A material history of our ecological crisis

The ecological crisis of today is often viewed through capitalist lenses; it is first assumed that the need for current levels of production exists and from there a deficiency in technology available is concluded. As Lynn White Jr. (2013) mentions in his cornerstone paper, "The historical Roots of our Ecological Crisis," environmental degradation is often treated as a technical or scientific issue, ignoring its roots in historical shifts in production, property, and power. While the role of technology in changing our relationship with the earth cannot be ignored, separating it from the historical moment during which it developed would be to ignore the very conditions of its creation, creating a blind spot for critiques of technology in our analysis. Lynn argues that the Abrahamic view of the earth, that humankind is the earth's shepherd, is instrumental in the use of technology as a means of exploitation rather than stewardship (White, 2013). Thus, it is imperative to develop a material history of our ecological crisis. While Lynn White Jr. has done much of the leg work in his essay, what he provides is genealogy, a study of the development of the ideas that powered the ecological crisis. Instead, this paper will outline the evolution of ecological crisis throughout history, starting from pre-capitalist and feudal economies, to colonialism, and finally the industrial age. By tracing these transitions, this paper argues that ecological crises cannot be solved through technological advancements alone. They are crises of social organization, born from the changing ways humans have extracted, valued, and owned nature.

Ecology in precapitalist societies

Agriculture in early societies is first and foremost an economic problem. There is a limited amount of land suitable for agriculture and an ever-growing number of mouths to feed. Even in the modern era, half of the planet's land is used for agriculture, and 77% of that is used

for pasture (World Economic Forum, 2019), showing us that this issue is still present in contemporary society. However, this statistic hides a paradox: much of the land used for agriculture today was historically unsuitable. The question then arises; how did past civilizations prosper in land not fit for growing crops? Further, how did those same lands become centers of ecological and social crises? The answer lies in the historical organization of production, which has shaped how human societies interact with the natural world.

One of the earliest large scale agricultural societies, the Akkadian empire of Southern Mesopotamia, was faced with this problem of infertility. This region of Mesopotamia receives on average less than 100 mm of rainfall per year with a sparse distribution across the land, making irrigation a necessity. Lang and Ertsen mention that “the contemporary climate still adheres to the prevailing weather patterns of ancient Southern Mesopotamia” (Lang & Ertsen, 2024), indicating that the availability of water through rainfall has historically been precarious. Early development of farmland in the region did not present inequalities in crop yield depending on the position relative to the stream, contrasting usual outcomes of the gravity-based irrigation system used today. Wilkinson et al. (2015) state that the water reservoir provided by the Euphrates and Tigris river was enough to maintain this equal development even at empire level societies, and that the later development of social stratification through monopoly of water availability and land is man made rather than purely a consequence of the pitfalls of agricultural technologies of the time: “Early communities in Mesopotamia therefore appear to have lived on the cusp between successful management and engineered disaster, and this creative tension may have formed a crucial aspect of human niche construction in the region” (Cookson, Hill, & Lawrence, 2019). Social stratification played a key role in the eventual ecological collapse of Mesopotamian empires. Natural shifts in rainfall and temperature caused decreased water

availability, which coupled with inefficient use of irrigation systems due to the aforementioned monopolization of farmland led to an insufficient yield of crops to meet the populace's needs. This foregoing of equality, both between humankind and nature and between humans, is a common denominator underlying all following ecological crises; from early capitalist and industrial societies, all involved inequality between man and nature in some way.

As the world transitioned into European technological and economic dominance through the Middle Ages, the transition from ancient to feudalist societies situates us squarely in the middle of Lynn White Jr's genealogy. He argues that "the victory of Christianity over paganism was the greatest psychic revolution in the history of our culture." (White, 2013, p. 7) The early adopters of this Christian ontology, the Greeks and Romans (adopters fittingly, as both cultures abandoned paganism in favor of Christianity), were characterized by beginning the shift from subsistence-based agriculture to imperial expansion or profit driven agriculture. Greek agriculture, based largely on dry farming of grains, olives, and vines, was adapted to the Mediterranean's thin soils and irregular rainfall. As Thommen (Thommen, 2012) notes, the Greek landscape was "a challenge of scarcity rather than abundance," which required intensive land use and constant expansion into marginal terrains. To sustain agricultural production, forests were cleared for timber and charcoal, a process that led to soil erosion and the loss of watershed stability. Roman agriculture extended this developmental ethic through the empire. Roman latifundia, large estates worked by enslaved labor, produced with the goal of exporting to urban centers rather than for local consumption. Deforestation, overgrazing, and the exhaustion of Mediterranean soils followed, while dams, aqueducts, and irrigation canals further altered local ecosystems. What distinguished Roman ecology was its goal of extensive development: ecological consequences were spatially displaced, exported to conquered territories, which would

be inherited by both feudalism and capitalism. This divorce between the producers and consumers would become central in our contemporary ecological crisis. As Wendell Berry (2013) puts it: “As the householder evolves into a consumer, the farm evolves into a factory—with results that are potentially calamitous for both.”

Greek rationalism and Roman law laid the philosophical groundwork for human dominion over nature. Nature became kosmos, a rational order to be studied and mastered; under Roman dominium, land became an object to be possessed, transferable and commodifiable. Christianity, as Lynn White Jr. (2013) suggests, later interacted with these classical notions, providing an a posteriori rationalization for the ongoing material reality of the exploitation of nature. Thus, the classical societies serve as the bridge between the local economies of early agrarian societies and the expansionist, accumulative ethic that would characterize the following systems to come, mainly feudalism and capitalism.

The feudal economy of medieval Europe continued the trend of classical societies of having a mix between self-subsistence and market driven trade. However, the increased inequality between the peasants and nobles caused further divide in the distribution of goods. Feudal societies organized land through manors owned by feudal lords, and serfs who were peasants that worked those lands in exchange for having a small plot of land to work for themselves. This land was known as the common land or the commons for short. Feudal lords only offered the means of production once and paid for their upkeep, while peasants had to provide their labor constantly, creating an imbalance in the production relationship they held between themselves. Additionally, legal disputes between them were settled through the feudal lord’s court rather than a public court, which meant that serfs had little to no say in their working conditions. Peasants often had just enough to survive as any surplus yield was appropriated by

their lords; although some peasants had better yields after paying their dues, allowing them to become merchants, a phenomenon that would become key in the future development of a middle class (Wallerstein, 2011, p. 50).

This imbalance in power created two economic hierarchies, the long distance intercontinental trade that occurred between nobles, and the local bartering economy within the peasantry (Economics Institute of the Academy of Sciences of the U.S.S.R, 1954). The local economies of towns allowed craftsmen outside of agriculture to emerge, who in exchange for some of the serf's agricultural proceeds provided commodities like clothes, smithing, etc. The relationship between craftsmen and peasants was the foundation of the economies of towns and settlements during Feudalism (Wallerstein, 2011, p. 46). This relationship was remarkably more equal than that of the serf and feudal lord, which meant that the use of the environment to extract materials for craftsmen did not lead to a wide scale ecological crisis (Wallerstein, 2011, pp. 50–51); instead, the limited availability of common land meant that the responsibility to protect it against exploitation was upheld by the peasantry, who acted more as stewards of the common land rather than owners; with the notable exception of those serfs who became merchants, as the new merchants would continue to perpetuate the exploitation of resources, be it land, minerals, etc. Contrasting these natural economies of towns, the production relationship between feudal lords and serfs put great strain on the land as well as the population.

The imperial expansion of the Middle Ages pushed feudal manors to their ecological limits. During the 13th century, Spain was being reconquered from Moors, England was expanding into Wales, Scotland, and Ireland, and eastern Europe was being conquered by Germany and Scandinavian countries. This frontier expansion strained the agricultural reserve that feudalism could produce, pushing feudal Europe's capacity to meet the agricultural needs of

their political interests. Wallerstein (2011) states that the byzantine reconquering of Constantinople, the expulsion of Crusaders from the Levant, and Mongolian conquering of parts of Russia put a brake on this frontier expansion of the European powers. Following this, from the 13th century to the 14th, Europe enjoyed a period of relative economic stability. The constant outflow of precious metals from Arab regions kept the European economy under peace, although the strain on the manorial economy was showing (Watson, 1967). Similarly to the Southern Mesopotamian societies, natural variations in weather patterns pushed a system already on the edge of sustainability overboard. During the 14th century, a sudden drop in temperatures caused decreased yields and often outright crop failure, a complete or near to complete loss of all crops in a field. Populations that were freer from the influence of feudal lords enjoyed greater resistance against the fluctuating weather patterns and crop diseases introduced through trade due to their more responsible approach to land use (Moore, The Crisis of Feudalism, 2002).

The downfall of feudalist economies was both ecological and political. Not only did the peasantry seek to improve their living conditions while the growing middle class provided a means of social mobility, but the lack of sufficient agricultural technology and manpower to meet the unnatural demands of feudal lords for extensive development, inherited from classical societies, caused the eventual fall of Feudalist systems of production.

Capitalism & the new ecological crisis

The fall of feudalism did not resolve the ecological contradictions of pre-modern economies, it globalized them. The extraction of surplus yield from serfs by lords transformed into the extraction of surplus value from wage laborers by capitalists. Capitalism enjoys social mobility a great deal more than feudalism. Success stories of the working-class becoming owners of businesses are not impossible to find, however most of this social mobility is enjoyed by those

already owning land, factories, or any means of production. However, unlike feudalism, capitalism presents a greater danger due to its tendency for extensive growth. The capitalist is no longer constrained by the power of the crown, instead it has become the crown. Everyone and everything bend their knee to the power of capital, even the religion that previously kept the owners in check during feudalism. Now unrestrained, the capitalist mode of production expands itself globally, it travels the world in search of more resources to extract, for more people to subordinate through wages and the appropriation of their labor. The evolution from feudalism to capitalism is not necessarily a total transformation like one would expect, but it is instead only an expansion of the pre-existing systems of exploitation created by the ancient, classical and feudal societies. Thus, a critique of the current ecological crisis must also be accompanied by a critique of capitalism, which is incomplete without our previous history of pre capitalist ecologies and modes of production. The following section will create said critique of capitalist ethics and the relationship those ethics build between humankind and nature using the historization provided before as its foundation.

Following the feudal crisis, the European powers began expansion campaigns to maintain the extensive development of feudalism. Taking from the frontier expansion of the 13th century, Portugal and Spain took initiative in finding new trade routes, which led to Colombus' expedition that would lead to the discovery of the New World. Following the return of Colombus' voyage, the Treaty of Tordesillas was signed, giving Portugal and Spain full authority to navigate and trade in the land found by Colombus, while dividing the world into two halves using a demarcation line along where Brazil is (then undiscovered). Anything east would be Portuguese territory, and anything west would be Spanish. The signing of this treaty marked the

historical beginning of modern European colonialism, which gave shape to capitalism as we know it today (Marx, Capital: A Critique of Political Economy. Volume 1, 1887).

The main distinction between capitalism and feudalism is, according to Marx, the division of humans into two groups: The owners of capital, and the owners of labor. Owners of capital are those who enjoy the surplus value, the capitalist, the feudal lords, the freemen, the guild masters, etc. (Marx & Engels, The Communist Manifesto, 1888) On the other hand, owners of labor are those who aspire to be owners of capital. Owners of labor sell their labor to owners of capital in exchange for capital, and then exchange capital for a myriad of commodities. In feudalist societies, feudal lords achieve and maintain ownership of the means of production, or capital, through legal or political power; whether it be through some god given right, inheritance from family, or use of court systems, feudal lords achieve absolute control over a piece of land mostly through non-economic means. Since the peasantry possess none of these, they are forced to work the land under the conditions imposed upon them by the feudal lord. In capitalism, however, everyone can acquire representative power through capital. Capital can be transformed into various material objects with a purpose or potential to become something else, like corn, iron, wheat, and even land (Marx, 1887), which gives it greater inherent value than labor, and makes it desirable. In a sense, every worker under capitalism is a mini salesman, since the capital they possess, whether it be significant enough to be part of the upper classes or not, allows them to make a stand in the market. The exchange between owner of labor and the owner of capital eventually allows the owner of labor to gain ownership of the land they work, turning them into a Bonafide owner of capital.

Although, one must realize the illusion of the power of capital acquisition by the owners of labor. It is in the best interest of the owners of capital to not allow the owner of labor to

become an owner of capital, as doing so would produce two related results: 1. The owner of capital would no longer possess capital as they exchanged labor for capital in equal terms, and 2. The owner of labor now takes on the same role as the owner of capital and no longer finds himself in the need to continue exchanging their labor, leaving the previous owner of capital with no labor left to buy. Because of this, owners of capital devise a scheme to trick owners of labor into working indefinitely. Owners of capital exchange their capital for labor through wages, which is simply defined as the amount of money that a worker receives for a certain amount of work, usually measured in hours. For example, say a worker takes 1 hour to produce a nail from just its raw materials. The raw materials and tools are provided by the owner of capital, and thus the nail belongs to them. If we stopped here, our example would be one of feudalism, not capitalism. However, here the owner of capital willingly submits some of its surplus: Instead of completely appropriating the end product, the worker is rewarded with a wage proportional to the value of the nail, which is determined through the costs of its making. If it costs one dollar to buy the necessary steel to forge the nail, and another dollar to fuel the furnaces used to smelt said steel, the materials will come to a cost of two dollars. The capitalist then pays the worker an extra dollar for their labor, which is counted as part of the cost of production of the nail. Now, our nail must be sold at a price of three dollars for the capitalist to break even. However, if the capitalist is the only one producing nails, they have full control over the price of nails, since everyone has to agree to their price or be unable to use nails. The capitalist can comfortably sell nails at a price of 6 dollars, making a profit of an entire extra nail, while the worker only sees a sixth of the real value of his labor in return. This economic coercion, also known as scarcity, is instrumental in the accumulation of capital, and replaces the political power of the feudal lords.

In this example, everyone can be satisfied without everyone seeing the full return on their investments. The capitalist appropriates a part of the profits of the laborer and the profits of the buyers of nails while at the same time maintaining both under the illusion that they can accumulate capital in the same capacity that the owner of capital can. Although the owner of labor is not one, they still act and seek to be an owner of capital in the same way the capitalist is, with absolute power over the labor of others. This illusion is one of capitalism's biggest dangers, as owners of labor are hardly able to recognize their true position in the capitalist mode of production and the necessity of their exploitation, and like those lucky enough to become merchants in feudal Europe, perpetuate capitalism on the off chance that they achieve higher social standing. Furthermore, since owners of labor perpetuate the capitalist ethic even if they are not capitalists in the true sense of the word, they are conditioned to exploit anything they can as capitalists do, which extends to the environment.

Following capitalist ethics, the agricultural worker no longer works the land in an equal relationship with it. Instead, the owner of labor is encouraged to extract as much as it can —since a greater yield directly translates into greater capital gain– a desire previously only held by the owners of capital, the feudal lords, the emperors, the kings and queens, etc. This phenomenon illustrates how capitalism is a convergence and perfection of all previous systems: It extends the trend of slowly approaching greater equality for those who work the land as a means of social control to an almost perfect conclusion, the ability for the oppressed to become oppressors. The farm stopped being a means of sustenance and instead became a means of generating capital. A farmer no longer produces with the aim of feeding their fellow townspeople, instead they produce with the explicit goal of generating the most capital possible. This model of farm would eventually end in the development of plantations in the colonies of European powers.

The discovery and colonization of the Americas revealed a new paradigm of ecological exploitation: the extraction of silver and sugar, the destruction of Indigenous agro-ecological systems, and the forced movement of plants, animals, and enslaved peoples across continents. Europe's expansion was not only a transfer of power but of ecosystems; diseases, species, and agricultural practices remade the entire continent of the Americas. This shift in viewing nature caused Nature to become "cheap," its value was no longer measured by coexistence and symbiosis but by how quickly it could be extracted and replaced.

Spanish colonization of the Americas was, contrary to popular belief, heavily motivated by agricultural needs. Wallerstein (2011, p. 62) mentions "If food needs dictated the geographical expansion of Europe, the food benefits turned out to be even greater than could have been anticipated. World ecology was altered and in a way which, because of the social organization of the emergent European world-economy, would primarily benefit Europe. In addition to food, the other great basic need was wood—wood for fuel, and wood for shipbuilding (and house building)." This ecological and material foundation of expansion is reflected in Grafe and Irigoin's (2012) findings that Spanish imperial administration was not a monolithic extractive machine, but a decentralized network of fiscal relationships that encouraged local production and reinvestment. Much of the wealth collected through colonial taxation was recycled into regional economies rather than exported to Spain, financing agricultural infrastructure, local trade, and the logistical systems that sustained crop and timber extraction. The Spanish Empire functioned as a stakeholder empire, where local elites became financially and politically invested in maintaining agricultural productivity and resource flows. Such a system produced ecological exploitation not just because of imperial command but because of a shared interest between

colonial and high standing citizens, increasing land conversion, deforestation, and the commodification of nature under early developments of capitalist ethic.

However, it is important to remember that "there was not one capitalism, but several European capitalisms, each with its zone and its circuits." (Wallerstein, 2011, p. 129) Capitalism had not yet consolidated into the global, unified hegemonic system that we see today: The capitalist mode of production developed in New Spain is different than the one developed in Brazil —which inherited more characteristics from its feudal past like a less developed land owning class (Wiarda & Kline, 1985)– or the one developed in Britain. That leap into total dominance over the means of production worldwide would not come until the technological advancements of the industrial revolution allowed capitalism to evolve beyond being bound to empires, and to rise as an abstract object of worship, to fully realize itself as above any and all authority, to fully replace the crown.

Ecology during early industrialization

Colonial expansion laid the foundations for the Industrial Revolution, both materially and ideologically. The influx of resources from the colonies provided the raw materials and capital that made industrial production possible. Firstly, the development of a middle class, the international merchants, was the engine that propelled colonial expansion forward (Wallerstein, 2011, p. 68). Yet more importantly, colonialism established the ethic of extraction as the organizing principle of global economy. By the eighteenth century, the accumulation of capital through colonial plunder had concentrated enough wealth in Europe to finance the machinery, factories, and technologies that defined industrial modernity. The same ethic that justified the enslavement of peoples and the destruction of Indigenous ecologies now justified the burning of coal and the transformation of landscapes into engines of production. With steam and fossil fuels,

capitalism escaped its geographical limits and extended its reach globally, creating the modern ecological crisis.

The early industrial structures of colonialism were where capitalism fully appropriated agricultural production within it. The most prominent example of this was the use of slaves in sugar cane plantations in Brazil, Hispaniola, and Jamaica during the 16th through 18th century (Moore, 2000). Slaves were used as a means of production in combination with mills, boiling houses, and furnaces to convert sugarcane into refined sugar on site. The large-scale production of these plantations and the use of technological advancements to maximize capital yield situated them in the emerging world economy as heavily interconnected centralizers of capital, thus classifying them as industrialized, proto-capitalist enterprises. Plantations also serve as an example of the ontological shift of agriculture mentioned before. These plantations did not provide for their immediate communities, instead the soil was overexerted for the purposes of generating capital, unlike in previous societies where the aim was territorial expansion, like in ancient and classical societies, or acquisition of commodities, like in feudalism. Additionally, many if not all the characteristics of Spanish sugar plantations were inherited by American plantations and the mid-industrialization factory model in industrial age Britain.

As the world progressed into the 19th century, the industrial age went into full swing. The industrial revolution of England was characterized by a transition from manual labor to machine labor. The need for skilled workers to produce commodities was reduced to insignificance, as the operation of machines was so much more straightforward that anybody could easily pick it up. Increased production also induced technological advancements in transportation infrastructure: Railroads and steam powered ships allowed for the transport of the surplus of goods produced by factories. These new modes of transport all functioned through coal and steam engines, both

producing greenhouse gases upon their use, a fact that while unknown to the capitalists of the time, would be the concrete point that created the ecological crisis we face in the 21st century.

Economically, the industrial revolution consolidated one of capitalism's crowning achievements, the middle class. Taking from the merchants of feudalism and the landowning class of the colonial period, the middle class was characterized by its higher standing compared to pure labor owners due to ownership of small amounts of means of production. The middle class of this time were the small businessmen and industrialists who owned the up and coming factories and manufacturing sites. However, the middle class were not truly owners of capital. Although they enjoyed more privileges than the labor owners, the middle class still existed under the exploitation of larger capital owning entities, mainly banks and large-scale businessmen. Often, these middle-class owners were unable to reach the status of capital owner during their lifetime, instead relegating it to be a generational project. The emerging middle class and the established capital-owning bourgeoisie

of the industrial age replaced the feudal lords and the crown respectively, although only by name: the production relationship they held with the labor-owning class remained unchanged, illustrating the fact that capitalism is a direct evolution of feudalism with all the same class relations.

Furthermore, Marx & Engels (1888) outline another danger presented by the class dynamics of capitalism brought forth during the industrial revolution, the alienation of workers: "Owing to the extensive use of machinery and to division of labor, the work of proletarians has lost all individual character, and, consequently, all charm for the workman. He becomes an appendage of the machine, and it is only the most simple, most monotonous, and most easily acquired knack, that is required of him" (Marx & Engels, The Communist Manifesto, 1888). The

alienated worker is unable to communicate with other workers, to realize its standing in the capitalist system and eventually organize with its fellow workers against it. The alienated worker is also unable to communicate with the environment it resides in. Through this reframing, the two spiritual dangers Aldo Leopold mentions at the beginning of *A Sand County Almanac* (1949) are no longer a personal moral responsibility, but instead a symptom of capitalist exploitation and historic modes of production.

The energy intensive processes used in manufacturing during this period released green house gases to the atmosphere, creating the foundation for what is currently the biggest problem addressed by ecologists worldwide, climate change. Not only that, the advent of the automobile and urban development centered around it continues to be one of the biggest sources of air pollution, contributing over a fifth of total greenhouse gas emissions in the U.S. today (United States Environmental Protection Agency, 2025).

What began as a theological and social reordering of nature in pre-capitalist societies culminated, through industrial capitalism, in a global system that treats the planet as a standing reserve of resource. The industrial revolution not only changed the way that we interact with the environment, making us blind to its needs and our relationship to it, but it also fundamentally changed how we interact within each other, isolating us and tearing down any possible line of escape against capitalism and its ecological exploitation. To resolve the ecological crisis, we must therefore confront not only our technologies but the historical relations of power that shape them.

The ecological crisis today: How do we proceed?

The history of ecology is inseparable from the history of production. From the irrigation fields of Mesopotamia to the steam engines of industrial Europe, the same pattern persists: the subordination of nature to systems of hierarchy and accumulation. Lynn White Jr. was correct in arguing that the Western religious worldview made possible a new relationship with nature, one in which humans imagined themselves as owners above it rather than participants within it. Yet, what his genealogy of ideas leaves open is how that worldview materialized through economic structures. The theological foundation for ownership of nature found its concrete expression in the manors of feudal Europe, the conquests of colonial empires, and the alienation of the industrial age.

What began as the monopolization of rivers and soil became the commodification of entire ecosystems. Each economic transformation intensified the divide between human and natural cycles. Colonialism extended that rift across continents, transforming the exploitation of land into a global system of extraction, and the Industrial Revolution completed it by binding economic growth to coal and fossil fuels, linking the generation of capital directly with environmental harm. The result is the ecological crisis of the present: climate instability, mass extinction, and the collapse of local ecologies under global capital.

If the roots of this crisis are historical, then so too must be its solutions. No technology, however advanced, can restore balance within the same logic that produced imbalance. To confront ecological collapse is to confront the social and economic order that sustains it, it is to confront capitalism, it is to rethink ownership, production, and our relationship to the earth itself. The challenge of the global ecological crisis is not a technological one as we've seen, but instead an introspective one. We must become archeologists; we must dig up the old truths of those who came before us and through them find the next step to take.

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