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Deutscher Prize Memorial Lecture

Marx's Theory of Metabolism in the Age of Global Ecological Crisis

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Abstract

When the existing order cannot offer a solution, the solution to climate crisis must come from the radical left, and this is precisely why Karl Marx's idea of ecosocialism is more important than ever. In this context, it is worth revisiting not only the legacy of István Mészáros's theory of 'social metabolism' and that of his successors – who can be categorised as comprising the 'metabolic rift school', which includes John Bellamy Foster, Paul Burkett, and Brett Clark –, but also Karl Marx's own theory of metabolism. In order to highlight the contemporary importance of Marx's theory of metabolism after its long suppression in the twentieth century, this paper aims at classifying the three different levels of Marx's concept of 'metabolic rift', which also entails clarifying three different levels of 'metabolic shift' as the theoretical foundation for updating Marx's theory of postcapitalism in the age of global ecological crisis.

Keywords

Karl Marx – metabolism – metabolic rift – ecology – MEGA

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Almost 50 years ago in 1971, István Mészáros began the first Deutscher Prize Memorial Lecture by referring to Isaac Deutscher's warning against the danger that 'threatens our biological existence', the prospect of nuclear war.[1] He then went on to extend Deutscher's warning to another contemporary existential crisis for the 'whole of mankind', i.e., ecological destruction under capitalism.[2] Mészáros's claim was provisional, as it was made even before the publication of *The Limits to Growth* by the Club of Rome in 1972. He pointed clearly to the destructive nature of capitalist development:

> [The] basic contradiction of the capitalist system of control is that it cannot separate 'advance' from *destruction*, nor 'progress' from *waste* – however catastrophic the results. The more it unlocks the powers of productivity, the more it must unleash the powers of destruction; and the more it extends the volume of production, the more it must bury everything under mountains of suffocating waste.[3]

Today, this fundamental contradiction of capitalism manifests itself most acutely as climate breakdown. Alaska, California, the Amazon and Australia are on fire. Ice in the Antarctic and Greenland is rapidly melting. Coral is dying because of the rising temperature of seawater. Super-typhoons and hurricanes destroy cities. All these phenomena are happening as a result of a 'mere' 1.0°C rise of the world's average temperature since the industrial revolution.

As the IPCC report estimates, if the current pace of CO_2 emission continues, the global average temperature will go up around 4.0°C, but it could go even higher due to various positive-feedback mechanisms that the IPCC report does not take into account. In contrast, in order to limit the increase of global temperatures by 2100 to 1.5°C (at the current pace of CO_2 emission, 1.5°C will be reached within 10 years), it is necessary to reduce CO_2 emission by roughly a half by 2030 and the net emission must be zero by 2050. This means the immediate reduction of CO_2 emission by roughly 7% per year. Obviously, this cannot be achieved without a radical transformation of the entire society and it highlights the urgent 'necessity of social control' on an unprecedented scale.

Social planning of production and severe regulation of market activities are, however, fully incompatible with the logic of neoliberal capitalism, which has

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2 Deutscher 1967, p. 110.

3 Mészáros 2014, pp. 49–50.

constituted the paradigm global system since the collapse of actually-existing socialism. This is precisely why politicians and elites are not able to respond to the climate crisis in an effective manner under the current framework, which pivots around the UN. Even if the promises of the Paris Agreement are fulfilled, the global average temperature is estimated to still rise around 3.0°C. Inability and ineffectiveness clearly demonstrate that capitalist production cannot offer any effective countermeasure against climate crisis, as long as it is fundamentally based on the concurrence of a non-regulated market for the sake of infinite economic growth. What is needed is precisely global cooperation and coordination for the sake of collective survival on this finite planet without a Plan B.

As Greta Thunberg points out, if it is impossible to find a solution within the current system, it is necessary to change the system itself. It is no wonder, then, that 'System change not climate change!' has become the slogan for radical environmental movements. When the existing order cannot offer a solution, the solution to climate crisis must come from the radical left, and this is precisely why Karl Marx's idea of ecosocialism is more important than ever. In this context, it is worth revisiting not only the legacy of Mészáros's theory of 'social metabolism' and that of his successors – who can be categorised as comprising the 'metabolic rift school', which includes John Bellamy Foster, Paul Burkett, and Brett Clark –, but also Marx's own theory of metabolism. In order to highlight the contemporary importance of Marx's theory of metabolism, after its long suppression in the twentieth century, this paper aims at classifying the three different levels of Marx's concept of 'metabolic rift', which also entails clarifying three different levels of 'metabolic shift' as the theoretical foundation for updating Marx's theory of postcapitalism in the age of global ecological crisis.

1 The Suppression of Marx's Ecosocialism

Famously, Marx was repeatedly accused of a naïve 'Prometheanism', which advocates the unlimited growth of productivity and uncritically endorses the capitalist tendency to develop technologies. It is well known that Ted Benton criticised Marx for his 'flight' from the recognition of natural limits.[4] According to critics, Marx uncritically assumed that technological development under capitalism enables the free manipulation of nature, which

4 Benton 1989.

ultimately functions as a material basis for the realisation of human emancipation in the future society.

The myth of Marx's Prometheanism still persists today. Axel Honneth points to the limitation of Marxism in that one of the inherent ideas of Marxism is a 'technological determinism' that presupposes the linear progress of productive forces for the sake of 'domination over nature' (*Naturbeherrschung*).[5] Furthermore, Sven-Eric Liedman believes that Marx was *not* an 'ecologically conscious person' in the modern sense, because 'he imagined that the society that would replace capitalism could also restore the balance between humanity and nature in agriculture'.[6]

However, the situation decisively changed with the deepening of the global ecological crisis. The more clearly the crisis manifests itself as the consequence of capital's endless war against the planet, the stronger the interest in the Marxian ecological critique of capitalism, as well as in the idea of ecosocialism as an alternative to the current irrational economic system. Authors such as John Bellamy Foster, Paul Burkett, James O'Connor, Joel Kovel and Michael Löwy have demonstrated convincingly, in publications such as *Monthly Review* and *Capitalism Nature Socialism*, how a Marxist approach can be useful to a critical analysis of today's environmental degradation, as well as to a vision of a sustainable society beyond capitalism.[7]

Once the existence of Marx's ecology is recognised, it appears so obvious that one may wonder why it was neglected for such a long time and why some people so stubbornly refused to recognise its theoretical importance as a basis for the ecological critique of capitalism. Here one can point to two main reasons.

First, the neglect of Marx's ecology has to do largely with the unfinished character of his critique of political economy. Famously, volumes II and III of *Capital* were not published during Marx's lifetime. Engels edited them following Marx's death, based on various manuscripts written at different times. Marxist scholars simply took Engels's edition of *Capital* to be the definitive version. It did not occur to them that Marx, especially in his later years, quite

5 Honneth 2017, p. 45.

6 Liedman 2018, p. 480. It would appear that this critique is quite peculiar, since it would render a large part of today's environmental movements non-ecological in the modern sense. It is not clear what kind of environmental movement can be regarded as 'ecologically conscious' under Liedman's definition.

7 O'Connor 1998; Burkett 1999; Foster 2000; Kovel 2007; Löwy 2015; Saito 2017. There are theoretical disputes between *Monthly Review* and *Capitalism Nature Socialism*, and my own approach is definitely closer to the former. However, I also draw inspiration from a series of Japanese Marxists such as Shigeto Tsuru, Tomonaga Tairako and Ryuji Sasaki.

intensively studied the natural sciences and left behind a large number of notebooks consisting of various excerpts and comments.

As discussed in *Karl Marx's Ecosocialism*, Marx began this new research after the publication of Volume I of *Capital*.[8] Since he barely published after 1868, including volumes II and III of *Capital*, he could nowhere elaborate on the results of his new research. Notably, it was in these notebooks where Marx's new ecological insights are documented, but they simply remained unnoticed and unpublished throughout the twentieth century. Even though these notebooks on natural science document Marx's interest in the destructive character of capital in the natural environment, and allow us to trace the development of Marx's ecological critique of capitalism, no one was really interested in studying these notebooks. For example, David Riazanov, who was the founder of the Marx–Engels Institute in Moscow and the chief editor of the first *Marx–Engels–Gesamtausgabe* (MEGA[1]), negatively commented on Marx's later engagement with the natural sciences, dismissing the importance of the notebooks for understanding his critique of political economy:

> If in 1881–82 he lost his ability for intensive, independent, intellectual creation, he nevertheless never lost the ability for research. Sometimes, in reconsidering these Notebooks, the question arises: Why did he waste so much time on this systematic, fundamental summary, or expend so much labour as he spent as late as the year 1881, on one basic book on geology, summarizing it chapter by chapter. In the 63rd year of his life – that is inexcusable pedantry.[9]

Consequently, most of Marx's notebooks on the natural sciences were not even published until 2019. This situation undoubtedly contributed to the widespread neglect of Marx's interest in ecological issues, leading some anti-Marxist ecosocialists like Engel-Di Mauro to argue even today that Marxian ecology 'extrapolates the ecological in Marx from brief and vague excursions in texts addressing subjects other than ecological dynamics'.[10]

Yet there is one more factor within Marxism that marginalised Marx's ecological critique of capitalism in the twentieth century. It was because so-called 'traditional Marxism' always interpreted Marx's theory as a closed system of historical materialism that ostensibly enables us to comprehend everything

8 Saito 2017.

9 Quoted in Anderson 2016, p. 249.

10 Engel-Di Mauro 2014, p. 137.

in the universe.[11] The establishment of a gigantic ideological apparatus was necessary for the mass mobilisation of workers for Marxism. Accordingly, his system as a 'world-view' was supposed to encompass the history of dialectical development in the spheres of both society and nature. There were, however, various problems. As mentioned above, volumes II and III of *Capital* exhibit a lot of theoretical lacunae. What is more, Marx did not write any systematic account of the dialectics of nature. Although there were a number of economic manuscripts and notebooks, traditional Marxists dared not publish and examine them because they were afraid that these unpublished writings might reveal the incomplete character of Marx's system.[12] They were 'suppressed'.

The founder of 'traditional Marxism', Friedrich Engels, plays an important role in this story. He knew about the existence of Marx's notebooks on the natural sciences, and they had conversations on ecological issues. Nevertheless, Engels did not even mention Marx's serious engagement with the natural sciences in his *Anti-Dühring*. This is presumably because Engels aimed at establishing Marxism as a worldview for *the* social and political movement of the working class. In this vein, he was compelled to highlight the systematic character of Marx's *Capital*, compared to Eugen Dühring's influential work. This worked out well and Engels achieved his goal, but not without cost. Because of Engels, the following generations of traditional Marxist theory simply took for granted that there is an intellectual division of labour between Marx and Engels; that Marx did not have much to say about nature, precisely because he had entrusted Engels with the further development of the dialectics of nature. Thus, Engels's *Dialectic of Nature* and *Anti-Dühring* became the key reference points in applying Marx's dialectical materialism to the sphere of nature. However, as Terrell Carver argues, there are significant theoretical differences between Marx and Engels.[13] The treatment of the natural sciences is no exception. Since Engels mainly dealt with the sphere of nature from a metaphysical and encyclopaedic perspective, Marx's own *ecological* interest in the natural

11 Heinrich 2012, pp. 24–5.

12 For example, the publication of the so-called *Economic and Philosophical Manuscripts of 1844* in 1932 as a part of MEGA[1] led to 'humanist' critique of Soviet Marxism. But it is also noteworthy that the Russians wanted to treat this bundle of text as 'manuscripts' and bestow a systematic character upon the general structure of the text, even though Marx did not have any actual plan to publish it. As Jürgen Rojahn shows, the text was rather a spontaneous result in the process of studying political economy. See Rojahn 2002.

13 Carver 1983.

sciences was not properly understood in relation to his critique of political economy.[14]

It goes without saying that there were other Marxists who challenged this worldview of traditional Marxism. In doing so, they drew upon Hegel in order to counter the crude materialism of a traditional Marxism that claims to explain everything in the universe. This theoretical current is called 'Western Marxism', the term sometimes connected with Merleau-Ponty.[15] However, while they rightly rejected mechanistic and positivistic understandings of traditional Marxism, Western Marxists targeted Engels as the misleading founder of this problematic philosophical *Weltanschauung*. Famously, it was György Lukács who insisted on this in his *History and Class Consciousness*:

> It is of the first importance to realize that the method is limited here to the realms of history and society. The misunderstandings that arise from Engels' account of dialectics can in the main be put down to the fact that Engels – following Hegel's mistaken lead – extended the method to apply also to knowledge of nature. However, the crucial determinants of dialectics – the interaction of subject and object, the unity of theory and practice, the historical changes in the reality underlying the categories as the root cause of changes in thought, etc. – are absent from our knowledge of nature.[16]

Although this passage was hidden in a footnote, Lukács founded Western Marxism with this provocative claim. His point is clear. Engels wrongly applied Marx's dialectical analysis of society to the knowledge of nature. Accordingly, when Western Marxists expelled Engels and his mechanistic dialectic of nature from their analysis, they at the same time completely excluded the sphere of nature and the natural sciences from Marxism. Nature disappears. This decision was inevitable for them in order to prevent Marx's social theory from descending into the crude materialism of Soviet Marxism, but the price Western Marxism had to pay was quite high: Western Marxism became unable to integrate the problem of ecology into its analysis, because ecology is the sphere where nature must come back into theoretical investigation. Once

14 For a more detailed discussion on the difference between Marx and Engels in terms of the natural sciences, see Saito 2019.

15 Merleau-Ponty 1973, p. 59. As Merleau-Ponty points out, the expression itself, however, originally comes from Karl Korsch's *Marxismus und Philosophie*. See Korsch 1966, p. 63. The relevant paragraph in Korsch was not translated into English, and this is probably why Merleau-Ponty became the reference point.

16 Lukács 1971, p. 24.

the problem of nature can no longer be suppressed in the age of ecological crisis, Alain Badiou loses his usual brilliance and hysterically denies its importance: 'Ecology is a new opium for the masses.'[17] Badiou wants to emphasise the centrality of class struggle for communism. I fully agree. However, loyalty to Marx must not lead to the underestimation of ecological issues for the socialist project – not least because Marx himself was deeply concerned with ecological issues!

In any case, both traditional Marxism and Western Marxism ended up ignoring the importance of Marx's serious research in the field of the natural sciences during the twentieth century. The new complete works of Marx and Engels, the *Marx–Engels–Gesamtausgabe* (MEGA^2), has been in the process of publishing for the first time materials that document how Marx in his later years developed his ecological critique of capitalism. Today, Western Marxism can no longer justify omitting the deliverances of the natural science from Marxist critical theory. However, the new MEGA also makes it clear that Marx, unlike Engels and other traditional Marxists, did not intend to expound the natural laws of the entire universe. It is necessary to open up a third way to understand the reason for Marx's engagement with the natural sciences. The key concept is 'metabolism'.

2 The Rediscovery of Marxian Ecology

In this context, Mészáros's theoretical contribution to the renewal of Marxism beyond both traditional and Western Marxism is key for highlighting Marx's concept of 'metabolism' (*Stoffwechsel*). In particular, his *Beyond Capital* radically changed the whole discursive constellation around Marx's critique of political economy by paying attention to this concept.[18] Mészáros developed the concept of 'social metabolism' in order to analyse the capitalist mode of production as a historically unique way of (re)organising the metabolic interaction between humans and nature. According to him, any critique of the capitalist mode of production must not simply observe the quotidian by focusing solely on the exploitation of workers by the capitalist. Mészáros argued for a

17 Badiou 2008, p. 139.

18 Mészáros 2000. This contribution was not so highly regarded in Japan, and Mészáros remains largely unknown there; other Japanese scholars such as Shigeaki Shiina and Fumikazu Yoshida had already attended to this concept and applied it to the analysis of environmental pollution in the 1970s and '80s. However, in my opinion, Mészáros more adequately grasped the theoretical core of Marx's argument.

much more holistic approach, which analyses the entirety of the metabolic interaction between humans and nature under the domination of capital, linking his approach to a much wider existential crisis of ecological breakdown.

What is metabolism? Marx wrote in *Capital*: 'Labour is, first of all, a process between man and nature, a process by which man [...] mediates, regulates and controls the metabolism between himself and nature.'[19] This metabolic process is, on the one hand, a natural-ecological process, which is common to any historical stage, because humans cannot live without working upon nature through labour.

In other words, humans are a part of nature and its process is mediated by labour on the 'primary' level, constantly changing the objective conditions of productive reproduction. Conditions change through human history, but this primary material condition remains throughout and cannot be abolished.

On the other hand, it is also a socio-historical process whose concrete forms are mediated by existing social relations. Notably, Mészáros maintained in *Beyond Capital* that there are the 'second order mediations of historically specific social reproductive systems'.[20] A particular set of second-order mediations is unique to each social system. For example, the logic of capital for the sake of maximal valorisation is unique to the capitalist mode of production and constitutes unique second-order mediations, such that

> every one of the primary forms [of metabolism between humans and nature] is altered almost beyond recognition, so as to suit the self-expansionary needs of a fetishistic and alienating system of social metabolic control which must subordinate absolutely everything to the imperative of capital-accumulation.[21]

The whole point of Marx's analysis of capital is to comprehend these second-order mediations of human metabolism with nature.

According to Mészáros, capital's organisation of social metabolism with its second-order mediations is incompatible with various material characteristics of metabolism between humans and nature on the primary level, leading to its destruction. He thus claimed that capital becomes no longer productive but destructive:

19 Marx 1976, p. 283.
20 Mészáros 2000, pp. 139–40.
21 Mészáros 2000, p. 140.

> capital's limits can no longer be conceptualized as merely the material obstacles to a greater increase in productivity and social wealth, and thus as a *brake* on development, but as the direct challenge to the very survival of mankind. And in another sense, the limits of capital can turn against it as the overpowering controller of the social metabolism [...] when capital is no longer able to secure, by whatever means, the conditions of its *destructive self-reproduction* and thereby causes the breakdown of the overall social metabolism.[22]

Furthermore, Mészáros added that 'the capital system as a mode of social metabolic reproduction finds itself in its descending phase of historical development, and therefore is only capitalistically advanced but in no other sense at all, thereby capable of sustaining itself only in an ever more destructive and therefore ultimately also self-destructive way'.[23]

Mészáros's legacy of the theory of metabolism is taken up by John Bellamy Foster and Paul Burkett, who have carefully examined Marx's usage of the concept of metabolism and developed the concept of 'metabolic rift' out of discussions in Volume III of *Capital*, in order to thematise the irrationality of the existing capitalist mode of production.[24] Today, there are various attempts to analyse the rifts in the metabolic interaction between humans and nature, such as they involve marine ecology (Stephano Longo), climate change (Naomi Klein, Brett Clark and Richard York), disruption of the nitrogen cycle (Philip Mancus) and soil erosion (Hannah Holleman). These excellent examples confirm the validity and fruitfulness of the contemporary ecosocialist application of Marx's theory of metabolic rift. Clearly, my work, *Karl Marx's Ecosocialism*, can be seen as belonging to this tradition.

One may object that such 'greening' of Marx's critique of capitalism is a mere imposition of 'our' concerns upon Marx's text, distorting and neglecting the existence of fatal flaws and limitations in Marx's theory.[25] In contrast, Marx clearly recognised the destructive power of capital and argued that disruptions in the universal metabolism of nature inevitably undermine the material conditions for free and sustainable human development:

22 Mészáros 2000, p. 599.
23 Mészáros 2012, p. 316.
24 See Foster and Burkett 2016.
25 Tanuro 2003.

> [Capitalist production] disturbs the metabolic interaction between man and the earth, i.e. it prevents the return to the soil of its constituent elements consumed by man in the form of food and clothing; hence it hinders the operation of the eternal natural condition for the lasting fertility of the soil. Thus it destroys at the same time the physical health of the urban worker, and the intellectual life of the rural worker.[26]

The robbery inherent in the capitalist development of productive forces does not bring about the progressions that would automatically lead to a communist society. Rather, Marx attempted to analyse how the logic of capital diverges from the eternal natural cycle and ultimately causes various disharmonies in the metabolic interaction between humans and nature.

Marx analysed this point with reference to Justus von Liebig's critique of modern 'robbery agriculture', which takes as much nutrition as possible from the soil without returning it. Robbery agriculture is driven by the need to maximise profits in the short term, which means that the material conditions of the soil under capitalism become simply incompatible with sustainable production. Thus, there emerges a grave gap between the logic of capital's valorisation and that of nature's sustainable metabolism, which creates a 'irreparable rift' in the human metabolic interaction with the environment. In Volume III of *Capital* Marx wrote:

> On the other hand, large landed property reduces the agricultural population to an ever decreasing minimum and confronts it with an ever growing industrial population crammed together in large towns; in this way it produces conditions that provoke an irreparable rift in the interdependent process between social metabolism and natural metabolism prescribed by the natural laws of the soil. The result of this is a squandering of the vitality of the soil, and *trade carries this devastation far beyond the bounds of a single country* (Liebig).[27]

Marx believed that as long as the capitalist system persists, there exists an inevitable tendency toward the degradation of the material conditions of production. In other words, the market cannot function as a good mediator for sustainable production *pace* the persistent belief that green capitalism would be somehow possible in the near future. The fundamental problem is that

26 Marx 1976, p. 637.

27 Marx 1991, p. 949; translation modified, following Marx 1993, pp. 752–3.

value does not provide a feedback mechanism between market and nature. Capitalist innovation in science and technology will not solve the ecological crisis either, but rather simply shifts and deepens the crisis. In order to comprehend these points, it is necessary to examine Marx's concept of metabolic rift more carefully.

3 Three Dimensions of Metabolic Rift

Marx did not elaborate on the concept of 'metabolic rift' in detail. As seen above, he simply used the term 'irreparable rift' in one passage of *Capital*. As a consequence, despite Foster's careful analysis of Marx's texts and the further application of this concept to various contemporary ecological issues, critics argue that 'the implications of Foster's thesis for contemporary thought are vague and the conclusions atavistic'.[28] Here would be a good opportunity to respond to critics by clarifying Marx's concept of metabolic rift based on his own usage. Although Marx did not explicitly classify the concept, three dimensions of metabolic rift are clearly discernible.

First and most fundamentally, there exists a rift in the material circulation within the metabolic cycle of nature. Marx's famous example is, as seen above, the disruption in the circulation of soil nutrients. Modern capitalist agriculture aims at making plants absorb soil nutrition as much as and as fast as possible, so that they may be sold as a commodity to customers in large cities.

As Liebig warned in his book *Agricultural Chemistry*, inorganic substances such as phosphor and potash are essential to enable sufficient plant growth, but their availability to plants is quite limited in terms of their naturally-occurring quantities in the soil, because the weathering process that disperses these inorganic substances, through the actions of the atmosphere and rain water, takes a long time.[29] Thus, Liebig advocated the 'law of replenishment' (*Gesetz des Ersatzes*) as the first principle of 'rational agriculture', emphasising the importance of carefully returning a sufficient amount of minerals absorbed by plants to the original soil, if one is to maintain the soil's fertility. However, those crops that are sold in large cities do not return to the original soil after they are consumed. They instead directly flow into the river as excrement via water closets. This disruption in the natural cycle of the metabolism between humans and nature undermines the natural ecological conditions of sustainable agriculture, causing widespread exhaustion of the soil in Europe and

28 Loftus 2012, p. 31.
29 Liebig 2018.

the USA at the time. Liebig harshly criticised this kind of short-sighted profit maximalisation as 'robbery agriculture'. His fundamental insight remains valid today, as this is exactly what is still happening as the disruption of the global nitrogen cycle and phosphorus cycle.

This fundamental level of metabolic rift in the form of disruption of material flow cannot occur without being supplemented by two further dimensions. The second dimension is the spatial rift. Marx problematised this rift unique to the capitalist organisation of space as the 'antagonism between town and country'.[30] Robbery agriculture does not exist without a social division of labour, which is based upon the concentration of the working class in the large cities and the emerging necessity for the constant transport of their food from the countryside. This is the antagonistic spatial separation within a capitalist country.

Yet it is noteworthy that Marx's expression in the passage quoted above also indicates international hierarchisation through the spatial rift. Namely, the metabolic rift is externalised on a global scale through long-distance trade. Consequently, the negative consequences of the rift, such as exhaustion of resources and pollution, disproportionally emerge in those peripheral areas from which resources are constantly mined and transported to the centre. This so-called 'ecologically unequal exchange' is how the centre accumulates more wealth and becomes more affluent.

In order to understand this antagonistic spatial organisation by capital, Andreas Malm's *Fossil Capital* is a useful point of reference. *Fossil Capital* reconstructs the historical transition from water mills to steam engines fired by coal. Water is abundant and free, so water is a perfectly sustainable and free energy. This is certainly an obvious fact, but an important one, considering the common 'Malthusian' explanation of technologies, according to which the increasing scarcity of resources, and their corresponding increase in price, in the process of economic growth, leads to the discovery or invention of other, cheaper substituting materials. However, Malm argues that this explanation does not apply to the eclipse of free and abundant water-power by the steam engine, dependent on the use of costly and scarce coal.

According to Malm, in order to explain this historical transition, it is necessary to take into account the dimension of the second-order mediation of 'capital'. The use of fossil fuel started not simply as an energy resource but rather as fossil *capital*. The natural characteristic of coal, in contrast to water, as a transportable and monopolisable energy possessed a unique social significance for the development of capitalist production. Thanks to coal, capital could leave

30 Marx and Engels 1970, p. 69.

the area near the rivers where workers were more resistant, since labour-power was scarce, and move factories to large cities where a large number of workers were in dire need of jobs. This is basically how the power balance between capital and labour radically changed with the invention of the steam engine.[31]

Fossil fuel is closely tied to the uniquely capitalist way of organising an antagonistic social division of labour between town and country. The relationship is antagonistic precisely because the negative consequences of the spatial rift are disproportionally redistributed in favour of large cities. They industrialise themselves and accumulate capital, while the countryside only continues to transport various natural resources. Natural resources in the countryside become more and more scarce, degrading the environment as well. This ecologically unequal exchange is clearly discernible on a global level because this spatial rift allows the Global North to externalise economic and environmental costs onto the Global South. This is ultimately the cause of the 'Netherlands fallacy', as if technological development alone solves the problem of environmental pollution.[32] The fallacy is a product of ignoring the constant spatial externalisation of the metabolic rift.

The third dimension of the rift is the temporal one. As is obvious from the slow formation of soil nutrients and fossil fuel, there is a rift between nature's time and capital's time. While capital constantly attempts to shorten its turnover time and maximise the valorisation, this process is inevitably accompanied by the increase of floating capital in the form of raw and auxiliary materials. Furthermore, capital constantly revolutionises the production process, increasing productive forces with an unprecedented speed. Productive forces can double or triple with the introduction of new technologies, but nature cannot change its formation processes of phosphor or fossil fuel. Ultimately, nature cannot catch up with the speed of capital, and there emerges a grave discrepancy between two kinds of time particular to nature and capital. Marx's example is excessive deforestation under capitalism, commenting on it thus:

> The long production time (which includes a relatively slight amount of working time), and the consequent length of the turnover period, makes forest culture a line of business unsuited to private and hence to capitalist production, the latter being fundamentally a private operation, even when the associated capitalist takes the place of the individual. The development of civilization and industry in general has always shown itself so active in the destruction of forests that everything that has been

31 Malm 2016.

32 Ehrlich and Ehrlich 1990, p. 39.

> done for their conservation and production is completely insignificant in comparison.[33]

There are three dimensions of metabolic rift. Marx's theory of metabolism is concerned with how the natural ecological process of universal metabolism of nature, as the fundamental material condition for reproduction, is reorganised under the second-order mediation of social metabolism. There exists a grave tension between social metabolism and natural metabolism, and he warned against the negative consequences of their disruption. Marx was, however, not simply satisfied with the recognition of the existence of the rift, but much more interested in how the rift emerges in nature and how it is spatially and temporally distributed in a disproportionate manner. This is the reason why Marx, in his later years, intensively studied natural science while attempting to complete his grandiose project of political economy.

4 Three Dimensions of Metabolic Shift

The metabolic rift deepens with the development of capitalism. In many cases, it manifests itself as the exhaustion of natural resources, their increase in price and the corresponding fall of the rate of profit. Thus, it is quite essential for capital to secure access to cheap resources, energy and food. This is what leads capital to construct 'a system of general exploitation of the natural and human qualities' and 'a system of general utility' as Marx argued in the *Grundrisse*:

> Hence exploration of all of nature in order to discover new, useful qualities in things; universal exchange of the products of all alien climates and lands; new (artificial) preparation of natural objects, by which they are given new use values. The exploration of the earth in all directions, to discover new things of use as well as new useful qualities of the old; such as new qualities of them as raw materials etc.[34]

This exploration of the earth and the invention of new technologies by capital, however, do not repair the rift. The rift remains 'irreparable' in capitalism. There is ultimately the need to 'shift' the metabolic rift to somewhere else, not only for the sake of buying time but also for minimising the manifestation of

33 Marx 1992, pp. 321–2.
34 Marx 1973, p. 409.

contradictions in the centre.[35] Here, corresponding to the three dimensions of metabolic rift, there are also three ways of shifting it.

First of all, the metabolic rift manifested as the exhaustion of natural resources, like soil exhaustion. Although Liebig warned against the collapse of European civilisation due to robbery agriculture, his prediction did not come true. This was because Fritz Haber and Carl Bosch invented the so-called Haber–Bosch process in 1906 that enabled the industrial production of ammonia, and thus of chemical fertiliser.

Nevertheless, the Haber–Bosch process did not heal the rift. The production of ammonia (NH_3) uses a massive amount of natural gas as a source of hydrogen (H). It simply uses another limited resource to produce ammonia, but it is quite energy intensive (it uses 2% of total energy consumption) and produces a lot of CO_2 (1% of the total carbon emission). Furthermore, excessive usage of chemical fertiliser causes eutrophication, as nitrogen and phosphorus, as well as water pollution, as a result of their leaking into the environment. Soil ecology is disrupted by the chemical fertiliser, the water-retaining capacity of the soil goes down, and plants become more susceptible to disease. Consequently, more and more fertiliser becomes necessary, as well as agrochemicals and pesticide. These chemicals also pollute the environment and disrupt the normal functioning of the ecosystem, deepening the ecological crisis.

In short, metabolic shift creates externality with the aid of new technologies: Soil fertility is artificially maintained and even strengthened, while capital does not pay for disruption, pollution and destruction in the wider eco-systems. At the same time, capital finds new business opportunities in these disruptions, taking the opportunity to sell more chemical fertiliser, agrochemicals and pesticide. This is how the formal and real subsumption of nature under capital proceeds through the metabolic shift.[36]

Secondly, there is spatial shift of the metabolic rift. Again, Marx discussed this issue in relation to soil exhaustion. On the coast of Peru there were small islands consisting of the excrement of seabirds that had accumulated over many years. These islands were called guano islands. Guano is quite rich in minerals that are useful for inducing plant growth. 'Guano' originally meaning agricultural fertiliser in the Andean Indigenous language Quechua, the Indigenous people traditionally used it as dung. It was Alexander von Humboldt who encountered the Indigenous usage of guano during his research trip to Peru in 1802. He investigated the effectiveness of guano and tested it in European soils.

35 Foster, Clark and York 2011, p. 74.

36 Boyd, Prudham and Schurman 2001.

The result was positive, and its usage became quite popular across those areas of Europe where soil exhaustion was a major social issue.

Soil exhaustion was a manifestation of the metabolic rift, but the 'solution' of guano did not repair the rift, as it simply shifted the problem to the Global South. As a result, guano was continuously transported from the periphery to the centre of capitalism, which sustained soil fertility in Europe and the USA, thus providing food for urban workers. On the other hand, its externality emerged in the form of brutal oppression of Indigenous people, severe exploitation of thousands of Chinese coolies, the rapid exhaustion of guano stocks, and more general environmental degradation. Ultimately, the exhaustion of guano reserves led to the Guano War (1865–6) and the Saltpeter War (1879–84). In short, the antagonism between town and country within one nation was spatially shifted and expanded to the global rift through guano. As John Bellamy Foster and Brett Clark argue, such a solution in favour of the Global North led to 'ecological imperialism'. Robbery continued. Although ecological imperialism shifts the rift to the peripheries and makes it invisible in the centre, the metabolic rift deepens.[37]

A similar ecologically unequal exchange persists in today's globalised capitalism. As a solution to climate crisis, solar power is essential, but the associated battery technology uses various kinds of rare metals. For example, most of the world's lithium is located in the Andean plateau, so Chile has become the largest lithium exporter. The Salar de Atacama salt flat is where all the lithium of Chile is extracted. Lithium only exists in dry places such as the large salt flats, as it is only gradually condensed in brine over a long period. Mining lithium is thus conducted by extracting this brine beneath the salt flats of Salar de Atacama and by letting the water evaporate such as to allow the further concentration of lithium.

In this situation, it is quite obvious that excessive mining of brine makes the area even drier and also degrades the eco-system. It endangers the Andean flamingo, which eats brine shrimp. Furthermore, it causes a lowering of the water table, reducing access to fresh water for Indigenous Antacameño communities.[38] The situation is exacerbated by copper mining that also extracts massive quantities of freshwater in the Salar. In other words, the greening of the Global North is not transforming the planet sustainably, but rather strengthening the robbery-mining processes of lithium and copper. The metabolic rift cannot be simply repaired by new technologies. Technological solutions sound attractive because they do not entail us changing our current

37 Clark and Foster 2009.

38 Aronoff, Battistoni, Cohen and Riofrancos 2019, pp. 148–9.

lifestyle. However, for as long as the current mode of living continues, it simply shifts the rift to somewhere else, deepening the rift on a global scale. Mészáros rightly warned against technocratic optimism, 'And finally, to say that "science and technology *can* solve all our problems in the long run" is much worse than believing in witchcraft'.[39]

The third kind of metabolic shift is the temporal one. The discrepancy between nature's time and capital's time does not immediately lead to ecological disaster. Nature possesses 'elasticity'.[40] Climate crisis is a representative case. Massive CO_2 emission due to the excessive usage of fossil fuels is an apparent cause of climate change. But its effects do not immediately crystallise, so capital uses the opportunity opened up by the ensuing time lag to make profits from previous investment in drills and pipelines. Capital reflects the voice of current shareholders, but not that of the future generations. The costs of robbery are shifted on to them. As a result, future generations suffer from what they are not responsible for. Marx famously characterised such an attitude of capitalist development with the slogan, 'Apès moi, le déluge!'

There is huge public expectation invested in future technological innovation against the climate crisis. It is true that shifting the rift buys time for the development of new technologies. However, new technologies do not spread quickly but take years before they replace the old ones. Continuous temporal shifts, counting on future technologies, will inevitably confront an unexpected worsening of the crisis, due to positive-feedback mechanisms. The time lag of introducing new technologies makes it even harder to control the situation, annulling the expected results of those technologies.

5 Ecological Crisis as the Contradiction of Capitalism

The power of capital to shift the metabolic rift is astonishing. Thus, it is questionable whether the increase in prices due to the 'end of Cheap Nature' will lead to the 'epochal crisis' of capitalism, as Jason W. Moore argues.[41] Bill McKibben better describes the historical dynamics of capitalism: 'The diminished availability of fossil fuel is not the only limit we face. In fact, it's not even the most important. Even before we run out of oil, we're running out of planet'.[42] This is not only because capital can find new opportunities for a

39 Mészáros 2014, p. 29.
40 Akashi 2016.
41 Moore 2015, p. 27.
42 McKibben 2007, p. 18.

'climate-change shock doctrine' amidst the ecological crisis,[43] but also because it always externalises the negative consequences onto the Global South.

In this way, the Global South suffers from doubly negative consequences. After suffering from the robbery of nature and humans under ecological imperialism, it also faces the real impact of ecological crisis, once it is no longer possible to postpone it. As Stephan Lessenich argues, capital's slogan 'After us, the deluge!' becomes 'Next to us, the deluge' (*Neben uns, die Sintflut*), in the age of global ecological crisis when it is no longer possible to buy time. This is the essence of the 'externalisation society' (*Externalisierungsgesellschaft*) that is dominant in the Global North.[44]

Affluent life in the Global North is obviously dependent on robbery from other areas, but this structural inequality and injustice was long kept invisible through the temporal, spatial and social shift and externalisation of the metabolic rift. This is what Ulrich Brand and Markus Wissen call the 'imperial mode of living' (*imperiale Lebensweise*). Their point is that a better life for a certain group of people in a certain region *presupposes* the degradation of living conditions for another group of people in another region.[45] The imperial mode of living essentially signifies a relation of domination and subordination. The current order of society appears attractive and comfortable to a certain social group in the Global North, but its real costs are imposed upon other social groups in other areas.

Of course, the fundamental problem is not a 'mode of living' but a 'mode of production', because the tendency towards the robbery of humans and nature and metabolic shift is inherent to the logic of capital. The imperial mode of production is constantly reproduced and its violence becomes invisible due to the metabolic shift. Consequently, people who enjoy the affluent life in the Global North are first forced to be 'ignorant' (*Nicht-Wissen*) about the structural inequality of the imperial mode of production, but later, as long as it promises the affluent life, they start to accept it as something desirable and to internalise it by looking away from the negative consequences. They do not want to know (*Nicht-Wissen-Wollen*). Consequently, the imperial mode of production transforms into the 'imperial mode of living'.

However, it is impossible to endlessly shift the metabolic rift. It is increasingly difficult to ignore the negative consequence of metabolic rift, as the competition for robbery becomes more brutal with the rapid development of China, Brazil and India. As the space for externalisation diminishes, the

43 Klein 2019, p. 36.

44 Lessenich 2018, p. 166.

45 Brand and Wissen 2017, p. 61.

once-obscured metabolic rift becomes increasingly visible, as the climate crisis causes heat-waves and super-typhoons, even in the Global North. Since communism is 'ultimately a question of justice',[46] climate justice is an essential component for communism. That is why Marx's idea of communism must be radically updated in the age of global ecological crisis.

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46 Žižek 2017, p. 29.

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