




Making Space in Critical Environmental Geography for the Metabolic Rift

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Marx's concept of metabolic rift has emerged as a prominent theoretical framework with which to explain the socioecological crises of capitalism. Yet, despite its relevance to key concerns in critical environmental geography, it has remained marginal within the field. Here we address this by distinguishing between metabolic rift theory and two predominant Marxist approaches in environmental geography: the production-of-nature thesis and posthumanist world ecology. We follow this comparative assessment with a detailed analysis of metabolic rift theory and a brief overview of how the concept relates to key concerns in critical environmental geography. We conclude by discussing how a stronger engagement with the metabolic rift approach could benefit the field. *Key Words:* Marxism, materialist dialectic, nature–society relationship, production of nature, world ecology hybridism.

马克思的代谢断裂之概念已浮现作为重要的理论架构,用以解释资本主义的社会生态危机。尽管其与批判环境地理学中的主要考量相关,但却仍然持续处于该领域的边缘。我们于此区分代谢断裂理论和环境地理学中两大主导的马克思主义取径:自然的生产之命题,以及后人类世界生态学,以此应对上述问题。我们追随此一比较性的评估,对代谢断裂理论提供细致的分析,并简要概述该概念如何与批判环境地理学中的主要考量相关。我们于结论中,探讨更进一步涉入代谢断裂之取径,如何能够对该领域有所助益。关键词:马克思主义,物质主义辩证,自然—社会关系,自然的生产,世界生态混合主义。

El concepto de la brecha metabólica de Marx ha surgido como marco teórico prominente con el cual explicar las crisis socioecológicas del capitalismo. Sin embargo, pese a su relevancia para temas claves de la geografía ambiental crítica, ha permanecido marginal dentro del campo. En este artículo abocamos esta cuestión distinguiendo entre teoría de la brecha metabólica y dos enfoques marxistas predominantes en geografía ambiental: la tesis de la producción de la naturaleza y la ecología poshumanista del mundo. Nosotros seguimos esta evaluación comparativa con un análisis detallado de la teoría de la brecha metabólica y una breve sinopsis del modo como el concepto se relaciona con preocupaciones claves de la geografía ambiental crítica. Concluimos arguyendo cómo un compromiso más fuerte con el enfoque de la brecha metabólica podría beneficiar el campo. *Palabras clave:* dialéctica materialista, hibridismo mundo–ecología, marxismo, producción de la naturaleza, relación naturaleza–sociedad.

Neoliberal capitalism in the early twenty-first century is characterized by a nexus of profound economic, political, and ecological crises, prompting, among other things, reassessments of classical traditions for insights into our contemporary situation. In the Marxian tradition, this led to the rediscovery of Marx's metabolic analysis and his concept of metabolic rift (Burkett 1999; Foster 1999, 2000; Foster, Clark, and York 2010; Saito 2017). As a comprehensive critique of capital's "ultimately uncontrollable mode of social metabolic control" (Mészáros 1995, 41), the metabolic rift approach

illuminates how the array of crises we face is part of a larger epochal crisis of the capital system itself brought on by the fundamental contradiction posited between the transformation of socioecological conditions to satisfy capital's perpetual thirst for profits and its ability to foster sustainable, human development (Foster 2013). Thus, this approach can make important contributions to efforts to confront the most pressing problems society faces.

Many academic and political responses to contemporary socioecological crises have been uninspiring, rarely deviating from the confines of neoliberal

ideology (Harvey 2011) and primarily seeking to co-opt ecological concerns by resurrecting and “greening” modernization theory. The resulting ecological-modernization theory generally reduces environmental problems to technical ones resolvable through further technocratic market-based governance (Hawken, Lovins, and Lovins 1999). Conceptions of socioecological sustainability in this vein also frequently promote individualist lifestyle changes in preference to social solutions and privilege capitalist growth despite its direct connection to socioecological degradation (compare Foster [2012] and United Nations Environment Program [2012]).

Critical responses to these same crises have varied, but a distinction can be drawn between (1) those who view the problem as primarily ideological, cultural, or both, with the defects of the present order ranging from the perceived absence of a sufficiently ecocentric ethic to claims that the entire Enlightenment tradition is (mis)guided by Cartesian dualism (e.g., Castree 2000), and (2) those who see the problem mainly in materialist-realist terms, of which the metabolic rift has emerged as a prominent perspective within the Marxian tradition (Malm 2018).

Scholarship in critical environmental geography has promoted a specific, disciplinary emphasis on the spatial dimensions of human–environment interaction and their constitutive relationships to the rest of the Earth system (Pattison 1990; Turner 2002; Castree, Demeritt, and Liverman 2009). As a materialist-dialectical approach that similarly transcends “idealism and the false dichotomization of Man versus Nature” (Kovats-Bernat 2001, 73), one could reasonably expect the theory of metabolic rift to be a welcome contribution to these efforts, engaging with critical environmental geography. Yet, despite convergences, the metabolic rift approach has frequently been accused of perpetuating the very idealism and dichotomization that it contests and has gained little purchase in critical environmental geography (e.g., Castree 2015), remaining a marginal concept despite its influence in related fields such as environmental sociology (Napoletano et al. 2018).

We consider this relative lack of engagement with the metabolic rift to be particularly harmful to critical environmental geography (including much work in political ecology; Napoletano et al. 2018), because it is thereby closed out of ecological discussions connected to the growing ecosocialist movement, which

has adopted the metabolic rift as a central concept—as in System Change Not Climate Change, the main ecosocialist organization in the United States, and ecosocialist movements worldwide (see <https://systemchangenotclimatechange.org>; Wittman 2009; Klein 2015; Angus 2016; Baer 2016). In the following section, we consider some of the antipathy expressed toward metabolic rift theory through a comparative assessment of the Marxian approaches in critical environmental geography from which such criticisms largely stem. We then discuss the theory’s relationship to key geographical themes, including areas where some initial engagement has occurred. We conclude by emphasizing the value of stronger engagement with metabolic rift scholarship in geography as a whole.

Theoretical Differences within Marxian Ecological-Spatial Analysis

Marxian theory continues to weather the “postmodern turn” in human geography—albeit not without being heavily contested (e.g., Jones 1999)—in part by vigorously defending the relational deployment of analytical categories and abstractions such as class, capital, and totalities where appropriate (e.g., Harvey 1987; Smith 2005) and in part by reflexively adjusting such categories with an eye to “post” theorizations (e.g., analyses of intersectionality and expropriation; Fraser 2018). Not surprising given the diverse readings of Marxian theory and the often bitter contentions between its different traditions (McLellan 2007), the most vocal opposition to metabolic rift theory in critical environmental geography—and particularly in the subfield of political ecology (Napoletano et al. 2018)—has come from Marxian scholars claiming that theorization of metabolic rift, despite its dialectical emphasis, remains trapped in a Cartesian, dualistic perspective (e.g., Castree 2015; Moore 2015). Whereas past efforts to impose partisan positions as doctrine suggest the value of a healthy dose of skepticism regarding attempts to establish what Marx “really said” on points that he and Engels left vague, commitment to *de omnibus dubitandum* does not mean that what the two founders of historical materialism did write should be ignored, particularly in the context of attempts to draw on classical Marxism’s immense theoretical corpus in addressing the socioecological crisis of our time.

Here we merely note that metabolic rift theory is now widely accepted among Marxian theorists worldwide as having strong claims to representing an authentic historical materialism, arising directly out of the interpretation of Marx's own writings—without denying that there are other, opposing traditions, each with its own claims in this regard. In challenging arguments that have been commonly used to deny the entrance of metabolic rift theory into geographical discussions, forcing the door so to speak, we necessarily enter into debates about historical materialism or the philosophy of praxis as a whole. At the same time, we deliberately reject the very different approach adopted by some in this context of pursuing a hybridization of Marxism with various postmodernist traditions (contra Castree 2002; White, Gareau, and Rudy 2017). The goal here is not polemic. Rather, we seek to follow Marx's practice of rubbing different conceptual blocks together to make fire (see Harvey 2001) to encourage deeper discussion and debate about the comparative merits and weaknesses of different approaches to the nature–society dialectic in critical environmental geography. The more this is done, the more intellectual fires we expect will flare up to stimulate creative evolution of ideas in the field (Turner 2002).

An immediate issue is a deep chasm between geography and other social sciences with respect to political ecology. On the one hand, Marxian work on the nature–society dialectic within geography (particularly that of Neil Smith) has been described as among “the most influential efforts by human geographers to conceptualize the matter of nature” (Braun 2009, 24) but is “little known in Marxist circles” outside geography (Castree 2000, 24). On the other hand, the metabolic rift has been described as the “one Marxist line of inquiry into environmental problems [that] has outshone all the others in creativity and productivity” in the twenty-first century (Malm 2018, 177)—including the awarding of the Deutscher Prize in 2018 to Saito (2017) for his analysis of the evolution of the metabolic rift concept in Marx's thought—but has received little attention in geography. The “metabolic rift” does not appear in the title, abstract, or keywords (although it does occasionally appear in the full text) of any article in *Progress in Human Geography*, the *Journal of Political Ecology*, or *Global Environmental Change* and only appears in the abstract of one article in *Antipode*. This symmetrical

pattern of nonengagement is suggestive of a profound disciplinary divide in need of being bridged or intense underlying antagonisms that could produce admittedly volatile, but nonetheless illuminating, intellectual fires when brought into contact—or perhaps both simultaneously. To help move forward a debate in the aforementioned direction, we continue here by examining the premises of the approaches advocated by two of the metabolic rift's most outspoken Marxian critics in geography: the Smith–Castree “production-of-nature” thesis (Castree 2002; Smith 2008) and the world ecology approach advocated by Moore (2011).

Construction and Production of Nature

Smith's (2008) production-of-nature thesis quickly gained a widespread following in geography due in part to its “deliberately provocative language” (Smith 1999, 274) aimed at addressing limitations to social constructivism in human geography without reverting to positivism. Reasons given by Smith (1999) for this framing of his thesis as a corrective to other conceptions can be generalized into the following three general thrusts: He opposed (1) what he saw as a neo-Kantian focus on the discursive construction of “nature” and so presented the production of nature as a Hegalian-constructivist alternative intended to emphasize the role of social practice, rejecting the “dualist” notion of nature as separate from society; (2) what he saw as the nature idealism of theses regarding the domination of nature—both Schmidt's (1971) and the Frankfurt School's view of such domination as inevitable and the “environmental romanticism” of its denunciations; and (3) the view of any “red-green” coalition of anticapitalist struggle arguing that capital has entirely subsumed nature in the production (e.g., restoration, biotechnology) and appropriation (via, e.g., rent, financialization, and taxation) of surplus value (Smith [2006] described capital's conversion of nature into “an accumulation strategy”). These three thrusts were built on a critique of what Smith (2008) viewed as a contradictory dualism in bourgeois ideology of nature, conceived as both *universal* (encompassing everything that exists) and simultaneously as *external* to society, neither of which he considered incorrect but together offering a contradictory image of reality.

The marketing of the production-of-nature thesis as Marxian rests heavily on a selective, incomplete reading of Marx's conception of production. Smith (2006; 2008) repeatedly and explicitly used the term to mean that humanity changes the form of "received" nature through interacting with it, primarily through social labor. Superficially, this follows Marx's (1976) observation that human labor, like nature, only proceeds by changing the "form" of existing material—*fabricatio ex materia* rather than *fabricatio ex nihilo*. Expressing this as the actual production of nature, however, poses a problem. The dialectical counterpart of Marx and Engels's (2010a) observation that a pristine, prehuman nature no longer exists is Marx's (1976) characterization of the labor process as the site of the "metabolism between [the human] himself and nature" (283), with nature an active participant in the process (Saito 2017; Napoletano et al. 2018). This conception explicitly precludes Smith's (2008) notion of the "production of first nature from within and as a part of second nature" (83)—as any material used in production by definition contains, beneath the layers of human labor added, a "substratum ... furnished by nature without human intervention" (Marx 1976, 133). That is, production always includes a contribution from first nature that labor has not produced. Put simply, humans can repeatedly transform first nature, rendering it virtually unrecognizable, but they cannot produce it in the sense that Marx used the concept.

Smith's (1999) arguments for a more expansive conception of production compound this inconsistency between the production of nature as form or essence, rendering the thesis more difficult to reconcile with Marx's approach. The identity that Marx posited between production and consumption in the *Grundrisse* that Smith invoked to justify his own approach is only one aspect of a complex, dialectical argument on identity-in-opposition that encompasses production, distribution, exchange, and consumption as nonidentical moments in a differentiated totality in which production predominates but without excluding the other three moments. Lefebvre (1991) might have pushed this concept further than most, but even he (erroneously, in Smith's view) stopped short of asserting the production of nature, and a superficial reading of Whitehead's (1920) comments regarding the reduction of nature to space and time hardly provides a sufficient platform for Smith's leap

from Lefebvre's thesis on the production of space to the production of nature. Finally, the empiricist definition of production is undeniably flat and lifeless, as Smith correctly observed, but also accurately captures the alienated nature of capitalist production. Simply opposing a preconceived idea of what production should be—especially by dissolving what Marx (1978, 134) called the "nature form" into a concept of the "value form"—is to substitute what Hegel would call an abstract universal for a concrete one and does nothing to change the meaning of capitalist production.

Understanding why Marx was careful to avoid conflating the transformation of nature with the production of nature is key to understanding his dialectical critique of capital as a materialist critique that transcends both idealism and crude materialism. Particularly when discussing the eco-regulatory aspects of production, Marx recognized capital's ability to really subsume nature within the value form is far more limited by the natural form than the technological optimism of the bourgeoisie would sometimes suggest, and not even (frequently exaggerated) advances in biotechnology have changed this (Burkett 1999). Moreover, incorporating entropy into his analysis drew Marx's attention to the fact that the perpetual expansion of production is inherently confronted by ecological contradictions due to biophysical processes (e.g., resource constraints) and factors that shape and constitute the use values found in nature (Saito 2017; Ekers and Prudham 2018). This, in turn, helped Marx avoid falling into the trap of asserting the inevitability of progress, instead describing economic development—particularly where intensified capitalist production is concerned—as "progress here, regression there" (Marx 1981, 369). As Harvey (2012) noted, Marx's whole concept of "universality" in production means that "the [human] metabolic relation to nature" is an "eternal necessity" (12) that cannot be suspended by positing a subject-object identity between society and nature, although the relation can be rendered less antagonistic through conscious control over the social metabolism. This complexity in Marx's ecological discussion, including the metabolic rift conception itself, is either lacking or severely obscured in Smith's production-of-nature thesis.

Castree (2015) posited the inconsistencies of Smith's thesis as "productive ambiguities" rather than weaknesses and argued that attempting a

coherent assessment of what is asserted in the production of nature would “risk overlooking important aspects of his [Smith’s] thinking” (280). His own reading of the thesis is as a corrective against what he saw as an ontological society–nature binarism in any mention of a nature external to humanity. This includes virtually all Marxian approaches to nature, from Engels’s (1934) *Dialectics of Nature* through contemporary work in ecological Marxism (including that of Benton) up to and including the metabolic rift (Castree 2000, 2002, 2015). All of this work, according to Castree (2000, 14), is informed by an ideology of nature’s “non-identity with humanity and its relative autonomy” within a “dualistic mindset” that recapitulates “the bourgeois and green views of nature it otherwise opposes: namely, an ontological, theoretical and normative separation of the social and natural realms” (21).

After initially (and explicitly) refusing to even discuss the concept (see Castree 2002, note 12), Castree (2015) reluctantly conceded that the “idea of a ‘metabolic rift’ between capitalism and the biophysical world has become well-known and influential in some Marxist academic circles” (289). His ultimate assessment, though, is that its engagement with the concept of planetary boundaries and emphasis on how the capitalist transformation of nature can be disastrous in human terms—rather than on how capital has turned its “environmental externalities” into sources of profit (although this issue is explicitly discussed in, inter alia, Burkett 1999; Foster, Clark, and York 2010)—renders the metabolic rift approach guilty of “nature washing” (whereby the “causal power of nature is not compromised but would seem to be augmented by social injections into that nature”; Smith 2008, 245). This seems to suggest that the metabolic rift is subject to the same assessment Castree (2000) offered of most other Marxian work on nature outside geography’s privileged domain as “ontologically, theoretically and politically disabling” (7).

Such charges are highly disingenuous, however, in the way that they (after Latour 1993, 57; 2010) paint any dialectical approach to the nature–society metabolism as “dualistic,” while pointing to the possibility of human actions provoking an unexpected response from nature. Smith (2008) and Castree (2000) repeatedly introduced qualifiers to suggest that the production-of-nature thesis should not be read as claiming that the entire material world was

created by human labor, nor that society has control over all of nature (e.g., the production of nature includes the “unintentional production” of “new ecologies” through pollution; Castree 2000, 26). But if at least part of nature is not produced by humans, or at best partially integrated into capital circuits, and outside human control, leading to all sorts of unforeseen human consequences, how exactly can reference to various natural processes as relatively autonomous or partially external to society—particularly when humans are recognized as a unique part of nature—be legitimately dismissed as dualistic or obfuscatory? If humans are part of nature, how can nature as a whole not be partly external, as well as partly internal, to human society?

Moreover, in his *Critique of the Gotha Program*, Marx (1938, 3; see also Burkett 2009) pointed to the politically debilitating consequences of eliminating the distinction between human labor’s and the rest of nature’s contributions to production, as in the tendency of bourgeois intellectuals to attribute “supernatural creative power to labor.” Such a stance, he implied, obscures how the expropriation of both nature and unpaid socially reproductive labor in the household, alongside the appropriation of unpaid labor, undergird bourgeois society (Foster and Clark 2018).

Again, this is not to argue that Smith’s production-of-nature thesis is conceptually barren, as it encourages more detailed examination of the mechanisms and strategies that capital uses to bring environmental concerns into its accumulation processes at multiple points (e.g., production of surplus value through formal subsumption of environmental restoration and preservation, capture of rent through produced scarcity, financialization of natural use values as fictitious capital, etc.) that dovetail with work on metabolic rift, emphasizing the way in which capital continues to profit from environmental degradation even as public wealth and the conditions for human development are depleted (Burkett 1999; Foster, Clark, and York 2010). We do challenge, however, the assertion that the production-of-nature thesis exhausts the range of possible Marxian perspectives on the nature–society dialectic.

Rather, the metabolic rift could be used to extend Smith’s critique of capital’s subsumption of nature, inter alia, by considering how newly capitalized nature (1) exacerbates human alienation from nature by imposing further second-order mediators (private

property, exchange, etc.; see the description of the metabolic rift later); (2) helps to grease the wheels of accumulation, such that the net effect is further deepening of the metabolic rift as well as an overexploitation of capitalized nature; and (3) reconciles the accumulation process to changed ecological conditions (and accelerates it) at the expense of the most politically marginalized population segments in the introduction of various socioecological fixes (e.g., McCarthy 2015; Ekers and Prudham 2018) and what Foster, Clark, and York (2010) called “shifting the rift” (which emphasizes technological alongside spatiotemporal fixes). Although sustainability, from the bourgeois standpoint of business as usual, might indeed mean little more than a profitable investment opportunity to capital, many scholars and activists, often drawing on the Marxian tradition, have approached environmental concerns in the broader context of a class struggle displaced from the workplace (Harvey 1997, 2006, 2014) and a much-needed radical critique of a system of relations that invariably prioritizes capital accumulation over human needs (Castro 2004).

Double Internalities and Hybridism

Moore (2015) has been one of, if not the most persistent (if nominally sympathetic; Moore 2011) critics of the metabolic rift theory within sociology, crossing over into political ecology. Although similar to Castree’s claims, Moore’s charges of dualism are more far-reaching in that an analytical distinction between nature and society at any level (ontological, epistemological, phenomenological, etc.) and in any direction (nature considered from the perspective of society or society from the [hypothetical] perspective of nature) constitutes a “Cartesian binary” that must be eradicated, leading him to embrace the notions of “double internality” and “bundling” as neutral-monist/hybridist approaches to the “web of life.” Unlike Smith (2008) and Castree (2000), who sought to transcend both dualism and monism, Moore (2014) openly described his approach as a “monist and relational view of metabolism” (16).

Such neutral monism implicitly evinces a strong affinity with Latour’s (1996) actor-network theory (ANT; Bakker and Bridge 2006), which presents a critique of dualism and relies heavily on the concept of “bundling,” as well as related notions of imbrolios, networks, assemblages, webs, and hybrids

(Latour 2005, 43, 84, 103). “Civilizations,” Moore (2015) declared in a Latourian vein, “are bundles of relations between human and extra-human natures” (46). As an approach that promises to resolve historical antagonisms between realism and constructionism by transcending both, ANT holds obvious appeal in environmental geography—although increasing failures to live up to this and other promises have prompted a growing shift to more sophisticated posthumanist theorization (Escobar 2010; Lave 2015). Moore is thus not the only one attempting a hybridization of Marxian political economy with ANT and other posthumanist approaches (Swyngedouw 1996, 2006; Castree 2002; White, Rudy, and Gareau 2015)—and despite the vehement antipathy expressed by Latour (2010) and (less vehemently by) other posthumanists (e.g., Whatmore [1999], in geography) for basic concepts such as the dialectic, capital, and reification.

Moore’s (2015) aforementioned characterization of any distinction between society and nature as a Cartesian binary overextends the category and misrepresents the dialectic. In the history of philosophy, treating nature and society as a Cartesian binary would be to claim that they consist of two different ontological substances—which was described by Malm (2018) as “precisely the opposite of what the metabolic rift school teaches” (180). Marx was sharply critical of Cartesian rationalism and developed his dialectical conception of metabolism as an alternative approach that avoids merely swinging constantly from dualism to monism and back (Marx and Engels 2010a; Foster and Clark 2018). What Moore seems to be proscribing is any relational-analytical separation of human and nonhuman forces whatsoever, even within an argument, such as the metabolic rift theory, which insists on their dialectical relations. Instead, he deployed a new hyphenated terminology such as “capitalism-in-nature” versus “nature-in-capitalism” and confusingly referred to “the messy bundle of relations” that constitute the “web of life” (e.g., Moore 2011, 5; 2014, 12; 2015). In this respect he went well beyond issues of Cartesian dualisms, to the point that any analytical distinctions between subject and object, part and whole are effectively obliterated, resulting in a world of endless bundles and imbrolios, in which everything is on the same plane: a “flat ontology” in a Latourian vein that constitutes more of an impediment than an aid to meaningful analysis and explanation (Heil 2004; Harman 2014).

In contrast, metabolic rift theory rejects dualism without falling back into crude monism or eclectic hybridism, thereby permitting a critical-dialectical and historical-relational analysis. It offers, at least potentially, a theory of emergent material realities, capable of explaining capital's socioecological contradictions without veering into naturalistic determinism, social idealism, or a flat ontology (Kovats-Bernat 2001; Prudham 2015; Choat 2018). In this vein, Harvey's (2014) reference to "the contradictory metabolic unity of capital and nature" is not dualistic but rooted in the notion of the "unity of opposites" (260). Such unity is understood within a process of change in which such seeming antinomies are seen as historically specific mediations within a developing totality (Mészáros 1972; Creaven 2002). In this abstract sense at least, "the dialectic is as much a part of natural history as it is of human history" (Harvey 2012, 13).

In understanding so-called natural disasters, for instance, differentiation between social factors that are subject to human control—and therefore capable of being changed—and natural factors that are beyond human control is vital in both assigning responsibility and attempting to reduce the risk of recurrences (Choat 2018; Malm 2018). The 2017 earthquake that struck central Mexico killed 370 people and injured thousands more. The geological substratum in which this earthquake originated is, even by Smith's socially expansive criteria, beyond the reach of humans and therefore the product of a nature external to society, but this does not negate the fact that the disaster was and continues to be a social one, as were the factors that transformed this otherwise unremarkable geological activity into a human tragedy. Inasmuch as these latter factors were and are not inevitable, they provide a basis for political accountability and the need for and possibility of action to prevent such tragedy from repeating.

In addition, the (at least partially) unintentional character of many ecological crises, emphasized by Engels (1934), makes the distinction between different levels of structure and agency more, rather than less, relevant. It underscores how ecological crises or crises of sustainable human development could arise from basic contradictions between the dynamic materiality of nature and the systemic logic of capital accumulation, with the latter treating social and environmental costs as "externalities" outside the market since excluded from the circular flow of

income output (Burkett 1999; Foster and Burkett 2018). Continuing to counterpose monism and dualism does little to move beyond the surface appearances of these dynamics and expose the underlying contradictions (Mészáros 2010).

It would be a mistake, therefore, to attempt to account for present-day ecological crises simply by means of an analytical extension of the capitalist "law of value" to all of existence—as if the whole problem of "capitalism in the web of life" could be traced to the appropriation of the "unpaid work" of extrahuman nature (e.g., Moore 2015, 17). Rather, the ecological crises that confront us—and their relation to the expropriation of external nature—need to be conceived much more dynamically and materialistically in terms of the "alienated mediation" of "the interdependent process of social metabolism" between a changing capitalism and a changing Earth system, as envisioned in metabolic rift theory (Marx 1974, 261; 1981, 949).

The Irreparable Rift in the Interdependent Process of Social Metabolism

A careful rendering of the metabolic rift perspective, in light of the aforementioned criticisms directed against it, seems necessary to explain how this approach could contribute to critical environmental geography.

The Nature of the Metabolic Rift

Metabolic rift theory is rooted in the material-dialectical approach of the classical Marxian tradition, which is opposed both to the mechanical materialism that predominated in the Second and Third Internationals and to the retreat from the dialectics of nature in Western Marxism (Rees 1998; Foster and Clark 2016). Creaven (2015) described this dialectical approach as a scientific realism that sublates both abstract humanism and structuralism and as closely aligned with dialectical critical realism (Bhaskar 1975, 1993) in the sense of questioning both constructionism and naturalism or mechanism as partial, distorted reflections of a differentiated totality.

Nature, in this material-dialectical conception of reality, incorporating emergence and integrative

levels (Needham 1943; Bhaskar 1993), encompasses the totality of our material existence, such that even human thought is part of it. Rather than ontologically flat, however, this totality is differentiated. Society is both part of nature and constitutes a new emergent level with its own social-historical laws that are never absolute or neatly demarcated from the rest of nature (Needham 1943; Bhaskar 1993). Both a dualistic view of nature as consisting of entities that are entirely separate or in absolute opposition and a monistic view in which one moment subsumes all others or in which all differences are obliterated in a conception of immediate identity are viewed as one-sided representations of a far more complex, dynamic, mediated reality in which society and nature cannot be grasped in isolation or by treating them as identical (Creaven 2002). The object then is to transcend such one-sided conceptions through a wider synthesis.

Despite the fact that social processes cannot be reduced to biological determinants, the unity-in-opposition of nature and society embodied in the dialectical perspective is asymmetrical in the sense that nature contains, and could exist (albeit in a very different form), without human society, but human society (and human beings themselves) does not contain all of nature and cannot exist without it. In this critical-relational sense, nature refers to “those material structures and processes that are independent of human activity (in the sense that they are not a humanly created product), and whose forces and causal powers are the necessary conditions of every human practice, and determine the possible forms it can take” (Soper 1995, 132–33). This includes both extrahuman nature and nature as a part of human corporeal existence and the human metabolism (e.g., the human microbiome; Friedman 2018). The social transformation of nature, therefore, or its internalization by society through both transformation of and adaptation to its forces, is only ever partial, and nature retains a degree of relative autonomy or remains partially (and in good measure) outside human control, not infrequently with unanticipated results. Conversely, humans have the advantage of recognizing the forces governing nature and reflexively adapting their own actions to work cooperatively with these forces, although the class structures of capitalist society prevent this unless the results can be reconciled with accumulation (Engels 1934; Mészáros 2014).

This general conception of nature and society as dynamic and partially autonomous yet mutually constitutive forces might coincide with that posited in some new-materialist and posthumanist accounts, but the asymmetry of agency (i.e., that humans—and to a lesser extent a few other species—are capable of, but do not always act according to, a conscious objective) plays an important part in the Marxian materialist dialectic (Choat 2018). Distinctions between the conscious agency of humans, the intentional agency of living nature, and the causal profile of nonliving nature are important politically in the sense that humans can consciously attempt to regulate their social metabolism according to their understanding of the rest of nature and that humans are capable of building another, better society—one in which conscious regulation is possible on the basis of socioecological transformations (revolutionary optimism vs. the politics of despair).

The counter to Moore’s (2011) assertion that the metabolic rift approach slides into dualism when it posits that society can do things to nature or vice versa is therefore that one needs to recognize the two as different—with society as an emergent form with its own social laws—to understand why and how society and nature interact on each other, as well as how the reification of this distinction obtains material force under capitalism (Engels 1934; Saito 2017). Moreover, recognition of humans as a self-conscious part of nature means that the demarcation of what is social and what is natural is highly relational and depends just as much on the questions being asked and their context as on the objects of investigation (Hornborg 2017). At the level of society, this dialectical relation of human beings to nature through the mediating force of production is a complex and ever-changing one, constantly presenting “different [historical] ‘moments’” in the “universal metabolic relation to nature,” of which society itself is a part (Harvey 2012, 13).

Alienated Mediation and Metabolic Rifts in the Capitalist Mode

For Marx (1976), the labor and production process of society “mediates the metabolism between man and nature” (133). Whereas labor, as the metabolic relation between human beings and the earth, constitutes a transhistorical basis of human existence in general, the particular “alienated mediation”

(Marx 1974, 261) manifested in the system of wage labor is historically specific to capitalist relations of production (Mészáros 2005).

When the direct producers lose control over the production process, production is no longer governed by their immediate needs but by the interests of the ruling classes. As capitalist commodity exchange increasingly dominates society, a qualitative shift occurs in the valuation of its products from their immediate use values to a process mediated by a structure of abstract value, removed from the use value or material production, such that materiality is viewed as largely incidental (a mere precondition for value and exchange; Marx 1976). This also generates qualitative transformations in alienation itself, as capitalist institutions such as exchange, private property, wage labor, and so on are reified as second-order, alienated mediators (Mészáros 2005).

In contrast to Smith's (2008, 245–46; see also Castree 2000, 26) argument that the alteration of nature includes unintentional by-products of commodity production—seen in, for example, climate change and toxic contamination—which are themselves instances of the production of nature, metabolic rift scholars understand consequences such as the destruction rather than creation of use values, noting this characterizes capitalism's "alienated mediation" (Marx 1974, 1981) with nature via production. The distinction again pivots on the question of agency. Here it is important to understand how and what structural features prevent bourgeois society from rationally and democratically regulating the metabolism between human beings and nature in such a way as to maintain the earth for the chain of future generations. To include in the production of nature all such "externalities"—from radionuclides to climate change—that capitalism leaves out of its value calculations further undermines the production-of-nature thesis as a radical critique of capital. Many peoples' concerns regarding the death of coral reefs or the melting of Arctic ice go well beyond their potential effects on the accumulation process.

Crises of Capital Accumulation and Human Development

Under capitalism, the mediated unity of the labor process as the metabolism between human beings and nature (Marx 1976) is alienated and

contradictory. "Real individuals" are estranged from "their activity and the material conditions of their life, both those which they find already existing and those produced by their activity" (Lenin 1973, 221–3; Rees 1998), which entails estrangement from "the physical organization of these individuals and their consequent relation to the rest of nature" (Marx and Engels 2010a, 31). The same fundamental contradiction of capitalism expressed in this alienation, rooted in the estrangement of the producers from the conditions of production, is also expressed in the fact that the reproduction of the natural conditions of production and the unpaid labor of social reproduction—in short, the conditions of human development—are defined not as the fundamental objective of production but as mere "background conditions" necessary to maintain the conditions of capital accumulation (Fraser 2014; Harvey 2006, 2018).

It follows that the crises affecting society and the environment can be reduced to neither those of the conditions of capital accumulation nor those of human-ecological development; rather, they mutually constitute each other but in highly contradictory ways. Whereas accumulation crises tend to occur periodically without generally posing systemic threats to the reproduction of capital, crises of human development (i.e., crises of the changing social metabolism of humanity and nature) reflect a long-term, "endemic crisis" (sensu Harvey 2006, 161) exhibiting a secular trend toward progressive impoverishment and degradation borne disproportionately by the working class and engendered by capital accumulation—while also undermining natural diversity (Burkett 1999).

The metabolic rift, then, is best characterized as a theory of socioecological crises in which the primary focus is on explaining anthropogenic changes in what Marx (Marx and Engels 2010b, 54–66) called the "universal metabolism of nature," generating severe ecological disruptions for human society including, but not limited to, its formal economy. The concept of *rift* in the metabolism, in this socioecological sense, can be seen as the alienated anthropogenic disruption of the biogeochemical processes of the planet—all the way down to the human corporeal metabolism—in ways that serve to undermine human society itself, generating a "fatal rift" in the material properties underlying human

existence (Lucretius [c. 55 BCE] 1884, 21, I 450–52; Foster and Clark 2018). This rift appears in different concrete manifestations in distinct contexts. It generally, however, entails anthropogenic changes that affect the rate, volume, spatial configuration, and technical composition of material and energy flows through which society and its constituent members (at multiple scales, collectively and individually) metabolize. Hence, it deleteriously affects biophysical processes that provide use values necessary to sustainable human development.

As a concrete instance of the metabolic rift, the disruptions in agricultural nutrient cycles and urban waste cycles that Marx (1976, 1981) discussed in *Capital* illustrate combinations of all four of these tendencies. In this instance, brute depeasantization and urbanization of populations (spatial configuration) disrupted processes whereby various nutrients were previously cycled back into agriculture, leading to the rapid depletion of soil fertility in agriculture and contamination from the concentration of human waste in urban areas (described by Engels 1845). The demand for increases in the productivity (rate and volume) of agriculture and the extension of industrial agriculture (technical composition) further exacerbated the problems of declining soil fertility, generating frequent problems of soil depletion in England, despite the importation of guano and other nutrient sources (Clark and Foster 2009). The subsequent introduction of synthetic fertilizers (technical composition) in the early twenty-first century (Smil 1999a) did not resolve this rift but “shifted” it within the universal metabolism of nature (Clark and York 2008). Although synthetic fertilizers have partially staved off the immediate problem of soil depletion (rate, volume, and technical configuration), the way in which capital accumulation has encouraged their widespread and inefficient use has led to an approximate doubling of the quantity of reactive nitrogen in the biosphere (Smil 1999b; rate, volume, technical composition, and spatial configuration), the effects of which—beyond the instances of water contamination and hypereutrophication leading to anoxic dead zones—are difficult to foresee (Smil 2002). Rather than treat it as a static or passive category, nature clearly operates as an active agent in this process, in a manner consistent with the metabolic rift perspective’s dynamic conception of nature and its role in the making of human history (Clark and York 2005).

This example of metabolic rift analysis also demonstrates that this approach often implicates the town–country antithesis of capital but without invoking any simplistic, binarist conceptions of the town as social and the country as natural or of absolute distinctions between the categories (cf. Wachsmuth 2012). Despite their apparent differences, rural landscapes cannot be designated categorically as more natural (sensu Soper 1995) than urban ones—as industrial monoculture, open-pit mining, and mountaintop removal all definitively illustrate (Austin and Clark 2012)—such that a strict rural–natural/urban–social dichotomy is precluded (Napoletano et al. 2018). Rather, the town–country antagonism in metabolic rift refers to capital’s structural imperative to organize space with profitability as its first concern and human needs (and even more so those of nonhumans) of only incidental concern—that is, profit requires exchange, which necessitates the provision of something useful (Burkett 1999). Competition to appropriate these profits generates an expansionary dynamic, which frequently encourages the intensification of land-use activities on any land supplying “natural” use values (the free appropriation of nature) conducive to capital accumulation—including those that contribute to rent (Harvey 2006)—and indicates that undermining the ability of biophysical processes to provide use values without human labor can be beneficial from the perspective of capital accumulation but disastrous from a human perspective.

Bringing the Metabolic Rift into Geography

In reintroducing Marx’s concept of the metabolic rift in the *American Journal of Sociology* two decades ago, Foster (1999) wrote that “geography, with its long history of focusing on the development of the natural landscape and on biogeography, was the social science that adapted most easily to growing environmental concerns” (366), comparing the field favorably to environmental sociology, where ecological analysis was weak. Ironically, the concept of the metabolic rift subsequently has resulted in numerous new theoretical and empirical efforts within environmental sociology directed at analyzing ecological crises, whereas the main Marxian-inflected category in geography, the production-of-

nature thesis, has tended—perhaps owing to its originator’s habit of viewing the natural sciences and environmentalism as mere instruments of capital (Castree 2017)—to inhibit engagement with ecological crises (which is not, however, to argue that such work is entirely absent).

As Castree (2002) bluntly acknowledged with respect to the production-of-nature concept developed by Smith, “Smith gives us an explanatory monism, which far from resolving the problems of dualism, gives capitalism all the power in the society-nature relation and therefore *erases* nature altogether” (131). Asserting the flat ontology of a more posthumanist approach such as Moore’s against a material-dialectical conception of nature and society compounds this monism (in Moore’s case, explicitly), inasmuch as it proscribes any analytical distinction between humans and their material environment, such as that used in metabolic rift analysis (Saito 2017). This therefore weakens our understanding of the role of class and other social structures of domination in the degradation of ecological conditions (Malm 2018). Critical ecological analysis, focusing on the antagonistic but conjoined coevolution of nature and society, becomes almost impossible in these restrictive terms. In sharp contrast to Castree’s (2000) assertions regarding geography’s “relatively marginal place in the academic division of labour” (24) and superior perspective on nature, we posit that it is precisely this dualistic counterpoising of monism to dualism that has constrained the ecological contributions of left- and Marxian-influenced thinkers within geography. Other disciplines, which effectively integrated dialectical and systems theories into critical ecological thought, have long since transcended the simplistic dualist–monist dyad, often without resorting to hybridization (Keller and Golley 2000).

Although the metabolic rift’s relevance to the nature–society tradition in political ecology is obvious, engagement with this perspective in other geographical traditions would also prove valuable. Although useful as a global-level, Earth system concept (e.g., Wachsmuth 2012; Castree 2015), Marx’s categories of “the universal metabolism of nature” (Marx and Engels 2010b, 54–66), social metabolism, and the metabolic rift are inherently multiscalar (as demonstrated in the way in which social metabolism has been used, albeit without attention to the metabolic rift [Newell and Cousins 2015]; in urban

political ecology [Keil 2005]).¹ Here the concept of metabolic rift provides a mechanism to interrogate the conditions of metabolic interchanges between humans and the rest of nature across and between scales. Such a method necessarily raises questions about how the metabolic rift interpenetrates with the spatial configuration of capitalist society within and between scales, including, for example, how rifts at larger scales are manifested at smaller scales and how more localized rifts are propagated and rebound on larger scale processes through historical processes that depend on the specificities of material history and social class struggles.

Similarly, in the area studies tradition, the metabolic rift points to the need for further examination and synthesis of existing studies of the ways in which capital’s alienating mediations are manifested and contested between different and within internally heterogeneous social, cultural, and locational contexts. Here the physical environment is to be regarded as one determinant of the real, grounded social struggles in which humans operate as conscious agents. The articulation within and between capitalist and other modes of production and social formations (Hindess and Hirst 1977) also suggests that further insights can be developed from work integrating the concepts of socioecological fixes built on Harvey’s concept (e.g., Ekers and Prudham 2018) with parallel work on metabolic shifts and techno-fixes (e.g., Clark and York 2008). This dialectical approach can help facilitate collaboration within and between physical and human geography in the Earth science tradition—without obliterating their important distinctions—to aid in humanity’s efforts to navigate the Anthropocene on the basis of what Pattison (1990) called “morally the most significant concept in the entire geographic heritage, that of the earth as a unity” (216).

Initial Signs of Engagement

Although the metabolic rift framework has been relatively absent from core discussions in political and environmental geography thus far, nascent attention to this approach, particularly in empirical studies, as well as shared problematics and theoretical frameworks of metabolic rift and historical geographical traditions (Quaini 1982; Sayer 2015), offer hope that at the very least a constructive debate could be initiated in geography in this area. It would

be possible to explore the geographical aspects of capital's transformations of the rate, volume, technical composition, and spatial configuration of the social metabolism and the rifts that these generate in the universal metabolism of nature, in ways that would greatly enhance political and environmental ecology. A consideration of some of these nascent contributions offers a sense of the possibilities opened up by the metabolic rift.

Metabolic Rifts of Urbanization. Swyngedouw's (1996) attempts to synthesize Latourian constructionism with Marx's (1970; Fischer-Kowalski 1997) concept of social metabolism is considered one of the foundations of urban political ecology—even if subsequent work there has reportedly used the post-humanist aspects of this synthesis openly to reject the Marxian framing of socionatural metabolism (Heynen 2014). Thus, it is not surprising that Swyngedouw (2006) began to examine how the separation of spaces of production and of consumption constitute a metabolic rift (albeit mistakenly attributing the concept to Liebig rather than Marx).

Scattered empirical studies related to urban political ecology have engaged constructively with the concept of metabolic rift as well. In an effort to draw more attention to the role of rent-seeking in urbanization, Baxter (2014) demonstrated how the pursuit of rent by real estate developers and speculators, operating through fragmented and contradictory regulatory apparatuses, generated and exacerbated ecological rifts in the hydrological processes that resulted in the severe flooding of eastern New Orleans triggered by Hurricanes Katrina and Rita, themselves intensified by anthropogenic climate change, in 2005. This study contradicts Castree's assertions (discussed earlier) that metabolic rift scholarship invokes climate change and socially transformed nature as new superdeterminants of social processes, as Baxter implicated both the global climatic factors responsible for the intensification of the hurricanes that struck New Orleans and the role of land and development speculation in the localized rifts in hydrological conditions that together resulted in massive flooding.

Emphasizing the organic relationship between the exploitation of labor and the expropriation of nature associated with Marx's metabolic rift approach, Farahani (2013) described how gentrification is exacerbating metabolic rifts in both labor process and land change associated with urbanization and

dislocation in a working-class community in Tehran. This suggests that the capture of land and resource rents through speculation, financialization, and commodification, in conjunction with the institutional manipulations that they encourage, tend to exacerbate the ecological rifts of capitalist urbanization and the underlying alienation (Knox-Hayes 2017). Similarly, Bahers and Giacchè (2018) find the metabolic rift framework useful in exploring how changes to the flows of organic waste in Rennes interpenetrate with aspects of alienation and commodification. Further investigations along these lines—particularly in light of the extent to which the metabolic rift “emphasizes the longer-term dimensions to metabolic transformation rather than a more historically diffuse emphasis on perpetual recombinations,” indicating a “clear directionality to the metabolic process engendered by the expanding scope of global capital” (Gandy 2018, 102)—could provide an important complement to work in critical environmental geography on the concept of an urban “sustainability fix” (e.g., While, Jonas, and Gibbs 2004).

Bigger, Greener Rural Rifts. Parallel to the discussion of the town–country antagonism as conceived in metabolic rift analysis, capital's metabolic imperatives are implicated in the intensification and alienation of landscapes traditionally characterized as rural. Dobrovolski (2012), for instance, combined Marx's analysis of monopoly and differential land rent in agriculture with the concept of metabolic rift to advance an explanation of the dynamics of continued deforestation in the Amazon. As initial work using the concept on coal extraction indicates (Austin and Clark 2012), the metabolic rift could also be highly valuable in addressing the socioecological dimensions of land expropriation and territorial dispossession surrounding the boom in extractive industries in Latin America and elsewhere.

Metabolic Rifts in Food Systems. As an issue that transects several vital themes in both environmental sociology and geography, examination of the food system from a metabolic rift perspective could be highly illuminating in critical-environmental geography and related fields. Work on this topic implicates the metabolism of water, nutrients, agrochemicals, fossil fuels, and other inputs and their flows through the biosphere, including the metabolism of fossil fuels associated with the industrialization of agriculture and the globalization of the

market for its products (see, e.g., Huber 2011, 2017; McMichael 2011; Harvey 2014). Much existing work engaging with the metabolic rift in this area involves the analysis of localized efforts to overcome particular aspects of rifts in the capitalist food system and the structural obstacles that capital imposes. McClintock (2010), for instance, examined urban agriculture as an attempt to address what he posited as three interrelated dimensions of metabolic rift: (1) an ecological rift in the rescaling of the metabolism between society and nature, (2) a social rift in the commodification of land and labor, and (3) an individual rift in the lived experience of alienation. Focusing more specifically on the Global South, Wittman (2009) described how successive metabolic ruptures and the nature–society relationships they entail contribute to peasant movements for agrarian citizenship and food sovereignty, such as those advanced by *La Vía Campesina*. Further examination of the metabolic rift in the context of the isolation of spaces of production from those of consumption could be similarly intriguing in this line, in addition to the spatial aspects of the numerous rifts present in the food system (Foster 2016).

Geographic Rift in the Production of Space. Napoletano, Paneque-Gálvez, and Vieyra (2015) drew explicit attention to the geographical dimensions of the metabolic rift in terms of a geographic rift associated with the human–environment dialectic and the helical deterritorialization and reterritorialization of social-metabolic processes under capitalism in different locations and spatio-temporal contexts. Whereas the metabolic rift covers multiple dimensions of human alienation from nature through alienated labor, the geographic rift focuses more explicitly on alienation from land, territory, place, and their use values (sensu Logan and Molotch 2007). The intent is to facilitate analysis of the organic relationships between alienation, the transformation and production of relational space, and the interrelated concepts of spatiotemporal fix, socioecological fix (Ekers and Prudham 2018), and metabolic shifts and techno-fixes (e.g., Clark and York 2008) as mutually constituting aspects of the metabolic rift in time and space, which brings together capitalist land-use dynamics as a metabolic process in two respects: (1) The configurations of relational space provide the spatiotemporal context for society’s metabolism and reproduction more generally (Harvey 2001) and therefore significantly

constrain, direct, and disrupt other metabolic flows—including the circulation of money and money capital (e.g., Baxter 2014). (2) The production of relational space through land change is shaped by these other metabolic processes, which are embodied in human labor and written into landscape (Harvey 1996), constituting land use as itself a social-metabolic process. In this way the geographic rift emerges as a type of metabolic rift. The irrational (from a human perspective) devaluation of existing territories brought on by the inherent contradictions of perpetual accumulation for its own sake (Harvey 2001, 2006) further inserts them and their inhabitants within the logic of capital, simultaneously producing profound experiences of alienation that have the potential of exploding into substantial, even antisystemic, resistance. Hence, the geographic rift is a process that occurs as much “inside” capitalism as on the frontiers of accumulation, even as these frontiers themselves become increasingly politicized as sites of struggle.

Taken together, work along these trajectories indicates that the metabolic rift could provide a number of avenues for fruitful investigation into the particular spatio-geographical characteristics of capital’s contradictory and antagonistic regulation of humanity’s social metabolism with the rest of nature; issues “to which the concept of metabolic rift alludes” but have “yet to be fully explored by political ecology” (Barca and Bridge 2015, 371). In addition to further empirical work such as that in the case studies mentioned here and others, this entails deeper theoretical engagement with the metabolic rift’s underlying conceptual framework and its articulation in terms of the rate, volume, technical composition, and spatial configuration of the social metabolism of materials and energy in different geographic contexts.

Engagement with the Metabolic Rift in Geography: An Open-Ended Conclusion

Engagement with metabolic rift theory as a concept drawing on the classical Marxian tradition can contribute to the extension of environmental geography’s critical-normative perspective in three important respects. First, the concept has proven itself effective in bringing together and politicizing the work of researchers within and across various disciplinary boundaries (see, e.g., Wishart, Jonna, and Besek’s [2018] bibliography) around shared concerns

regarding society's prospects in the Anthropocene and sustainable alternatives to both ecological modernization and nature romanticism (Clark and York 2005). Far from succumbing to neoliberal environmentalism or contributing to the reification of nature (cf. Castree 2017), this scholarship has become highly politically charged as part of a project of radical activism within and through the academy aimed at the identification and advocacy of progressive, socially just alternatives to the status quo (sensu Blomley 2008).

Second, metabolic rift scholarship has as strong an organic link to red-green politics and activism beyond the strict confines of the academy as it does to the debates within it (e.g., Wittman 2009; Klein 2015; Malm 2018; Wallis 2018). In addition to strengthening the theoretical rigor of its scholarship, this dialectical unity of theory and praxis has resulted in the concept's warmer reception by such movements than what Castree (2002) considered typical of Marxian work in critical environmental geography. Given that science is never politically neutral, this organic link to radical politics both within and beyond the academy helps to ensure that metabolic rift scholarship and the environmental research with which it engages is used to challenge, rather than reinforce, the hegemony of existing power structures (sensu Peet 1977). Stronger engagement with this scholarship in critical environmental geography, therefore, could help the field to overcome the disjuncture between academic theorization and social praxis (Mitchell 2008) in line with Harvey's (2001) call for a radical, "applied people's geography" (120).

Finally, the overtly radical orientation of most metabolic rift scholarship could help to sharpen environmental geography's critical edge by bringing the full weight of important currents of the evolving, dynamic critical-Marxian tradition to bear on the geographical dimensions of the capital system's socioecological contradictions, while continuing to criticize the top-down, managerial assumptions in many calls for integrative research on the human-environment problematic (Demeritt 2009).

In transcending both Cartesian dualism and social monism, the metabolic rift perspective cannot reasonably be construed as a "millenarian and apocalyptic proclamation that ecocide is imminent" (Harvey 1997, 194)—although growing and highly unpredictable threats to humanity are not downplayed

either—but as a call for critical engagement with struggles to defend and improve the socioecological conditions for sustainable human development as part of a class struggle extended beyond the narrowly construed confines of the workplace (Harvey 2001; Burkett 2009). The true significance of the "dangerous if not potentially fatal contradiction" posed by "capital's changing metabolic relation to nature" (Harvey 2014, 253) is not that the contradiction might eventually prove fatal to capital but that long before then it will have already proven fatal to untold numbers of people rendered expendable by the imperative to continue accumulating wealth at the expense of humans and the rest of nature.

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Note

1. Marx's role in originating the concept of social metabolism—a category that has been crucial to fields such as industrial ecology and urban political geography—is widely recognized (Swyngedouw 1996; Fischer-Kowalski 1997), leading to two very different theoretical approaches known as social-metabolism theory (Molina and Toledo 2014) and metabolic rift theory. These are distinguished from each other primarily by the latter's focus on an analysis of socioecological crisis rooted in Marx's (1981) concept of a "rift in the interdependent process of social metabolism" (949). Metabolic rift theory is at the center of contemporary Marxian debates, whereas the social-metabolism perspective is increasingly distant from ecological-Marxist discussions. This article thus considers social-metabolism theory only tangentially, where the two approaches overlap.

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References

- Angus, I. 2016. *Facing the Anthropocene*. New York: Monthly Review.
- Austin, K., and B. Clark. 2012. Tearing down mountains. *Critical Sociology* 38 (3):437–57. doi: 10.1177/0896920511409260.
- Baer, H. A. 2016. Towards democratic eco-socialism as the next world system. Accessed January 21, 2019. <http://thenextsystem.org>.
- Bahers, J.-B., and G. Giacchè. 2018. Towards a metabolic rift analysis: The case of urban agriculture and organic waste management in Rennes (France). *Geoforum* 98:97–107. doi: 10.1016/j.geoforum.2018.10.017.
- Bakker, K., and G. Bridge. 2006. Material worlds? Resource geographies and the “matter of nature.” *Progress in Human Geography* 30 (1):5–27. doi: 10.1191/0309132506ph588oa.
- Barca, S., and G. Bridge. 2015. Industrialization and environmental change. In *The Routledge handbook of political ecology*, ed. T. Perreault, G. Bridge, and J. McCarthy, 366–77. London and New York: Routledge.
- Baxter, V. 2014. Rent, real estate, and flood mitigation in New Orleans east. *Antipode* 46 (4):1014–31. doi: 10.1111/anti.12080.
- Bhaskar, R. 1975. *A realist theory of science*. London: Verso.
- . 1993. *Dialectic*. London: Verso.
- Blomley, N. 2008. The spaces of critical geography. *Progress in Human Geography* 32 (2):285–93. doi: 10.1177/0309132507084401.
- Braun, B. 2009. Nature. In *A companion to environmental geography*, ed. N. Castree, D. Demeritt, D. Liverman, and B. Rhoads, 17–36. West Sussex, UK: Wiley-Blackwell.
- Burkett, P. 1999. *Marx and nature*. New York: St. Martin’s.
- . 2009. *Marxism and ecological economics*. Chicago: Haymarket.
- Castree, N. 2000. Marxism and the production of nature. *Capital & Class* 24 (3):5–36. doi: 10.1177/030981680007200102.
- . 2002. False antitheses? *Antipode* 34 (1):111–46. doi: 10.1111/1467-8330.00228.
- . 2015. Capitalism and the Marxist critique of political ecology. In *The Routledge handbook of political ecology*, ed. T. Perreault, G. Bridge, and J. McCarthy, 279–92. London and New York: Routledge.
- . 2017. Unfree radicals. *Antipode* 49:52–74. doi: 10.1111/anti.12187.
- Castree, N., D. Demeritt, and D. Liverman. 2009. Introduction. In *A companion to environmental geography*, ed. N. Castree, D. Demeritt, D. Liverman, and B. Rhoads. West Sussex: Wiley-Blackwell.
- Castro, C. J. 2004. Sustainable development. *Organization & Environment* 17 (2):195–225. doi: 10.1177/1086026604264910.
- Choat, S. 2018. Science, agency and ontology. *Political Studies* 66 (4):1027–42. doi: 10.1177/003232117731926.
- Clark, B., and J. B. Foster. 2009. Ecological imperialism and the global metabolic rift. *International Journal of Comparative Sociology* 50 (3–4):311–34. doi: 10.1177/0020715209105144.
- Clark, B., and R. York. 2005. Dialectical materialism and nature. *Organization and Environment* 18 (3):318–37. doi: 10.1177/1086026605279387.
- . 2008. Rifts and shifts. *Monthly Review* 60 (6):13–24. doi: 10.14452/MR-060-06-2008-10_2.
- Creaven, S. 2002. The pulse of freedom? *Historical Materialism* 10 (2):77–141. doi: 10.1163/156920602320318093.
- . 2015. The “two Marxisms” revisited. *Journal of Critical Realism* 14 (1):7–53. doi: 10.1179/1572513814Y.0000000008.
- Demeritt, D. 2009. Geography and the promise of integrative environmental research. *Geoforum* 40 (2):127–29. doi: 10.1016/j.geoforum.2008.08.010.
- Dobrovolski, R. 2012. Marx’s ecology and the understanding of land cover change. *Monthly Review* 64 (1):1–7. doi: 10.14452/mr-064-01-2012-05_3.
- Ekers, M., and S. Prudham. 2018. The metabolism of socioecological fixes. *Annals of the American Association of Geographers* 108 (1):1–19. doi: 10.1080/24694452.2017.1309962.
- Engels, F. 1845. *The condition of the working class in England in 1844*. Moscow: Institute of Marxism-Leninism.
- . 1934. *The dialectics of nature*. Moscow: Progress.
- Escobar, A. 2010. Postconstructivist political ecologies. In *The international handbook of environmental sociology*, ed. M. R. Redclift and G. Woodgate, 91–105. Cheltenham, UK: Edward Elgar.
- Farahani, I. 2013. Vanished in gaps, vanquished in rifts. *Journal of Political Ecology* 20 (1):395–412. doi: 10.1.1.673.8738.
- Fischer-Kowalski, M. 1997. Social metabolism. In *The international handbook of environmental sociology*, ed. M. R. Redclift and G. Woodgate, 119–37. Cheltenham, UK: Edward Elgar.
- Foster, J. B. 1999. Marx’s theory of metabolic rift. *American Journal of Sociology* 105 (2):366–405. doi: 10.1086/210315.
- . 2000. *Marx’s ecology*. New York: Monthly Review.
- . 2009. *The ecological revolution*. New York: Monthly Review.
- . 2012. The planetary rift and the new human exemptionalism. *Organization & Environment* 25 (3):211–37. doi: 10.1177/1086026612459964.
- . 2013. The epochal crisis. *Monthly Review* 65 (5):1–12. doi: 10.14452/mr-065-05-2013-09_1.
- . 2016. Marx as food theorist. *Monthly Review* 68:1–25. doi: 10.14452/MR-068-07-2016-11_1.
- Foster, J. B., and P. Burkett. 2018. Value isn’t everything. *Monthly Review* 70 (1):1–17.
- Foster, J. B., and B. Clark. 2016. Marx’s universal metabolism of nature and the Frankfurt School. In *Changing our environment, changing ourselves*, ed. J. Ormrod, 101–35. London: Palgrave-Macmillan.
- . 2018. The robbery of nature. *Monthly Review* 70 (1):1–20.

- Foster, J. B., B. Clark, and R. York. 2010. *The ecological rift*. New York: Monthly Review.
- Fraser, N. 2014. Can society be commodities all the way down? *Economy and Society* 43 (4):541–58. doi: 10.1080/03085147.2014.898822.
- . 2018. From exploitation to expropriation. *Economic Geography* 94 (1):1–17. doi: 10.1080/00130095.2017.1398045.
- Friedman, M. 2018. Metabolic rift and the human microbiome. *Monthly Review* 70 (3):69–107. doi: 10.14452/MR-070-03-2018-07_4.
- Gandy, M. 2018. Cities in deep time. *City* 22 (1):96–105. doi: 10.1080/13604813.2018.1434289.
- Harman, G. 2014. *Bruno Latour*. London: Pluto.
- Harvey, D. 1987. Three myths in search of reality in urban studies. *Environment and Planning D* 5 (4):367–76.
- . 1996. Cities or urbanization? *City* 1 (1–2):38–61. doi: 10.1080/13604819608900022.
- . 1997. *Justice, nature and the geography of difference*. West Sussex, UK: Wiley-Blackwell.
- . 2001. *Spaces of capital*. London and New York: Routledge.
- . 2006. *The limits to capital*. London: Verso.
- . 2011. *The enigma of capital and the crises of capitalism*. Oxford, UK: Oxford University.
- . 2012. History versus theory: A commentary on Marx's method in Capital. *Historical Materialism* 20 (2):3–38. doi: 10.1163/1569206X-12341241.
- . 2014. *Seventeen contradictions and the end of capitalism*. Oxford, UK: Oxford University.
- . 2018. *Marx, Capital, and the madness of economic reason*. Oxford, UK: Oxford University.
- Hawken, P., A. Lovins, and L. H. Lovins. 1999. *Natural capitalism*. New York: Little, Brown and Company.
- Heil, J. 2004. *Philosophy of mind*. London and New York: Routledge.
- Heynen, N. 2014. Urban political ecology I. *Progress in Human Geography* 38 (4):598–604. doi: 10.1177/0309132513500443.
- Hindess, B., and P. Q. Hirst. 1977. *Mode of production and social formation*. London: Palgrave.
- Hornborg, A. 2017. Artifacts have consequences, not agency. *European Journal of Social Theory* 20 (1):95–110. doi: 10.1177/1368431016640536.
- Huber, M. T. 2011. Oil, life, and the fetishism of geopolitics. *Capitalism Nature Socialism* 22 (3):32–48. doi: 10.1080/10455752.2011.593883.
- . 2017. Value, nature, and labor. *Capitalism Nature Socialism* 28 (1):39–52. doi: 10.1080/10455752.2016.1271817.
- Jones, A. 1999. Dialectics and difference. *Progress in Human Geography* 23 (4):529–55. doi: 10.1191/030913299676750977.
- Keil, R. 2005. Progress report—Urban political ecology. *Urban Geography* 26 (7):640–51. doi: 10.2747/0272-3638.26.7.640.
- Keller, D. R., and F. B. Golley. 2000. Introduction. In *The philosophy of ecology*, ed. D. R. Keller and F. B. Golley, 1–19. Athens: University of Georgia.
- Klein, N. 2015. *This changes everything*. London: Penguin.
- Knox-Hayes, J. 2017. Finance capital and the environment. In *International encyclopedia of geography*, ed. D. Richardson, 1–15. West Sussex, UK: Wiley.
- Kovats-Bernat, J. C. 2001. Marx's ecology. *Contemporary Human Ecology* 8 (1):73–75.
- Latour, B. 1993. *We have never been modern*. Cambridge, MA: Harvard University.
- . 1996. On actor-network theory. *Soziale Welt* 47 (4):369–81. doi: 10.22394/0869-5377-2017-1-173-197.
- . 2005. *Reassembling the social*. Oxford: Oxford University.
- . 2010. *On the modern cult of the factish gods*. Durham, NC: Duke University.
- Lave, R. 2015. Reassembling the structural: Political ecology and actor-network theory. In *Handbook of political ecology*, ed. T. Perrault, J. McCarthy, and G. Bridge, 213–23. London and New York: Routledge.
- Lefebvre, H. 1991. *The production of space*. Oxford, UK: Blackwell.
- Lenin, V. I. 1973. *Collected works*, vol. 38. Moscow: Progress.
- Logan, J. R., and H. Molotch. 2007. *Urban fortunes*. Berkeley: University of California.
- Lucretius. [c. 55 BCE]. 1884. *The scheme of Epicurus*, trans. T. C. Baring. London: Kegan, Paul, Trench.
- Malm, A. 2018. *The progress of this storm*. London: Verso.
- Marx, K. 1938. *Critique of the Gotha programme*. New York: International.
- . 1970. *A contribution to the critique of political economy*. Moscow: Progress.
- . 1973. *Grundrisse*. New York: Penguin.
- . 1974. *Early writings*. New York: Penguin.
- . 1976. *Capital*, vol. 1. New York: Penguin.
- . 1978. The value form. *Capital and Class* 2 (1):130–50.
- . 1981. *Capital*, vol. 3. New York: Penguin.
- Marx, K., and F. Engels. 2010a. *Collected works*, vol. 5. Digital ed. Chadwell Heath, UK: Lawrence & Wishart.
- . 2010b. *Collected works*, vol. 30. Chadwell Heath, UK: Lawrence & Wishart.
- McCarthy, J. 2015. A socioecological fix to capitalist crisis and climate change? *Environment and Planning A: Economy and Space* 47 (12):2485–2502. doi: 10.1177/0308518X15602491.
- McClintock, N. 2010. Why farm the city? *Cambridge Journal of Regions, Economy and Society* 3 (2):191–207. doi: 10.1093/cjres/rsq005.
- McLellan, D. 2007. *Marxism after Marx*. London: Macmillan.
- McMichael, P. 2011. The food regime in the land grab. Paper presented at International Conference on Global Land Grabbing. University of Sussex, Sussex, UK.
- Mészáros, I. 1972. *Lukács's concept of dialectic*. London: Merlin.
- . 1995. *Beyond capital*. London: Merlin.
- . 2005. *Marx's theory of alienation*. London: Merlin.
- . 2010. *The social determination of method*. New York: Monthly Review.
- . 2014. *The necessity of social control*. New York: Monthly Review.

- Mitchell, D. 2008. Confessions of a desk-bound radical. *Antipode* 40 (3):448–54. doi: [10.1111/j.1467-8330.2008.00613.x](https://doi.org/10.1111/j.1467-8330.2008.00613.x).
- Molina, M. G. D., and V. Toledo. 2014. *Social metabolism*. New York: Springer.
- Moore, J. W. 2011. Transcending the metabolic rift. *The Journal of Peasant Studies* 28 (1):1–46. doi: [10.1080/03066150.2010.538579](https://doi.org/10.1080/03066150.2010.538579).
- . 2014. Toward a singular metabolism. *New Geographies* 6:10–19.
- . 2015. *Capitalism in the web of life*. London: Verso.
- Napoletano, B. M., J. Paneque-Gálvez, and A. Vieyra. 2015. Spatial fix and metabolic rift as conceptual tools in land-change science. *Capitalism Nature Socialism* 26 (4):198–214. doi: [10.1080/10455752.2015.1104706](https://doi.org/10.1080/10455752.2015.1104706).
- Napoletano, B. M., P. S. Urquijo, J. Paneque-Gálvez, B. Clark, R. York, I. Franch-Pardo, Y. Méndez-Lemus, and A. Vieyra. 2018. Has (even Marxist) political ecology really transcended the metabolic rift? *Geoforum* 92:92–95. doi: [10.1016/j.geoforum.2018.04.008](https://doi.org/10.1016/j.geoforum.2018.04.008).
- Needham, J. 1943. *Time*. London: George Allen & Unwin.
- Newell, J. P., and J. J. Cousins. 2015. The boundaries of urban metabolism. *Progress in Human Geography* 39 (6):702–28. doi: [10.1177/0309132514558442](https://doi.org/10.1177/0309132514558442).
- Pattison, W. D. 1990. The four traditions of geography. *Journal of Geography* 89 (5):202–6. doi: [10.1080/00221349008979196](https://doi.org/10.1080/00221349008979196).
- Peet, R. 1977. The development of radical geography in the United States. *Progress in Human Geography* 1 (2):240–63. doi: [10.1177/030913257700100203](https://doi.org/10.1177/030913257700100203).
- Prudham, S. 2015. Property and commodification. In *The Routledge handbook of political ecology*, ed. T. Perreault, G. Bridge, and T. McCarthy, 430–45. London and New York: Routledge.
- Quaini, M. 1982. *Geography and Marxism*. London: Blackwell.
- Rees, J. 1998. *The algebra of revolution*. London and New York: Routledge.
- Saito, K. 2017. *Karl Marx's ecosocialism*. New York: Monthly Review.
- Sayer, A. 2015. Critical realism in geography. In *International encyclopedia of the social & behavioural sciences*, ed. J. D. Wright, 2nd ed., 277–80. Oxford, UK: Elsevier.
- Schmidt, A. 1971. *The concept of nature in Marx*. London: New Left.
- Smil, V. 1999a. Detonator of the population explosion. *Nature* 400 (6743):415. doi: [10.1038/22672](https://doi.org/10.1038/22672).
- . 1999b. Nitrogen in crop production. *Global Biogeochemical Cycles* 13 (2):647–62. doi: [10.1029/1999gb900015](https://doi.org/10.1029/1999gb900015).
- . 2002. *The Earth's biosphere*. Cambridge, MA: MIT.
- Smith, N. 1999. Nature at the millenium. In *Remaking reality*, ed. B. Braun and N. Castree, 269–82. London and New York: Routledge.
- . 2005. Neo-critical geography. *Antipode* 37 (5):887–99. doi: [10.1111/j.0066-4812.2005.00538.x](https://doi.org/10.1111/j.0066-4812.2005.00538.x).
- . 2006. Nature as accumulation strategy. *Socialist Register* 43:16–36.
- . 2008. *Uneven development*. Atlanta: University of Georgia.
- Soper, K. 1995. *What is nature?* New York: Wiley-Blackwell.
- Swyngedouw, E. 1996. The city as a hybrid. *Capitalism Nature Socialism* 7 (2):65–80. doi: [10.1080/10455759609358679](https://doi.org/10.1080/10455759609358679).
- . 2006. Metabolic urbanization. In *In the nature of cities*, ed. N. Heynen, M. Kaika, and E. Swyngedouw, 20–39. London and New York: Routledge.
- Turner, B. L., II. 2002. Contested identities. *Annals of the Association of American Geographers* 92 (1):52–74. doi: [10.1111/1467-8306.00279](https://doi.org/10.1111/1467-8306.00279).
- United Nations Environment Program. 2012. Global outlook on SCP policies. Report, United Nations Environment Program, Stockholm. Accessed April 18, 2019. <https://index.php?pag/index.php?page=view&type=400&nr=559&menu=1515>
- Wachsmuth, D. 2012. Three ecologies. *The Sociological Quarterly* 53 (4):506–23. doi: [10.1111/j.1533-8525.2012.01247.x](https://doi.org/10.1111/j.1533-8525.2012.01247.x).
- Wallis, V. 2018. *The red-green revolution*. Chicago: Political Animal.
- Whatmore, S. 1999. Hybrid geographies. In *Human geography today*, ed. D. Massey, J. Allen, and P. Sarre, 22–39. Hoboken, NJ: Wiley.
- While, A., A. E. G. Jonas, and D. Gibbs. 2004. The environment and the entrepreneurial city. *International Journal of Urban and Regional Research* 28 (3):549–69. doi: [10.1111/j.0309-1317.2004.00535.x](https://doi.org/10.1111/j.0309-1317.2004.00535.x).
- White, D. F., B. J. Gareau, and A. P. Rudy. 2017. Ecosocialisms, past, present and future. *Capitalism Nature Socialism* 28 (2):22–40. doi: [10.1080/10455752.2017.1296479](https://doi.org/10.1080/10455752.2017.1296479).
- White, D. F., A. P. Rudy, and B. J. Gareau. 2015. *Environments, natures and social theory*. London: Palgrave.
- Whitehead, A. N. 1920. *The concept of nature*. Cambridge, UK: Cambridge University.
- Wishart, W., R. J. Jonna, and J. Besek. 2018. Metabolic rift. Accessed June 4, 2018. <https://monthlyreview.org/commentary/metabolic-rift/>.
- Wittman, H. 2009. Reworking the metabolic rift. *Journal of Peasant Studies* 36 (4):805–26. doi: [10.1080/03066150903353991](https://doi.org/10.1080/03066150903353991).

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