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THE ENVIRONMENT At the Time of the INDUSTRIAL REVOLUTION

The mercantilist period saw the development of a commercial, agrarian, and mining capitalism in England, which by the eighteenth century had replaced the Netherlands as the most advanced capitalist economy. The proceeds from the trade in spices, sugar, tea, coffee, tobacco, gold, furs, and slaves fed profits into a post-feudal English social order that was manifested in the rural areas by what Raymond Williams called “the country-house system of the sixteenth to eighteenth centuries.”

This system, in which landlords in great houses owned vast estates run by tenant farmers and worked by agricultural wage-laborers, had been made possible by the agricultural revolution that had taken place under mercantilism. England was notable among European countries in that the traditional peasantry disappeared early, primarily as a result of the enclosure movement. The percentage of English agricultural land that was enclosed by stone walls and hedges—so as to be more systematically monopolized by rural landlords—rose from 47 percent in 1600 to 71 percent by 1700. A further 6 million acres were enclosed in the eighteenth century. By the end of the seventeenth century, 40 percent of the English population had moved out of agricultural employment, mostly into industrial pursuits. By the end of the eighteenth century, nearly half the cultivated land in England was owned by 5,000 families, while nearly 25 percent was owned by a mere 400 families.

This system, despite the inequality built into it, was more productive than anything that had preceded it. The agricultural revolution, by introducing new crops, improving methods of cultivation, and bringing additional land under cultivation, increased domestic agricultural output in England between 1550 and 1750 sufficiently to feed a population that doubled over the same period, while at the same time reducing the share of agriculture in total employment. Large numbers of workers were “liberated” from the land and sought employment in the industry of the towns.

These conditions thus set the stage for the Industrial Revolution, which began in the late eighteenth century. The Industrial Revolution added a new intensity to capitalism’s relation to its environment. Although the commercial and agricultural revolutions of the mercantilist period had begun to alter the human relationship to the earth on a global scale, mercantilism was mainly an extensive phase of development, working its changes more by a process of ecological takeover than ecological transformation. It was the rise of machine capitalism that made possible the real subjection of the original sources of wealth—the soil and the worker—to capital. Driven by its inner logic to commodify such essential elements of industry as land and labor, yet unable to do so without undermining the natural and human bases of
existence, capitalism found itself more and more at war with its environment.

The fact that the Industrial Revolution had adverse ecological effects was understood from the very beginning. Surveying the iron works around Coalbrookdale in 1830, James Nasmyth, the inventor of the steam hammer, wrote: "The grass had been parched and killed by the vapours of sulphureous acid thrown out by the chimneys; and every herbaceous object was of a ghastly grey—the emblem of vegetable death in its saddest aspect." It is therefore surprising that it is sometimes suggested today that the harsh conditions of the Industrial Revolution did not lead to the immediate growth of environmental criticism. Thus political ecologist Hans-Magnus Enzensberger has argued that the contamination of the environment associated with "English factories and pits" should have provided "food for ecological reflection. But there were no such observers. It occurred to no one to draw pessimistic conclusions about the future of industrialization from these facts." In this he was mistaken. Poets, novelists, journalists, physicians, Romantic social analysts, and defenders of the working class gave eloquent testimony to the horrors of the new industrial system. For the great English poet William Blake, the question was posed as follows:

And was Jerusalem builded here,
Among these dark Satanic Mills?²

The political economists of the period introduced what was to become the classic debate on the relations between overpopulation, poverty, and environmental degradation. Two broad positions were put forward, one associated with the name of Thomas Malthus and the other with that of Karl Marx. Even today, as the renowned environmental economist Herman Daly has written, "The Marxian and Malthusian traditions represent the major competing explanations of poverty in Western thought," without which modern environmental problems cannot be addressed.³

DARK SATANIC MILLS

The Industrial Revolution can be defined as a sudden take-off in growth as the result of a series of economic, social, and ecological transformations. Its principal elements were the growth of the factory system, the expansion of wage labor, the increased reliance on machine production, and the rise of the modern industrial city—symbolized above all by the English city of Manchester.⁴ For those who witnessed the emergence of this new stage of production, it was the contrast between the enormous riches
produced by this system and the deterioration of environmental conditions that was most shocking. “From this foul drain,” the noted French social analyst Alexis de Tocqueville wrote of Manchester in 1835, “the greatest stream of human industry flows out to fertilize the whole world. From this filthy sewer pure gold flows. Here humanity attains its most complete development and its most brutish, here civilization works its miracles and civilized man is turned almost into a savage.”

At the center of the Industrial Revolution was the cotton industry. The British cotton industry was originally an outgrowth of overseas trade, which provided both its raw material and the bulk of its final product in the form of calicoes imported from India by the East India Company. Soon, however, the British wool industry managed to secure import prohibitions against Indian calicoes, giving British cotton manufacturers, who were originally uncompetitive, a chance to develop. This facilitated the rapid growth of the internal market for cotton goods in Britain, although the main growth market for these goods would soon be found in the British colonies and overseas dependencies.

Colonialism thus launched the British cotton textile industry and remained a key to British expansion throughout the Industrial Revolution. The cotton-goods industry’s fastest growth in the eighteenth century was on the outskirts of the major colonial-trade ports of Bristol, Glasgow, and particularly Liverpool, the great hub of the slave trade. And this was no coincidence: during the entire first phase of the Industrial Revolution (up until 1840) “slavery and cotton marched together,” as British historian Eric Hobsbawm put it. Prior to the industrial take-off, the greater part of Lancashire’s cotton exports went to markets in Africa, where they were exchanged for slaves, and to the Americas, where West Indian sugar planters bought cotton goods in large quantities. By the 1790s, the insatiable needs of the British cotton mills had created a rocketing demand for the raw cotton produced on the slave plantations of the U.S. South.

Between 1750 and 1769 British cotton goods exports rose ten times over. The great bulk of these exports were to colonial and semi-colonial regions. In 1840, Europe took 200 million yards of English cotton exports, while the Americas outside of the United States, Asia, and Africa took 529 million yards. Beginning with the Napoleonic wars, Latin America became an economic dependency of Britain and by 1840, despite its poverty, was absorbing one and a half times as many British textiles as Europe. India, which had been a traditional manufacturer and exporter of cotton textiles, was deindustrialized under British colonial rule. In 1820 the Indian subcontinent took 11 million yards of British cotton textiles; by 1840 this had grown to 145 million yards.

“The division of labour,” Adam Smith observed in *The Wealth of Nations*, is “limited by ... the extent of the market.” The fact that the market for cotton was from the start a global one meant that the prospects for economic expansion were enormous, making rapid changes in specialization and the division of tasks within the workplace possible. This allowed for the emergence of the modern factory, dominated by machine production, which up until the mid-nineteenth century was largely identified with the cotton goods industry.

Cotton manufacture led to urbanization, and what happened in the British city of Manchester is only an extreme case of what was happening in other cities. The population of the city rose more than tenfold, from 17,000 to 180,000, between 1760 and 1830, presenting a view of “hundreds of five- and six-storied factories, each with a towering chimney by its side, which exhalles black coal vapour.”

In *Hard Times* (1854) novelist Charles Dickens describes an “imaginary” Coketown as follows:

It was a town of red brick, or of brick that would have been red if the smoke and ashes had allowed it.... It was a town of machinery and tall chimneys, out of which interminable serpents of smoke trailed themselves for ever and ever, and never got uncoiled. It had a black canal in it, and a river that ran purple with ill-smelling dye, and vast piles of buildings full of windows where there was a
leading exponent of the principles of manufacturing, replied in indignation that the gas lighting of the factory was an adequate substitute for the sun.

If the factory environment during the Industrial Revolution was grim, the larger urban environment was even more so. Factory workers across England lived in squalor and were plagued by hunger and disease. In the first-hand description provided in his *Condition of the Working Class in England* (1845), Frederick Engels (who was to become Karl Marx's lifelong intellectual collaborator) walked the reader through whole areas of Manchester, street by street, describing what was to be seen and arguing that the environment of the streets occupied by the working class was so different from that of the bourgeoisie as to constitute two different worlds. The homes of the “upper bourgeoisie” of Manchester were to be found “in remoter villas with gardens in Chorlton and Ardwick, or on the breezy heights of Cheetham Hill, Broughton, and Pendleton, in free, wholesome country air, in fine comfortable homes passed once every half-hour or quarter-hour by omnibuses going into the city. And the finest part of the arrangement,” Engels observed, “is this, that the members of this money aristocracy can take the shortest road from the middle of all the labouring districts to their places of business, without ever seeing that they are in the midst of the grimy misery that lurks to the right and the left.”

In surveying the conditions of the working class in London, Manchester, and elsewhere, Engels was particularly concerned with environmental toxins. Relying on the reports of physicians and on his own personal observations, he provided a detailed analysis of public health conditions. Using demographic data compiled by public health officials, he pioneered in arguing that mortality rates were inversely related to social class, which could be seen most dramatically by examining specific sections of each city. The poorly ventilated houses of the workers, he argued, did not allow for adequate ventilation of toxic substances, and carbon gases from combustion and human breathing remained trapped...
inside. Since there was no system for the disposal of human and animal waste, these accumulated and decomposed in apartments, courtyards, and streets, producing severe air and water pollution. The high mortality from infectious diseases, such as tuberculosis (an airborne disease) and typhus (carried by lice), was the result, he argued, of overcrowding, bad sanitation, and insufficient ventilation.

In 1845 a young (24-year-old) Frederick Engels gave the following first-hand account of living conditions in industrial Manchester: “In a rather deep hole, in a curve of the Medlock and surrounded on all four sides by tall factories and high embankments, covered with buildings, stand two groups of about two hundred cottages, built chiefly back to back, in which live about four thousand human beings, most of them Irish. The cottages are old, dirty, and of the smallest sort, the streets uneven, fallen into ruts and in part without drains or pavement; masses of refuse, offal and sickening filth lie among standing pools in all directions; the atmosphere is poisoned by the effluvia from these, and laden and darkened by the smoke of a dozen tall factory chimneys.... The race that lives in these ruinous cottages, behind broken windows, mended with oilskin, sprung doors, and rotten doorposts, or in dark, wet cellars, in measureless filth and stench, in this atmosphere penned in as if with a purpose, this race must really have reached the lowest stage of humanity. This is the impression and the line of thought which the exterior of this district forces upon the beholder. But what must one think when he hears that in each of these pens, containing at most two rooms, a garret and perhaps a cellar, on the average twenty human beings live; that in the whole region, for each

one and twenty persons, one usually inaccessible privy is provided.... Dr. Kay asserts that not only the cellars but the first floors of all the houses in this district are damp; that a number of cellars once filled up with earth have now been emptied and are occupied once more by Irish people; that in one cellar the water constantly wells up through a hole stopped with clay, the cellar lying below the river level, so that its occupant a hand-loom weaver, had to bale out the water from his dwelling every morning and pour it into the street.”

Engels also described the skeletal deformities caused by rickets as a nutrition-related problem, even though the specific dietary deficiency associated with this, the lack of Vitamin D, was not yet known. He provided accounts of occupational illnesses, including detailed descriptions of orthopedic disorders, eye disorders, lead poisoning, and black lung disease.

It was “plain,” Lewis Mumford wrote in his magnificent study The Culture of Cities (1938), “that never before in recorded history had such vast masses of people lived in such a savagely deteriorated environment.” Epidemics of cholera and typhoid took an appalling toll in the years after 1830.

**MALTHUS AND POPULATION**

For the well-to-do of the nineteenth century, these conditions were seen as part of the “population problem,” which they decried as an ill but at the same time used to argue that it made the harsh environment of capitalist industrialism necessary—since, as one of them put it, where else “could the millions by which the population of England has increased find work?” Prior to 1700 the increase in population over the course of each one hundred years was about 1 million. Between 1700 and 1800, the increase was 3 million. The industrial takeoff gave added momentum to
this, making England a center of both industrialization and rapid population expansion."

In 1798 the classical economist Thomas Robert Malthus published his *Essay on the Principle of Population*. His central theme was that the vast majority of the population faced extreme poverty, and that efforts to remedy this situation would do more harm than good. Anticipating the views of many of today's ecologists, Malthus argued that all animals, including human beings, had the capacity to increase geometrically (1, 2, 4, 8, 16, and so forth). The human population, if unchecked, would thus be expected to increase "in a geometrical progression of such a nature as to double itself every twenty-five years." But since the world's population had rarely if ever increased at this "natural rate," the greater part of Malthus's analysis was concerned with analyzing the forces that had held it in check.

The most important of these was the limitation on the food supply within any given territory. Although the food supply would, Malthus contended, have a tendency to increase as a result of the application of additional labor, the extension of the land under cultivation, and improvements in agricultural technique, the increase in supply from one generation to another would nevertheless tend to diminish, largely because all of the best land would eventually be brought under cultivation. Food production would thus increase only arithmetically (1, 2, 3, 4, 5, and so on) at best. Without any other checks, therefore, starvation would limit population growth to the rate at which the food supply could be increased. But there were additional checks: preventative checks, those that reduced the birth rate and included sterility, sexual abstinence, and birth control; and positive checks, those that increased the death rate and included misery, plagues, and war (along with famine).

Both preventative and positive checks maintained an equilibrium between population growth and the available means of subsistence. Ultimately, Malthus argued, they boiled down to "moral restraint, vice and misery." He defined moral restraint as "the restraint from marriage which is not followed by irregular gratifications." Perhaps the most important distinction between the rich and the poor, he believed, was the greater moral restraint of the former: "Carelessness and want of frugality," vice and misery, he argued, were common among the impoverished elements of society. For these reasons Malthus opposed all measures that would alleviate the harsh impact of the market on the poor.10

In expert testimony before a Parliamentary Committee on Emigration in 1827, Malthus advocated reforms in the Poor Laws that would create an even harsher environment for those seeking parish relief and urged the committee to refuse relief to all children who were born two years after his reforms had been instituted. He also commended landlords who pulled down cottages the moment they became vacant, and argued against the construction of new cottages, since he believed that a shortage of housing would discourage early marriage.11

Although Malthus’s views on overpopulation were to influence many later ecologists, Malthus himself was not particularly interested in, or even aware of, what would nowadays be called the larger ecological implications of his analysis (i.e., the carrying capacity of planetary ecosystems). Rather, he was engaged in a dispute with radicals such as William Godwin (1756-1836), who had been sympathetic to the ideals of the French Revolution and who advocated humanitarian measures to ameliorate the worst hardships of the poor. For Malthus, the population doctrine showed conclusively that "the future improvement of society" could not occur through any process that reduced inequality.12

The weakest part of the Malthusian doctrine was the purported "arithmetical ratio" governing food supply. Malthus provided no evidence for its existence, merely asserting that "by great exertion, the whole produce of the Island might be increased every twenty-five years, by a quantity of subsistence equal to what it at present produces. The most enthusiastic speculator cannot suppose a greater increase than this."13 In his later work he placed greater emphasis on the role played by the law of diminishing returns in
agriculture, the result of the gradual extension of cultivation to physically inferior land. This led him to even more pessimistic conclusions. Once all the land was occupied, he wrote, “the rate of increase of food would ... have a greater resemblance to a decreasing geometrical ratio than an increasing one. The yearly increment of food would, at any rate, have a constant tendency to diminish.”

**MARX AND RELATIVE SURPLUS POPULATION**

Malthus based his analysis of overpopulation, poverty, and the decline of the environment on presumed “natural laws” of food production and human fertility. Karl Marx attributed such problems primarily to social causes. Marx contended that “every particular historical mode of production has its own special laws of population, which are historically valid within that particular sphere. An abstract law of population exists only for plants and animals, and even then only in the absence of historical intervention by man.” “Overpopulation,” he wrote, “is ... a historically determined relation in no way determined by the absolute limit of the productivity of the necessaries of life, but by limits posited rather by specific conditions of production [along with] the conditions of reproduction of human beings.”

Under industrial capitalism the most important law governing population, Marx argued, is that of relative surplus population or the industrial reserve army of the unemployed. Wages (or historically defined subsistence levels) are not determined by the relation between population and food but by the relation between population and employment. The existence of a mass of unemployed is the lever capitalism uses in its efforts to reduce labor power (an individual’s capacity to work) to the status of a commodity—a good to be bought and sold like any other. But this law of relative surplus population does not hold for all stages of capitalism: it only comes into being with the rise to dominance of machine production. Before this could happen, capitalism had to alter labor’s relationship to the land by making the land itself into a good to be bought and sold. This—the expropriation of the land, which made possible the expropriation of the agricultural laborer—was the real secret of the English agricultural revolution that preceded the Industrial Revolution.

The presence of an industrial reserve army leads to increased competition among workers for the limited amount of employment, and this in turn holds down wages. Wages are thus determined not by an iron law revolting around the price of grain (as earlier economic thinkers, such as Adam Smith and Malthus, had argued), but by historically determined standards of subsistence and by “the respective power of the combatants” in the class struggle. The industrial war, Marx argued, differs from other forms of modern warfare in that “the battles in it are won less by recruiting than by discharging the army of workers.” He referred to the law of relative surplus population as “the absolute general law of capitalist accumulation,” since it is the “lever” for the concentration of relative wealth at one pole and relative poverty at another.

Marx believed that not only labor but nature too was increasingly being subjected to capital as a result of the new conditions ushered in by the Industrial Revolution. By separating town and country, and by applying industrial techniques to the latter as well as the former, capitalism disrupted the ecological basis of human existence:

All progress in capitalist agriculture is a progress in the art, not only of robbing the worker, but of robbing the soil; all progress in increasing the fertility of the soil for a given time is progress towards ruining the long-lasting sources of that fertility. The more a country proceeds from large-scale industry as the background of its development, as in the case of the United States, the more rapid is this process of destruction. Capitalist production, therefore, only develops the techniques and the degree of combination of the social process of production by simultaneously undermining the original sources of all wealth—the soil and the worker.
These were not offhand comments but reflected careful study of the work of the German agrarian chemist Justus von Liebig, often known as the founder of soil chemistry. The intensification of agriculture during the first phase of the Industrial Revolution had led to a progressive loss of fertility and a drop in agricultural yields in some regions. The desperation of the farmers was so great that some retrieved animal and human bones from the battlefields of the Napoleonic wars to spread over their land. Liebig had been a major advocate of the importation of Latin American guano for fertilizer. In 1842 the first artificial fertilizer was introduced by the English agricultural chemist John Bennett Lawes, who devised a means of making phosphate soluble and established the first fertilizer factory. But it was not until just before World War I that the German chemist Fritz Haber developed a way to make an artificial nitrogen fertilizer.27

Until the early 1860s, Marx, who rejected the classical liberal theory of diminishing returns in agriculture, thought that the progress of capitalist agriculture might be so rapid that it would outpace industry. But by the time he wrote Capital, his studies of the work of Liebig and other agronomists had convinced him otherwise. “Large landed property,” he explained,

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 interdependence process of social metabolism, a metabolism prescribed by the natural laws of life itself. The result of this is a squandering of the vitality of the soil, which is carried by trade far beyond the bounds of a single country.

Large-scale industry and large-scale agriculture thus had the same results: both contributed to the ruining of the agricultural worker and to the exhaustion of the “natural power of the soil.” “The moral of the tale,” Marx observed, “is that the capitalist system runs counter to a rational agriculture, or that a rational agriculture is incompatible with the capitalist system (even if the latter promotes technical development in agriculture) and needs either small farmers working for themselves or the control of the associated producers.”28

Unlike Malthus and the other classical political economists, Marx’s tendency to seek out historical rather than “natural” laws took him far beyond the issues of population and soil fertility to larger issues of sustainability. For example, he argued that, “The development of civilization and industry in general has always shown itself so active in the destruction of forests that everything that has been done for their conservation and production is completely insignificant in comparison.”29 The capitalist mode of production, Marx wrote, “presupposes the domination of man over Nature.” It treats Nature’s contribution to productive wealth as a “gratuitous” gain or free gift.

Engels described this freebooting relationship of humans to nature graphically: “The people who, in Mesopotamia, Greece, Asia Minor, and elsewhere destroyed the forests to obtain cultivable land, never dreamed that they were laying the basis for the present devastated condition of these countries, by removing along with the forests the collecting centres and reservoirs of moisture. When on the southern slopes of the mountains, the Italians of the Alps used up the pine forests so carefully cherished on the northern slopes, they had no inkling that by doing so they were cutting at the roots of the dairy industry in their region; they had still less inkling that they were thereby depriving their mountain springs of water for the greater part of the year, with the effect that these would be able to pour still more furious flood torrents on the plains during the rainy season.... Thus at every step we are reminded that we by no means rule over nature like a conqueror over a foreign people, like someone
standing outside nature—but that we, with flesh, blood, and brain, belong to nature, and exist in its midst, and that all our mastery of it consists in the fact that we have the advantage of all other beings of being able to know and correctly apply its laws."

INDUSTRIALISM AND ROMANTIC ECOLOGY

From the beginning of the Industrial Revolution the conflict between machine capitalism, with its harsh and relentless impact on the environment, and an ecological ideal in which society and nature would no longer be alienated from one another was constantly invoked by Romantic social critics. In 1844, while Engels was writing *The Condition of the Working Class in England*, the Romantic poet William Wordsworth authored a sonnet protesting the building of a railway through the English lake district. "Is then no nook of English ground secure/From rash assault?"

A year later, on the other side of the Atlantic, Henry David Thoreau retreated to Walden Pond outside Concord, Massachusetts, seeking through solitary communion with nature those principles that would offer an alternative to a world with which he was increasingly at odds. "I cannot believe," Thoreau wrote in the opening chapter of *Walden*, "that our factory system is the best mode by which men may get clothing. The condition of the operatives is becoming every day more like that of the English; and it cannot be wondered at, since, as far as I have heard or observed, the principal object is, not that mankind may be well and honestly clad, but unquestionably, that the corporations may be enriched."

Walden Pond offered Thoreau no impenetrable retreat from the glaring contradictions of commercial and industrial society: it was connected to the social world by the train tracks that bordered the pond itself. His deep concern for the natural world was at one with his appreciation of craftsmanship, as opposed to modern industry; his opposition to the endless pursuit of wealth; and his rejection of the Southern slave system.  

Thoreau's commitment to both the natural world and to traditions of human craftsmanship, along with his critique of acquisitive society, had its counterpart in such English Romantic critics as John Ruskin and William Morris. Ruskin stressed the need for a more "organic society" influenced by the principles of art and intrinsic value, as opposed to mechanics and money. In *Unto This Last* (1860), he argued that production and possession may not constitute wealth but may instead be "illth," a word he coined. Wealth, he argued, was the "possession of useful articles, which we can use." Conversely, the production of useless things, or the possession of things we cannot use, can only be defined as illth.  

Ruskin's ideas, along with those of Marx, helped inspire the great English artist, master-craftsman, poet, and social critic William Morris, who merged Ruskin's Romantic critique of industrialism with a socialist cultural critique of capitalism. Morris believed, like Ruskin, that society should follow art. "Everything made by man's hands has a form," Morris wrote in 1878, "which must be either beautiful or ugly; beautiful if it is in accord with Nature, and helps her; ugly if it is discordant with Nature, and thwarts her." "Wealth," he later wrote, "is what Nature gives us and what a reasonable man can make out of the gifts of Nature for his reasonable use.... But think, I beseech you, of the product of England, the workshop of the world, and will you not be bewildered, as I am, at the thought of the mass of things which no sane man could desire, but which our useless toil makes—and sells?"

For Morris, capitalist civilization offered a "stupendous organization—for the misery of life!" The method of distribution under capitalism, he wrote, "is full of waste; for it employs whole armies of clerks, travellers, shopmen, advertisers, and what not, merely for the sake of shifting money from one person's pocket to another's; and this waste in production and waste in distribution, added to the maintenance of the useless lives of the possess-