provide insights into the ecological dimensions of capitalism and into changing human relations to nature, but they are nevertheless distinct. While primitive accumulation concerns the origins of capital, the metabolic rift concerns industrial capitalism and the town-country antagonism in the nineteenth century. Alternatively, Moore (2000) sees the two concepts as mutually conditioning, where original (financial) accumulation in the world market was articulated with original (landed) accumulation in the countryside. By locating the metabolic rift in these combined processes of accumulation, Moore sees an original rupture in nutrient cycling that occurred with the emergence of a general capitalist division of labour and the associated separation of people from the soil.

³Moore notes that in his earlier study of capitalism and nature, *The vulnerable planet* (1994), Foster argues that it is capital’s drive for ceaseless accumulation that tends to destroy biodiversity. Here, capital and capitalism are the problems, and social revolution is the solution. It is curious, therefore, that Foster would propose the metabolic rift as a problem of industrialism.

Each new phase of world capitalist development, he argues, is accompanied by a new form and scale of rupture in socio-ecological relations.⁴

These disagreements over the history of the metabolic rift embody larger debates about situating significant changes in human-nature relations and defining historical concepts. In his book *The centrality of agriculture*, Colin Duncan (1996) argues that capitalism is not solely responsible for the disruption of natural cycles and subsequent environmental crises; rather, it is agriculture that is the problem (and potentially the solution⁵). Distinguishing capitalism, modernity, and industrialism is central to his argument: 'surely one must distinguish sharply between, on the one hand, capitalism as a social system that accelerated the modernisation of the world in the sense of causing an increase in human interdependence, and, on the other hand, industrialism as a quantitatively new type of human-natural metabolism' (Duncan 1996, 26). Duncan suggests that English high farming – an agricultural system he views as capitalist and modern, but not industrial – illustrates the problems associated with conflating historical concepts. For Duncan, Marx's argument that human-nature relations were first ruptured with the advent of industry is misplaced. Duncan claims agriculture – not capitalism or industry – originally transformed human/nature relations,⁶ foreshadowing environmental degradation. We return to English high farming and Duncan's argument in the following sections.

The metabolic rift is attractive as a concept to explain the links between contemporary crises of soil fertility and environmental degradation and the politics of increasingly long-distance global agricultural trade. Moore argues that his re-periodisation of the origins of the metabolic rift, along with his conception of successive rifts with each phase of capitalist development, helps to link contemporary (environmental) crises to the transition from feudalism to capitalism, and also situates the concept as central to capitalist history.⁷ Foster also proposes that his conception of the rift is useful today. With Magdoff, Foster argues that a second break in the cycling of nutrients occurred in the second half of the twentieth century when post-war nitrogen fertiliser production allowed farms to specialise as either crop or livestock operations, and corporations began to encourage livestock

⁴Elsewhere, Moore refers to these phases as 'biological regimes' (2003a) or 'socio-ecological regimes' (2008).

⁵Duncan's larger project is to reorient socialist thought toward an approach that views social and ecological considerations together, and that places agriculture at the centre of an economy that is embedded in both nature and society (1996, 12). By this he means specifically that industry should be subordinated to agriculture, such that 'agriculture must become our environmental monitor' (p. 44).

⁶Strictly speaking, this means that the exercise of human labour in managing and/or transforming plant growth, that is, 'agriculture', is at the same time the management or transformation of humanity as a natural species. This is *German ideology* material (Marx & Engels 1968), and reappears in Moore (2003a) and Araghi (2009), who emphasize that capitalist relations, on a specific world-historical scale, set in motion a universal process of environmental degradation via divisions of labour, as capital incorporates/subordinates nature through the labour relation. The exercise of labour, as part of nature, transforms (some of) its material elements, or modifies or adapts (but does not eliminate) (some of) its biological cycles to human use, depending on the level of development of the human species. But this does *not* mean that natural cycles *no longer exist, as such*. Subordination is not equivalent to control, as we are becoming increasingly aware.

⁷Thus Moore produces a general law of capitalist accumulation: 'If the rural-urban dialectic expresses the geographical moment of the law of value, the metabolic rift is its ecological expression' (2003, 452).

production near their large processing facilities. Foster and Magdoff claim that this separation of livestock from feed-source mirrored the separation of people from the land that concerned Marx in the nineteenth century (2000). While these different conceptions underline the significance of human/nature relationships and their transformations, they also share a limited understanding of the material dimensions of the metabolic rift, to which we now turn.

Material critiques

The following critiques focus on material conceptions of the metabolic rift. First, we clarify how Marx (following Liebig) originally theorised the materials involved in the metabolic rift, namely, soil nutrients. Clark and York (2005, 396) argue the strength of this concept is that it is ‘an approach for conceptualising relationships, but it also provides the basis for processing the empirical reality of the nature-society relationship, as any theory should do’. While most analysts agree with this view, we argue that Marx’s original conception of the metabolic rift is in fact quite limited materially. Second, we propose that by focusing on those materials and processes that Marx identified as constituting the metabolic rift, we can better understand what the rift, as proposed and as reproduced, is not. This critique can refine how the concept is deployed in analyses of different socio-environmental problems and in different historical moments.

The metabolic rift might be framed as an *ecological* concept to describe ruptures or imbalances in natural cycles, as a *social* concept to describe social causes and consequences of different human-nature relations, and as a *historical* concept to describe the historical contingency of social and natural relations. To understand the metabolic rift in these ways, it is important to be clear about how Marx⁸ defined and understood the materials and mechanisms involved in the ‘metabolic’ exchange between humans and nature. Writing in the nineteenth century, Marx was concerned with widely perceived crises in soil productivity. The material rift was therefore framed in relation to historical changes in soil and in soil nutrient cycles. Whether it is capitalism or industrialism that is the primary cause of environmental degradation, Foster and Moore both associate the metabolic rift with a rupture in soil nutrient cycling, within the context of the town-country division of labour.⁹

Marx viewed private property and the capitalist town-country division of labour as the key starting points for historicising and theorising declining soil fertility. As manufacturing progressed, capital’s labour supply came through the separation of rural producers from their means of subsistence and swelling rural to urban migration. Grain movements followed demographic patterns, as the physical and social distance between production and consumption grew. In the process, the soil nutrients that had been taken up by crop plants in the field were literally shipped out of the soil and into factory towns for distribution to newly formed urban-industrial consumer classes. Nutrients that were not absorbed by human bodies to carry out various biological functions were excreted as waste. At the time, urban waste systems were ill-equipped to deal with the mass influx of population, giving rise to growing

⁸We take Foster’s interpretation as our baseline, given his comprehensive reconstruction of Marx’s intellectual project.

⁹Although Moore also extends the town-country division of labour to the world scale (2000, 2003a).

sewage disposal problems. The corollary to this urban problem was the permanent removal of soil nutrients that would never return to the agricultural fields from which they came. Thus, as capitalism exploited the countryside and its exported labour, cities and towns with burgeoning populations became sinks for soil nutrients, resulting in an ‘irreparable rift’ in soil nutrient cycling and in human-nature relations.

The *materials* involved in this conception of the metabolic rift are soil nutrients that move from the soil, into grain, through human bodies, out into urban sewage systems, and finally into bodies of increasingly contaminated water. The *mechanisms* of this flow of soil nutrients are twofold: the separation of humans from soil and the long-distance grain trade, both of which are related to the social division of labour.¹⁰ Marx’s conception of metabolism, then, centres on a particular nutrient pathway, whereby nutrients move from the soil, through humans, and back to the soil in the form of ‘humanure’. The ‘irreparable rift’ occurs when this pathway is broken with the physical separation of humans as fertiliser producers from the soil, and the deleterious effects of this process on soil fertility.

From here our critique proceeds through three interrelated parts. First, we suggest that while Marx set out to show that soil fertility was ‘bound up in the social relations of the time’ (quoted in Foster 1999, 375), his overly simplistic understanding of soil and of biogeochemistry and agroecology hindered his larger argument. This is a reflection of the limits of Western soil science at the time, but it also presents a space for a methodological intervention that improves how we can apply the concept to contemporary issues. Second, we argue that the concept is generally disembodied from agricultural practice and, as a result, gives only a partial rendering of the historical specificity and central causes of declining soil fertility. Finally, we argue the metabolic rift might usefully be expanded to include both an accompanying ‘knowledge rift’ and a broader, but related, ‘epistemic rift’.

The problem of soil

An important political project for Marx was countering Thomas Malthus and David Ricardo’s ideas of differential soil fertility and capitalist ground rent. Malthus and Ricardo claimed that ground rent was necessary to equalise producers in the market since unlike air and water, land was not unlimited and therefore not free (Deleage 1994). Further, they understood soil as having natural or absolute productivity and viewed agricultural improvement and degradation of soil to be of limited importance. James Anderson, a Scottish agronomist, practicing farmer, and political economist (and a contemporary of Adam Smith), influenced Marx’s understanding of rent. Anderson argued that differential rents were the result of continual improvements to soil productivity and not of conditions of absolute fertility as Malthus and Ricardo would argue later (Foster and Magdoff 2000). To historicise soil fertility as being bound up in social relations was therefore a condition for

¹⁰In Moore’s general representation of the metabolic rift, the town-country division of labour is also the driving antagonism. The difference is that Moore sees the nineteenth-century rift as one historically specific manifestation. He situates the origins of the metabolic rift in the transition from feudalism to capitalism, so the separation of humans from the soil is related to the wave of enclosures at that time, evicting peasants from the land.

debunking Malthusian arguments that sought to naturalise the conditions of the poor.

But Marx's method for this task – deploying the concept of human-nature metabolism – rested on an inadequate understanding of soil processes. Duncan states that Marx focused only on soil matter, ignoring the wider ecological functions of soil (1996, 9). Put another way, Marx, following Liebig, built his theory solely on *soil chemistry*, failing to recognise that soils have important biological and physical properties as well. More than this, the empirical grounding for Marx's concept focused on a single material (human waste) and a single nutrient pathway (soil-grain-human-soil). While illustrative, this is incomplete for understanding soil nutrient pathways writ large. Further, Marx under-theorised the more general role of agriculture in affecting nutrient cycles and pathways. Current understandings of soil and soil fertility as *processes* challenge the utility of the metabolic rift for analysing soil crises, and because social scientists often under-theorise ecosystems more generally, this critique also has broader relevance.

To begin, we identify four important differences in the ways in which soil scientists and agroecologists understand soil dynamics today, from how they were understood in Marx's time. First, the ability of a soil to produce crops is not based solely on a measure of soil nutrients. Rather, it is based on a set of interrelated factors and processes that together constitute 'soil health' (Doran 2002). Second, certain characteristics of any soil can be changed through the choice and timing of agricultural practices, while others, at least in geological time, cannot (Sullivan 2004). Third, soil is understood as a living ecosystem nested within larger agroecosystems (Bird *et al.* 1998). Finally, understanding soil and soil fertility as processes means that looking at either one at a certain point in time necessitates an examination of the processes that converged to create the soil conditions observed at that moment. Let us briefly sketch present-day conceptions of soil dynamics.

Soil is composed of both biotic (living) and abiotic (non-living) components. About 45 percent of a given soil is comprised of minerals (sand, silt, or clay), 25 percent is air, 25 percent is water, and two to five percent is organic matter. *Soil texture* describes the relative proportions of sand, silt, and clay present in a soil, which is related to the geological processes (such as the action of glaciers) that deposited minerals in particular places. The mineral composition of soils is relatively stable and does not change with agricultural activities unless intensive erosion occurs (Bird *et al.* 1998). In other words: once a 'sandy loam' always a 'sandy loam'. *Soil structure* describes the relative aggregation or clumping of soil particles. Aggregated soils that crumble easily are best for growing crops, and they are affected by the choice and timing of agricultural practices (Sullivan 2004). Soil texture and structure together determine a soil's air space and water circulation capacity, erosion resistance, ease of tillage, and degree of possible root penetration. The dynamics of these two characteristics are also related to *soil fertility* and *soil organic matter*.

An acre of living topsoil contains approximately 900 pounds of earthworms, 2,400 pounds of fungi, 1,500 pounds of bacteria, 133 pounds of protozoa, 890 pounds of arthropods and algae, and even small mammals in some cases (Sullivan 2004). These soil organisms feed on soil organic matter (once-living residues in various stages of decomposition), and each other, releasing inorganic nutrients, especially nitrogen, phosphorus, and sulphur, in the process. Soil organisms interact in myriad and complex ways, moving material and energy through the soil (Bird *et al.* 1998). The 'natural' fertility of a soil, and the availability of plant nutrients, is

therefore based on a complex soil food web and metabolic reactions between living and non-living soil components.

With hindsight from contemporary soil science, we can say that Marx was mostly correct in claiming that soil fertility is historically contingent. However, a soil's productive potential is given and fixed through soil texture, and some, such as highly sandy soils, are inherently challenged as productive agricultural soils. While Marx was ahead of his time in examining material cycles and the influence of social relations and organisation on soil fertility, he unnecessarily limited his notion of the metabolic rift to the soil-grain-human-soil nutrient pathway of the capitalist mode of production. Beyond this limit, he likely would have discovered that agriculture by definition disturbs the soil.¹¹ As soon as seed is planted, it begins using soil nutrients for growth and development. When grains (grass seeds) are harvested, the soil nutrients contained within them are lost from the system. Some may be recycled if the manure of the humans or livestock who ate the grains returns to the soil, but the majority are metabolised for the growth and development of the consumer. Even if manure is returned to the soil, if crop residues (leaves, roots, etc.) are harvested, the soil nutrients stored within them leave the system.¹² More importantly, agricultural practices can degrade (or improve) soil organic matter and structure, which has a direct impact on soil fertility and on the ability of a soil to remain in place. Inventories of soil productive capacity over the last 15 years indicate human-induced degradation on 40 percent of the earth's arable land as a result of atmospheric pollution, extensive soil cultivation, overgrazing, land clearing, salinisation, desertification, and soil erosion (Doran 2002). The wholesale loss of topsoil through some of these processes is in fact the greatest threat to soil productivity since agriculture began (Sullivan 2004). Declining soil fertility, then, is just one problem in soil and is contingent on a complex set of processes both in the soil and outside of it.

In short, Marx neglected to include agriculture as a primary driver of the mechanisms of the metabolic rift and failed to understand soil formation as a historical process. Foster's presentation of Marx's argument indicates that Marx ignored the role of pre-capitalist agriculture and relations of production in changing soil fertility and nutrient cycles.¹³ Apparently, he took for granted that pre-capitalist agricultural soils were healthy, productive, and well managed (cf. Rudy 2001). Arguably, what mattered to Marx was that soil degradation began when people were separated from the soil, taking their humanure with them. A fuller analysis would explore how the soil and conditions of soil fertility present at the time of the

¹¹Agroecologists and soil scientists recognize this truth. Today, sustainable soil management strategies are modelled on 'native' soils, such as grassland and forest soils, which have not been disturbed or disrupted by agriculture. Sullivan (2004) comments on these practices.

¹²According to the ecological concept of mass balance and the second law of thermodynamics, nutrients cannot be created or destroyed, and so are never actually lost. Rather, nutrients can be exported or removed from a *particular system*, being essentially lost from that system because they have moved beyond the boundaries of it (Drinkwater *et al.* 2008). Marx and others who use the metabolic rift concept to theorize environmental degradation under capitalism correctly argue that nutrients exported from the soil can end up in urban sewage systems. Where they falter is in conflating scales of analysis, simplifying ecological systems, and abstracting from agricultural practice. We expand on these points in the following sections.

¹³Quite possibly because of his particular concern with the mechanisms through which the *social division of labour* (most developed under industrial capitalism) exploited both labour and land.

transition to capitalism (for Moore) or at the time of the Industrial Revolution (for Foster) came to be, taking into account the role of soil management. In other words, had Marx applied his historical method of analysis to understanding soil fertility as a process, his argument could have been vastly more powerful and applicable to contemporary crises.

We do not intend this critique to undermine the metabolic rift as a concept in general, nor do we wish to dwell on the particularities of living material cycles of soil. However, this critique suggests a methodological adjustment in how we theorise material flows and human-nature relations today. We would be better served to conceptualise these flows and relations dialectically as interactions between processes,¹⁴ giving more careful attention to how we define ‘natural processes’ in more than abstract terms. Marx’s notion of the dialectic relationship between humans and nature through labour lays the groundwork for this type of engagement, but the ‘nature’ side of the dialectic remains under-theorised as in much social science.

From a perspective that more explicitly engages nature as a historical process, if capitalism (or industrial capitalism) degrades the soil, it is not just through the removal of people from the land. Rather, a wide range of agricultural practices impact soil fertility. As analysts of the relations between capitalism and agriculture (or perhaps of the relationship between capitalism and nature understood through agriculture), we should think about how capitalism and *agroecosystems* encounter and reshape one another as dynamic processes, instead of as static or organised systems.¹⁵ This necessitates not only an ecological understanding of agricultural systems, but also a focus on the agricultural practices of particular times and places. It is the practices of farming, after all, that define human interaction with environmental conditions to influence and reproduce the conditions of soil. In the next section we argue that to historicise soil fertility, we must also historicise agricultural practice.

The problem of practice

As we have argued, while Marx was correct in exploring social relations and soil, his understanding was constrained in part by the state of soil science in his time. But Marx could have better theorised declining soil fertility had he paid more attention to how people were growing crops and raising livestock, instead of basing his ideas on abstractions. Our critique in this section is that Marx’s metabolic rift concept is disembodied from practice. By disembodied we mean that the metabolic rift concept abstracts from actual practices of human labour and the local contexts within which those practices are embedded. In its original form, the concept is narrowly focused (1) on a single source of soil nutrients (humanure), the agroecological importance of which is empirically indefensible,¹⁶ and (2) on the capitalist aspects of agricultural

¹⁴Cf. David Harvey’s notion of dialectic inquiry that emphasizes the understanding of processes, flows, fluxes, and relations over elements, things, structures, and organised systems (1996, 49).

¹⁵This informs Moore’s intellectual project of building a ‘world-ecology’ (2003a).

¹⁶In the context of peak oil, peak soil, etc., the failure to ‘close the loop’ of nutrient pathways between city and country is indeed a limiting problem for sustainability. That is, even though nutrients from sewage sludge are not a primary nutrient source for current agricultural systems, and even though sludge contains pharmaceuticals, heavy metals, and other

systems without adequately engaging ecological aspects. We consider the concept first empirically and then employ differential treatments of English ‘high farming’ to begin to highlight some important contradictions.

First, there are important problems with how Marx understood soil fertility. In farming, there are a number of practices that enhance soil structure, build soil organic matter (SOM), and maintain soil fertility.¹⁷ Marx’s myopic focus on the role of a single practice – incorporating human waste into crop fields – is inadequate as an explanation of the overall decline in soil fertility as observed in his time. For Marx to be correct that the capitalist town-country division of labour caused soil depletion because humans were separated from the soil, humanure would have to have been *the* most important material for maintaining fertility in pre-industrial or pre-capitalist agriculture. In other words, the ability of soils to provide adequate nutrients for crop growth and development would have been dependent on the immediate presence of humans as fertiliser producers, or nutrient recyclers. However, in Foster’s representation of Marx’s argument, there is no discussion of the practice of spreading human waste in capitalist or pre-capitalist agriculture. By failing to establish the relative importance of this source of nutrients, Marx’s material argument is empirically indefensible. It is also reductionist in its narrow focus on a single material instead of considering the mix of practices that constitute agricultural production in particular times and locations.¹⁸ In these ways, the metabolic rift as an ecological concept regresses to outmoded understandings of (agro) ecosystems.

It is important here to consider how and why Marx might have come to propose the metabolic rift in such a disembodied form. The people from whom he drew inspiration provide one clue. Foster (1999, 2000) details at considerable length how Marx was impressed by the work of Justus von Liebig, the prominent German agricultural chemist.¹⁹ Liebig’s work on soil chemistry and plant physiology influenced Marx’s understanding of soil nutrient cycles as they related to crop production. These understandings helped Marx counter Malthusian arguments based on differential rent. Liebig’s later critique of capitalist agriculture, however, was perhaps most influential in how Marx developed the metabolic rift. For his part, Liebig was influenced by Henry Carey, a political economist in the US who wrote about the separation of town and country and the long-distance grain trade as major factors in the net loss of soil nutrients from agricultural fields and the growing soil fertility crisis. Building on Carey and Liebig, Marx would propose capitalist trade as the cause of declining soil fertility.

contaminants, the failure to recycle phosphorus, potassium, and micronutrients back to the soil is potentially a long-term issue. The only ‘new’ source of these nutrients is weathering, a process that occurs over long periods of years or even centuries.

¹⁷Some of these practices include incorporating livestock manure to build SOM and nutrients; adding composted kitchen scraps, crop residues, and manure for the slow release of nutrients; planting cover crops and green manures (legumes) to improve SOM, cycle nutrients, fix nitrogen in the soil, suppress weeds, break pest cycles, and provide food sources for beneficial insects; and fallowing fields to enhance nutrient cycles and SOM.

¹⁸Alan Rudy’s (2001) critique that Foster’s development of the metabolic rift concept ignores different dynamics of soil depletion is similarly framed.

¹⁹He details this relationship in Foster (1999, 2000), Foster and Magdoff (2000), and Clark and Foster (2008). Clark and York (2005), Martinez-Alier (2007), and Duncan (1996) also mention Liebig’s influence on Marx’s understanding of ‘metabolism’.

As important as who influenced Marx is who did not. The lack of attention given to farming practices in relation to the metabolic rift indicates that Marx was not particularly tuned in to the methods employed by agricultural producers. This is somewhat surprising since the key to Marx's theoretical approach to the problem of capitalist agriculture is metabolism, a concept rooted in his understanding of the labour process. In *Capital*, volume 1, Marx wrote of labour in general,

Labour is, first of all, a process between man and nature, a process by which man, through his own actions, mediates, regulates and controls the metabolism between himself and nature. He confronts the materials of nature as a force of nature. He sets in motion the natural forces which belong to his own body, his arms, legs, head and hands, in order to appropriate the materials of nature in a form adapted to his own needs. Through this movement he acts upon external nature and changes it, and in this way he simultaneously changes his own nature . . . It [the labour process] is the universal condition for the metabolic interaction between man and nature, the everlasting nature-imposed condition of human existence. (Quoted in Foster 1999, 380)

Here, humans produce their own historical relation to nature through material production. The way in which labour processes are organised, then, becomes key in changing human-nature relations. In this way, the metabolic rift concept, which hinges on the capitalist town-country division of labour, can be seen as an analysis of the alienation of nature; an alienation that is 'at one and the same time the estrangement of humanity from its own labouring activity and from its active role in the transformation of nature' (Foster 2000, 73).

Although labour is central to the concept of metabolism as Marx proposed it, Foster's account indicates that it is a very abstracted form of labour, focused only on organisation and not on practice (of labour). But abstracting from practice enables a theoretical orientation to agricultural systems that privileges their capitalist aspects to the detriment of understanding their ecological aspects. This distinction can be illustrated by comparing the differential treatment of English high farming by Liebig, Marx, and Foster on the one hand, and by Duncan and Harriet Friedmann on the other.

English high farming was a sophisticated form of self-renewing agriculture practiced by capitalist farmers for several decades in the eighteenth and nineteenth centuries (see Duncan 1996). For Liebig, high farming was 'not the open system of robbery [of the soil] of the American farmer . . . but is a more refined species of spoliation which at first glance does not look like robbery' (Foster 1999, 378). Following Carey, Liebig was concerned here about the distance grain travelled from its site of production to market. Marx echoed this focus on trade when he wrote that the result of the town-country division of labour was 'squandering the vitality of the soil, which is carried by trade far beyond the bounds of a single country' (quoted in Foster 1999, 379).²⁰ But under high farming, healthy, productive soil and capitalist

²⁰The argument proposed here by Carey, Liebig, and Marx is that the long-distance of the grain trade is most problematic. On the surface, the argument sounds convincing, and similar arguments are made today in support of locally based food systems. But it is not *distance* that determines nutrient loss. Soil nutrients start to leave the soil as soon as a crop is planted. If nutrients are not *willfully* returned to the soil through agricultural practice, they are lost from the system whether harvested grain is sold and consumed thousands of miles from the point of production, or just down the road. It is also important to note that what is shipped away from

production co-existed. Despite the fact that high farmers produced wheat for exchange,²¹ and that wheat entered into circuits of long-distance trade, the soil in this system was quite fertile. Further, high farmers not only maintained soil fertility, but also created agroecosystems that carried out nutrient, pest, and weed management functions without industrial methods or external inputs. Because Liebig and Marx focused only on the capitalist aspects of high farming, abstracting from agricultural practice, they missed the ecological processes of the system and mischaracterised this highly productive, highly sustainable mixed-species farming system as just another form of soil robbery.

Duncan, concerned with distinguishing capitalism, modernity, and industrialism, presents a much different picture. He argues that high farming was capitalist and modern, though not industrial, since production was achieved by 'biological or ecological, as opposed to industrial (chemical), methods' (Duncan 1996, 65). He also argues that English high farming was 'perhaps the most ecologically benign among all the highly productive farming systems the world has seen' (p. 54).

To specify high farming as a non-industrial form of modern, capitalist agriculture, Duncan details its practices, which he urges cannot be 'specified in the abstract' (1996, 72). High farming was practiced by relying on internal ecological processes, and enhancing them locally. This system introduced a four-course crop rotation integrated with sheep as suppliers and recyclers of nutrients. The simplest version of the system involved four fields passing sequentially and repeatedly through a series of wheat, turnip, barley, and clover crops. Sheep were set out to graze grassy hillsides by day, and were brought down to arable fields at night where their manure added nutrients to the soil. Agricultural labourers used sheepfolds, or movable fences, to control the movement of sheep through crop fields, and to ensure an even distribution of manure. Although wheat was the *raison d'être* of high farming (the sale crop), it only occupied one-quarter to one-third of total acreage farmed at any one time. The other crops were necessary to maintain and enhance agroecosystem functions for continued wheat production. Turnips were grown as a winter feed for sheep when grazing was limited. Clover, a legume, was grown as livestock feed and to enhance soil fertility by fixing nitrogen in the soil. Barley provided food for most humans (including agricultural labourers) and was also an animal feed (Friedmann 2000, 490). Under this form of rotational grazing, together with synergistic mixed crop production, high farming was able to maintain the condition of the land indefinitely. Duncan remarks that despite the high degree of urbanisation in England at the time, high farming involved several labour-intensive practices and a negligible level of mechanisation. He states, 'that English farming had functioned so long and so well as the basis for so much industrial activity with only a very small proportion of the population being engaged on the land, and that it had been so productive without being mechanised, underscores the importance of the land itself and the way it was being treated under the classical English system' (1996, 71).

the field is nutrients in the form of grain. Crop residues are separated prior to grain transport and can be composted and applied to soil. This practice is important for managing soil fertility and for keeping carbon in the system. Again, the scale of analysis is central.

²¹To be clear, tenant farmers produced wheat to pay ground rent (Friedmann 2000).

By Duncan's account, high farming was a highly sustainable agricultural system, at least ecologically.²² Friedmann observes, 'The controversies over High Farming focus on its capitalist, rather than material aspect. That is, how it structured relations among people, rather than how people worked with physical substances and processes' (2000, 489). This seems to be precisely the contradiction in Liebig's, and by extension, Marx's, interpretation of high farming. They focus on the *division* of labour, minus the *practice* of labour.

Friedmann goes on to outline the ways in which high farming was socially unsustainable. Villagers suffered eviction by landowners. Capitalist tenant farmers forced some of their former neighbours into exploitative work in mines and mills, others they hired. Agricultural labourers worked long hours, but received little food, and money income, grain, and wool were highly unequally distributed. The social relations and conditions of high farming were exploitative, to be sure. And yet, as Friedmann argues, the system did not succumb to social inequity or popular resistance. Rather, the repeal of the Corn Laws (protective tariffs) in 1846, subsequent exposure to world commerce, and the creation of a world wheat market in the 1870s brought this system to an end. High farmers could not compete with the cheap grain that began flowing into England, especially from the Great Plains in America. There, settlers produced mostly transplanted crops using transplanted methods (i.e. animal-pulled steel ploughs) cheaply by taking advantage of nutrients stored and cycled in grassland soils over thousands of years. Soil fertility, in the early years of American monocrop agriculture, was not a problem (Friedmann 2000).

Empirically, Marx's conception of the metabolic rift as a rupture in soil nutrient pathways linked to the division of labour between town and country and trade is problematic, as argued above. The success and relative ecological sustainability of high farming in England further challenge Marx. Together these critiques suggest the need to reframe the materials and mechanisms involved in the metabolic rift.

Scholars avoid these empirical problems in part by discussing the metabolic rift in the abstract, using the language of 'nutrients' and 'nutrient cycles'. Moore, for instance, defines the rift as a 'rupture in nutrient cycles' (2000, 128), focusing on movement of nutrients through the soil-grain-human-soil pathway.²³ Araghi (2009) refers to the neoliberal period as an intensification of the metabolic rift: a 'rift within the rift'. Other scholars use the metabolic rift to analyze an entirely different set of materials and cycles. Clark and York (2005) and York *et al.* (2003) apply rift analysis to biospheric carbon cycles and climate change. Clausen and Clark (2005) study ocean ecosystems and crises. But Marx built his theory on a specific source of nutrients (humanure) and a specific nutrient pathway (soil-grain-human-soil) that are of only limited use ecologically. If the metabolic rift is useful in these contexts, it is because the authors have moved beyond its initial ecological (mis-) conceptions.

The mechanisms of the metabolic rift concept also need to be reframed. Where Marx saw the capitalist division of labour and long-distance trade as key factors in

²²We should note, however, that this production system could not be sustained indefinitely without fertilising the hillsides (manure, legumes, etc.) from which sheep essentially mined soil nutrients through grazing.

²³Wittman (2009) echoes Moore, but broadens the nutrient cycle to food, fodder, and fibre, and their wastes.

the disruption of material pathways, adding the practice of (agricultural) labour and how labour interacts with ecological processes would greatly enhance the analytical utility of the concept. A handful of authors add the *practice* of labour to the *organisation* of labour in analyses of the relationship between capitalism and nature.

In his treatment of capitalist environmental history, Jason Moore follows Marx and Wallerstein in proposing that ‘the degradation of the soil and the degradation of the labourer are dialectically bound’ (2003b, 357). He illustrates this relationship by examining the relations and practices of early modern silver mining and sugar planting. In addition to analysing the organisation of labour at work in these two ‘commodity frontiers’ of early capitalism, Moore explores the practices of labour and how they degraded bodies of land and water, as well as human bodies. In a particularly telling case, Moore links soil erosion and exhaustion on the Atlantic island of Madeira in the late fifteenth century to intensive agricultural practices employed to produce sugar for the world market. Once the Portuguese cleared the island’s forests for shipbuilding, Genoese and Flemish capital financed new sugar plantations, which because of the altered hydrology of the island had to be constructed on terraces. Moore shows how practices like building terraces and irrigation systems to grow sugar in an ecosystem not suited to producing it led to exhaustion of both the soil and workers. He states, ‘African slaves not only supplied the labour power necessary to degrade local ecosystems, but in the process of capitalist exploitation the slaves themselves experienced the most thoroughgoing form of ecological destruction – death’ (2003b, 350). He continues by looking at the relocation of sugar production to Brazil in the mid sixteenth century, and then to the Caribbean in the seventeenth century, commenting on the relation between ‘overexploitation of land and labour’ in each case. In Moore’s analysis, we see how particular agricultural practices resulted in soil degradation and exhaustion, and how these processes at the same time had serious implications for human health and survival. This is one piece of the puzzle, and one way that using agricultural practice can bring the human-nature dialectic into sharper focus.

Another use of the method we propose is to focus attention on the agricultural practices carried out by communities of farmers who know how to produce food in ways that are socially and ecologically sustainable. Friedmann’s (2000) approach provides an example that opens the door to restorative practices. Although she does not employ the metabolic rift specifically in her argument that ecological crises are intertwined with crises of agriculture and territory/states, she details the ecological significance of changing farming practices – from high farming, to early monocrop agriculture in the US, to contemporary monocrop production based on biotechnology – and relates changes in agroecosystems to world-economic developments (specifically the price of wheat and meat for her purposes). Our interest here in Friedmann’s argument is primarily that it adds the *practice* of labour to the *division* of labour and evaluates the relative embeddedness of agricultural practices and systems within ‘natural’ or biological systems. She discusses the paradox that on one hand, humans alter ‘webs of living cycles and material cycles’ of air, water, and soil in the process of ‘foodgetting’. On the other hand, we largely get food under the illusion that we have transcended these webs and flows (2000, 481). Thus Friedmann analyses crises in relation to the relative embeddedness of agricultural practices and systems, insisting that regardless of the particularities of historically contingent forms of social organisation, our modes and systems of production are always embedded in ecological cycles, and vice versa.

Rebecca Clausen offers a perspective on ‘healing the metabolic rift’ based on her analysis of Cuban agriculture (2007). She argues that developments in Cuban agroecology illustrate the concrete ways in which the metabolic rift can be healed through farming practices and through the transformation of socio-metabolic relations of food production. She details agroecological practices that address the material rift in nutrient cycles (including a complex understanding of soil nutrient cycles) and changes in labour relationships, decision-making structures, and land and food distribution patterns that have altered social-nature metabolism. Clausen also discusses the role of agricultural knowledges, ideas, and visions in ‘healing the rift’. Her argument anticipates that of Hannah Wittman, who broadens this perspective to question whether the food sovereignty model, and its agroecological turn, is able to repair the metabolic rift (2009). Noting the contradictory relations (class, gender, ethnic) within contemporary agrarian social movements, Wittman nonetheless identifies ‘agrarian citizenship’ as a crucible within and through which diverse producers and rural labourers are advocating an agricultural practice ‘that re-works the metabolic relationship between society and nature, [linking] material practices to local, global, and transnational advocacy networks’ (2009, 820). Her investigation is based in the notion of a ‘socio-ecological double movement’ where, as a consequence of the metabolic rift and its contribution to climate uncertainty, humanity faces an active and ‘lively’ nature that feeds back and ‘shapes and constrains human activity’ (2009, 821). Ultimately, she views food sovereignty practices as presaging an ‘agrarian citizenship’ that can ‘reclaim the notion of a humanistic community that not only demands state re-regulation of the market but also acts to protect itself against the continued decimation of social and ecological spaces’ (2009, 822).

We propose, therefore, that practices of labour must figure centrally in our analyses of the relations between capitalism and nature, particularly when agriculture is the analytical lens. Abstract concepts such as labour, metabolism, and nutrient pathways must be defined and embodied in order to avoid oversimplifying the ecological processes that underlie them, or worse, getting those processes wrong. Adding the practice of labour to the organisation of labour refines our analyses and helps to specify the ways in which human and non-human processes interact to mutually constitute nature. Further, this approach enables us to see agricultural practices that degrade soil and labourers, as well as those that support and sustain healthy food and agricultural systems, including human, soil, plant, animal (extra-human), community, and ecosystem health.

The problem of knowledge

In this section we expand the idea of embodied practice to the idea of embodied knowledge, particularly in relation to agricultural practice and local ecosystems. We draw on Clifford Geertz’s (1983) concept of local knowledge and Donna Haraway’s (1991) concept of situated knowledge to argue for a (cultural) ‘knowledge rift’ to accompany the (material) ‘metabolic rift’. Our critique in this section illustrates therefore what Marx’s concept is not, but suggests what it could be by moving beyond a strict focus on material pathways and the capitalist division of labour.

Posing the metabolic rift as a rift in material pathways (soil nutrient pathways) leaves out an important aspect of the separation of human beings from the land (or, in Foster, the alienation of nature) through the capitalist town-country division of

labour. By focusing solely on the material aspects of human-nature relations, the metabolic rift concept ignores a rift in the production and reproduction of knowledges. Following Marx's basic formula for the metabolic rift as a material concept, we can see how framing the rift in relation to embodied knowledge and practice might look.

In the classic account, through the rise and reproduction of capitalist relations, the antagonism between town and country widened, as peasants were proletarianised. Of the people remaining in the countryside, most became agricultural labourers, working for capitalist tenant farmers for a wage. As people physically moved from the country to towns, they took with them not only their ability to recycle soil nutrients (as in Marx's argument), but they also took culturally, historically, and geographically specific knowledges about farming practices and local ecosystems (among other things). Each wave of newly proletarianised peasants who came to work in the mines and mills of the capitalist world brought with them knowledges that they could not use, and therefore that could not be reproduced. Similarly, peasants who became agricultural labourers, while they were still involved in the processes of farming, did not make production decisions. Framed in this way, we can ask questions about how the capitalist town-country division of labour affected (and affects) the production and reproduction of knowledges about agricultural practice and local ecosystems. Is there a knowledge rift that accompanies a material, metabolic rift?

In Geertz's conception, local knowledge refers to two ideas: first, that all knowledge is located and historically and geographically bound, and second, that local contexts affect the nature of knowledge that is produced. Haraway argues that knowledge is embodied and partial, or 'situated' within complex social constructions, which are processes of collective interaction, negotiation, and debate. In a passage relating a story about nineteenth-century English farmers who were unable to verbalise the agroecological wisdom of their farming practices, Duncan demonstrates the relation between local, situated knowledge and agricultural practice: '(t)he reasoning behind such literally embodied knowledge built up over centuries for each different ecological area might not be accessible to the memory of any single person, if it is lodged only in customary practice' (1996, 67). Analysing practice, then, is important for understanding the ecology and material aspects of an agroecosystem *and* for understanding locally situated forms of knowledge in relation to an agroecosystem. This becomes particularly important when addressing agricultural crises.

When the people within whom knowledge of agricultural practice and local ecosystems is embodied are forced off the land and into waged labour in mines and mills, how does this process affect the reproduction of that knowledge? Arguably another form of capitalist violence is to set people who carry 'agroecological wisdom' to the mundane tasks of capitalist production. It is a form of violence for the labourers, who are alienated from the object of their labour, from the labour process, from their human species-being, and from each other. It is also a crisis for humanity in the sense that the capitalist division of labour creates a rift in the production and reproduction of embodied knowledge of local ecosystems and potentially sustainable agricultural practices.

There is, however, a further layer of violence, that of abstraction. This concerns the problem of knowledge in a paradigmatic, or epistemic, sense. Not only is the metabolic rift a material transformation of production, with spatial and ecological

consequences, but also it involves an epistemological break. The metabolic rift, whenever its origins in the capitalist epoch,²⁴ conditions social thought. Here, social production, knowledge, and institutions, embedded in market structures, are increasingly subordinated to value relations: where the ‘market operates as an abstract disciplinary mechanism through which concrete productive activities are compared and value is socially ascribed’ (Taylor 2008, 25). For Marx, the social content of value was pivotal in his methodological critique of capitalism. His demystification of ‘price’ (the value-form of a commodity) revealed prices as fetishised representations of the social relations involved in producing commodities. In denaturalising this value-form, Marx historicised the value relations governing capital’s movement and accumulation. In other words, he clarified the social origins of value at a time when classical political economy understood it as a natural attribute.

Marx’s critique, however, risks a one-sided representation of the social-nature relationship (cf. Burkett 1999, 3) in focusing on demystifying ‘value’ as the foundation of capitalist social reproduction and its representations. Here, value is a relation, not a thing, as classical political economy viewed it. As a relation, Marx’s concept of ‘value’ enabled a methodological critique, as a way of discovering the ‘secret’ of value creation under capitalism, behind the objectified appearance of price as the value-form. As such, in the form of an axiom of unity, value is an abstraction, focusing on the general social organisation of the commodity labour-power (and labour-time) and abstracted from its particular forms, including appropriations of nature. While Marx understood nature as ‘man’s body’ and labour as nature, his critique of capitalist production was that its estrangement of labour simultaneously alienates humans from nature. Further to this, the subsumption of labour by capital, in divesting labour of its human qualities and subordinating it to the mechanical rhythms and demands of industrial technology, accomplishes an analogous subsumption of the natural elements of production. As we have argued above, this objectification of nature (as ‘commodity’ or ‘raw material’) is both condition and consequence of the metabolic rift and its foundational role in capitalist environmental transformation. Together, the abstraction of value and of nature discount ecological relations in capital theory.²⁵

Arguably, the concept and history of the metabolic rift are key to this tendency to discount ecological relations, premised as they are upon the alienation of nutrients and nutrient pathways in the process of social reproduction. Theoretically, the estrangement of labour is at one and the same time the rupture of the human/nature metabolic exchange. Practically, or historically, the metabolic rift has reinforced an ontology informing how capitalist relations of social reproduction are understood

²⁴As noted, Moore (2003) dates the metabolic rift from the sixteenth century, with ‘world-economy’ and ‘world-ecology’ emerging as a singular world-historical process, where capitalism’s ‘spatial fix’ represents the attempt to resolve the contradiction between value accumulation as a(n) open-ended) social process and material accumulation as a physical (and therefore environmental) process.

²⁵Note that analysts such as Burkett (1999), Moore (2003a, 2003b), and Araghi (2009) recognize, and theorise, nature as a relation of production: here as *more* than a ‘free gift’ and intimately involved in the production and reproduction of labour, as capital. Arguably in this form nature is defined through the capital relation, both in its contribution to value production and in being consumed/laid waste as part of the accumulation process. Our point is that this limits our understanding, in their terms, of natural metabolisms and their collaborations with the labour process.

(and practised), by rendering ecological relations and processes extrinsic to social existence. This is perhaps reflected in Marx's (1973, 489) claim in *Grundrisse*:

It is not the unity of living and active humanity with the natural, inorganic conditions of their metabolic exchange with nature, and hence their appropriation of nature, which requires explanation, or is the result of a historic process, but rather the separation between these inorganic conditions of human existence and this active existence, a separation which is completely posited only in the relation of wage labour and capital.

Marx's *explanandum* here, in focusing on the social fact of separation, privileges the capital/labour relation over the 'metabolic exchange with nature'. The capital/labour relation is the logical form through which the totality of capitalist commodity relations and the process and tendencies of accumulation are then developed in *Capital*, which presents as a theoretical structure based on capital as a logical, rather than historical, set of relations.²⁶ Here, the historical question of social/natural metabolism is subordinated to the *theoretical* treatment of capital's social metabolism in the process of generation of value. While analysts such as Burkett (1999) argue cogently that Marx's *corpus* sustained an equivalent recognition of the natural elements of material production, our point is simply that the method of abstraction in the critique of political economy reproduces the abstraction from ecological relations in the concept of the metabolic rift. The consequence is twofold: first, that ecology has been absent from most accounts of capitalist developments,²⁷ and second, and related, the abstraction of ecological relations embedded in labour practices especially discounts those locally situated knowledges and practices that are grounded in people's accumulated experiences and understandings of local ecological conditions. This encourages an ontology that encloses the field of view (and possibility) much like the fetishism of commodities misrepresents the social origins and consequences of capitalism. Here, taking capital as our methodological point of departure, as Marx directs in his method of political economy, we carry out a double movement, as it were: we analyse the subordination of labour and the natural world to capital, and, in seeing like capital²⁸ we simultaneously render invisible labour practices/cultures engaged in reproducing or restoring natural cycles and processes ecologically.

The epistemic rift

To the extent that the metabolic rift privileges a capital logic, whereby social (material) relations are mediated by value relations, it creates an 'epistemic rift'. This involves a separation of the experience and knowledge of human/nature relations

²⁶Cf. Tomich (2004, chapter 1).

²⁷Relatedly, Burkett (1999) details the series of claims of Marx's 'one-sided' treatment of the social, as opposed to the natural, dimensions of material production, which arguably stem from a misapplication of the critique of political economy to capital's history.

²⁸Cf. the discursive stance, 'seeing like a state', from Scott (1998). Moore's comment, in distinguishing capitalism's value form from nature's wealth – 'Marx does not deny that external nature does work useful to humans, only that (*from the perspective of capital*) its productions do not directly enter into capitalism's particular crystallization of wealth' (2003, 450, emphasis added) – exemplifies the determination of wealth under capitalism by value relations as an ontology.

(or the practice of agro-ecology) from the conditions of social life under capitalism.²⁹ Just as the spatial consequences of the metabolic rift erase sensuous knowledge of ecological relations and processes, so its social and ideological consequences obscure recognition of the ecological dimensions of economic/material relations and processes. The result is that political economies of capitalism and markets have generally externalised the environment. In parallel, Martinez-Alier has noted that while 'conventional economics looks at environmental impacts in terms of externalities which should be internalised into the price system, one can see externalities not as market failures but as cost-shifting successes which nevertheless might give rise to environmental movements' (2002, 257). And so, alongside green mobilisations has arisen an industry of ecological accounting, now generalised into a dismal science of imposing a value metric on natural 'resources' with a view to 'costing' their exploitation, all the better to exploit them (cf. Lohmann 2006). There is an obvious epistemic, and ontological, implication of this all-too-present contradiction.

Epistemically, there are two tasks: first, historicising value relations as governed by ecological relations,³⁰ and second, recognising that the metabolic rift's epistemological break from agricultural practices and knowledges of ecological relations and processes forecloses ecological futures – especially those critical to the preservation and sustainability of the natural world in which we live. Polanyi, for one, challenged the episteme expressed in the fetish (and critique) of value relations, even though he did not name the metabolic rift. He implied an epistemic rift in his concept of land and labour as 'fictitious commodities', subject to annihilation, as 'the human and natural substance of society', by 'the idea of a self-adjusting market' (Polanyi 1957, 3). Economic liberalism's politically instituted self-regulating market realised its limits in the counter-movements of agrarian and working classes and the end of the gold regime. While market regulation was short-lived, Polanyi's metaphor of 'society' protecting itself against socio-ecological degradation addressed, if not resolved, the epistemic rift within value theory. Lack of resolution was in part the result of Polanyi's lack of attention to agricultural practices, with his focus instead on political regulation.

This is where the ontological implication comes into play. Wittman (2009, 812) notes, for example, that today 'changing weather patterns and disease vectors stimulated by climate change are forcing changing practices in agriculture' and goes on to observe the greater resilience of 'localised, agro-ecological, and small scale initiatives' compared with the lesser adaptability of large-scale industrial agriculture. Such a distinction between agricultural practices invokes a value divide stemming from the metabolic rift – a divide that is simultaneously ontological and consequential for the environment and those practices embedded in the reproduction of natural cycles and processes. Martinez-Alier (2002, 215) expresses it in temporal and spatial terms: that, given capitalism's need to extract natural resources in order to sustain accumulation, the 'antagonism... between economic time, which proceeds according to the quick rhythm imposed by capital circulation and the interest rate, and geochemical-biological time controlled by the rhythms of Nature, is

²⁹This is of course a variant, or sub-set, of the condition of modernity, as argued by Bruno Latour (1993), whereby the essential humanism of modernity depends on separating (in thought) humans and non-humans (nature).

³⁰In different ways Burkett (1999), Moore (2003a, 2003b), Weis (2007), and Araghi (2009) move us in this direction.

expressed in the irreparable destruction of Nature and of local cultures which valued its resources differently'. Underlining this value divide in more positive terms, at the *Terra Preta* Forum (Rome 2008) a representative from the Network of Peasant Organisations and Agricultural Producers in West Africa (ROPPA by its French acronym) reported that flexible seed selection by farming women in West Africa has managed recurring drought, and that these practices and outcomes are being documented as an act of political recognition and survival. Similarly, ActionAid's recent report *We Know What We Need: South Asian Women Speak Out on Climate Change Adaptation* documents how women farmers (in the Ganges basin bordering Nepal, India, and Bangladesh) manage livelihoods under conditions of erratic monsoon patterns, concluding that their evidence 'proves that women in poor areas have started to adapt to a changing climate and can clearly articulate what they need to secure and sustain their livelihoods more effectively' (2007, 4). There are of course countless examples of labour practices within the metabolic exchange between humans and nature that are systematically made invisible and marginalised through an ontology deriving from the consequences of the metabolic rift. To represent this historic opposition in the stylised terms of a 'market calculus' versus an 'ecological calculus', with attendant interpenetration and associated contradictions, is simply to confirm the possibility of metabolic integrity in agricultural practice.

Given the current political dominance of the 'market calculus' in neo-liberal forms of 'governance', the response has been twofold: first, rampant 'market environmentalism', and second, coordinated mobilisation of an environmental countermovement in which the food sovereignty movement has become increasingly important – notably in insisting on revaluating those practices that work to renew and sustain ecological cycles and the values in which they are embedded. As Friedmann (2000, 508) notes, 'humans have developed two competing and evolving visions of the earth: global production chains managed by transnational corporations, which disrupt and attempt to replace self-organising cycles; and a biosphere in which humans work with the self-organising material living processes of the planet'. With respect to the latter vision, Marx remarked, 'The moral of the tale . . . is that the capitalist system runs counter to a rational agriculture, or that a rational agriculture is incompatible with the capitalist system (even if the latter promotes technical development in agriculture) and needs either small farmers working for themselves or the control of the associated producers' (quoted in Foster 2000, 165). In these terms, polyculture and/or peasant agricultural production systems hold keys for the realisation of 'sustainable' agricultures that produce local foods and reproduce ecosystems and help mitigate contemporary environmental crises.³¹ The production and reproduction of knowledges of agroecological practices and local ecosystems are central to the continued success of these local systems.

Conclusion

In conclusion, we offer an assessment of the relative utility of the metabolic rift as an ecological, historical, and a social concept. Ecologically, the metabolic rift is

³¹For discussions of the role of small-scale, locally based farming systems in mitigating climate change, see for example Altieri (2008), Ho & Ching (2008), and La Via Campesina (2008). Discussions of peasant movements and food sovereignty are also relevant (Desmarais 2007, McMichael 2008b).

outmoded as a way to describe ruptures in natural pathways and processes unless it theorises ecological systems and cycles as dynamic processes and takes the practice of labour more seriously. As a historical concept, the metabolic rift is tied into debates about the definitions and relations of capitalism, industrialism, and modernity as historical concepts. At the same time, it is also the progenitor of an epistemic rift, insofar as the separation of the natural and social worlds comes to be expressed in social thought and critical theory, which have one-sidedly focused on the social. Socially, the metabolic rift presumes that metabolism is understood in relation to the labour process. This conception describes human-nature relations dialectically, emphasising that through labour humans change nature and are themselves changed as nature degrades. These relations are, of course, historically contingent as Foster (1999, 390) states,

For Marx, human beings transformed their relation to nature but not exactly as they pleased; they did so in accordance with conditions inherited from the past and as a result of a complex process of historical development that reflected a changing relation to a natural world, which was itself dynamic in character.

Accordingly, we argue that a reunification of the social and the ecological, in practice and in thought, is the key to understanding how to address and possibly resolve ecological crises. Given the centrality of agriculture in creating environmental, including climatic, degradation, this reunification starts there, in repairing the consequences of the metabolic rift.

Arguably, the food sovereignty movement offers a multiplicity of socio-ecological experiments which are thoroughly political in re-linking the social and the ecological at democratic scales. The food sovereignty movement also practices an epistemic restoration in positing the renewal of forms of agroecology among small-scale biodiverse farms, once viewed as redundant in a capitalist episteme founded in the separation of agriculture, and humanity, from its biological base. As scholars and practitioners continue to deploy the metabolic rift concept to analyse social (and ecological, political, and historical) phenomena, they will simultaneously reproduce and reframe it in new ways. We can hope that these new ways take into account the complexity of 'natural' systems, the dialectic of human-nature relations, and the importance of valuing ecological knowledges.

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