# Sustaining What? Scarcity, Growth, and the Natural Order in the Discourse on Sustainability, 1650-1900

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## Introduction

Questions of sustainability — the interaction between human economic practices, on one hand, and natural resources and the web of life, on the other — are ancient.[1] Concerns over deforestation and soil erosion are documented in literatures from ancient Mesopotamia, Greece and Rome, and Mauryan India, to name a few.[2] But in the early modern era a distinctive discourse of sustainability arose, even if it initially lacked a standardized vocabulary.[3] The capitalist heartlands of Europe and their ex-colonial appendages deployed economic and military advantage to seize control of the world's land surface — from 10 percent in 1700 to 30 percent in 1800 and 85 percent in 1900. The transformations associated with capital and colonialism sparked, and propelled, a revolution in nature-society relations, with the construction of what Jason Moore terms regimes of abstract social nature: spatio-temporal practices of quantification, mapping, and standardization that facilitated the "quantitative expansion of abstract labor."[4] With new regimes of economic order and abstract social nature came new ideas concerning the purposes and dynamics of economic activity and the management of nature.

It was above all at the frontiers of colonial expansion that new environmental discourses and conservation practices evolved. The expansion of European maritime travel and settlement, Richard Grove has shown, stimulated new and more complex ways of apprehending nature-society relations, and a more vivid sense of humanity's ability to radically alter its physical environment. It was fed by information flowing from all continents, including the systematic observation, recording and classification of the natural world, experiments in forest, soil and animal conservation and water-pollution control by scientists in the employ of the colonial companies, and the acquisition of local knowledge of the natural world and its symbolism. European encounters with new territories, societies, fauna and flora promoted the attachment of "a new kind of social significance to nature,

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2 Caradonna, *Sustainability*, p.40; Richard Grove, *Green Imperialism: Colonial expansion, tropical island Edens and the origins of environmentalism, 1600-1860* (Cambridge University Press, 1995).
3 Caradonna, *Sustainability*, 53.
4 Jason Moore, *Capitalism in the Web of Life: Ecology and the Accumulation of Capital* (Verso, 2014), 204.

reflected especially in the philosophies underlying the transfer to, and development of the Middle Eastern idea of the botanical garden in, Europe and in the emergence of the tropical and oceanic island as an important new social metaphor and image of nature."[5]

If the emergence of ideas and techniques of conservation and sustainability were most evident at the colonial periphery, they were also assimilated into the research of scholars in the imperial core. And here, too, new ideas concerning society's interaction with nature were deeply marked by the imperial framework within which they grew. This is the central concern of this chapter. Its subject is British environmental and environmental-economic theory between the seventeenth and nineteenth centuries, as well as the interconnections among discourses of scarcity, sustainability and economic growth.

**Empire of Biomass**

Would it be hyperbolic to suggest that the concepts of sustained economic growth, scarcity, and sustainability were triplets — the more or less simultaneous progeny of the transformations mentioned above? Consider sustainability. The evolution of the concept, according to Ulrich Grober, is best understood with reference to the Enlightenment-era crumbling of the belief in divine Providence. Earlier, in medieval times, the preservation of Creation had been God's responsibility: His providential hand sustained the world meticulously, continuously and perpetually. That belief disintegrated in the seventeenth and eighteenth centuries but it left its imprint on subsequent social and economic thought, notably Adam Smith's invisible hand of the market, and, Grober shows, "the modern discourse of sustainability."[6]

Grober's magisterial survey locates a number of originary impulses in the story of sustainability in eighteenth-century Germany. They include the first use of "sustainable" ("nachhaltig") in its modern sense, yoking together commitments to the preservation and continuous utilization of natural resources as well as respect for nature. This was in *Sylvicultura oeconomica* (1713) by the tax accountant and mining administrator Hans Carl von Carlowitz, as illustrated in his advice that the conservation and cultivation of timber should be practiced in order to ensure its "continuous, steady and *sustaining* [*nachhaltende*] use."[7] Of equal importance in the history of sustainability is its Romantic modification, exemplified in

5 Grove, *Green Imperialism*, p.23.
6 Ulrich Grober, *Sustainability: A Cultural History*, trans. R. Cunningham (Green Books, 2012), 39.
7 Ulrich Grober, *Sustainability: A Cultural History*, trans. R. Cunningham (Green Books, 2012), 83.

the work of Alexander von Humboldt and Johann Wolfgang von Goethe. Humboldt's ecological writings drew on his travels in the New World as well as the holistic thought of Hindu philosophy.[8] Goethe challenged the utilitarian and Cartesian conception of sustainability by establishing the "'economy of nature' as a foundation for *all* economic activity," thereby planting ecology "at the heart of sustainability."[9]

The concept of sustainability today contains both these strands of thought, the utilitarian or instrumental and the ecological or aesthetic. They were vividly present, too, in a precursory work that Grober also explores — John Evelyn's *Sylva, or a Discourse of Forest Trees and the Propagation of Timber in His Majesties Dominions*.[10] Evelyn was a proto-green thinker. He railed against urban pollution, originated the idea of the garden city, and maintained that it is possible to live on "wholesome vegetables, both long and happily."[11] His *Sylva* is a remarkable document in its aspiration to marry utility to aesthetics, bankability to beauty, the preservation of the natural world to the imperative of sustained profitability. Landlords dedicated to making a quick buck — condemned by Evelyn for their "avarice," with its associated sins of "*Pride, Effeminacy* and *Luxurie*"[12] — erode nature's substance, which, he advises, would undermine profitability in the long run, too. Tree planting, by contrast, is manly and heroic, driven in large part by self-interested landlords and championed by Evelyn out of concern for national power and autonomy. (No trees, no navy or trade.) Over and again, Evelyn enjoins his landowning readers that if they follow his silvicultural guidance their woodlands "will both prove more profitable, and more delightful"; the trees thus preserved and managed will augment "both profit and pleasure," for they will "increase the beauty of forests, and value of timber, more in ten or twelve years, than all other imaginable plantations can do in forty or fifty." In preserving woodland for judicious exploitation, "Persons who are Owners of Land" will reap "infinite delight, as well as profit," in addition to supporting national sovereignty. "What can be more delightful," Evelyn rhapsodises, "than for noble persons to adorn their goodly mansions and demesnes with trees of venerable shade and profitable timber."[13] Moreover, for Evelyn trees are not simply a feast for the eyes and a revenue stream, they also form the basis of (what we would call) ecosystems and make their presence felt in local climates. In "the Indies" in particular, trees contribute to cloud formation, such that "if their woods were once destroyed, they

[8] Grove, *Green Imperialism*, p.11.
[9] Ulrich Grober, *Die Entdeckung der Nachhaltigkeit: Kulturgeschichte eines Begriffs* (Kunstmann, 2010), 95.
[10] John Evelyn, *Sylva*…, vol. II (London, 1664).
[11] Thomas, Keith (1991) *Man and the Natural World: Changing Attitudes in England 1500-1800*, 2nd edn, Penguin.
[12] Evelyn, in Wood 1984, p.99
[13] Evelyn 1664b ~~PAGE?~~ ONLINE

might perish for want of rains; upon which account Barbadoes grows every year more torrid, and has not near the rain it formerly enjoyed when it was better furnished with trees; and so in Jamaica at Gunaboa, the rains are observed to diminish, as their [sugar] plantations extend."[14]

Little wonder, then, that Evelyn heads the pantheon of theorists of sustainable development. In Henry David Thoreau's eyes, "Evelyn is as good as several old druids, and his 'Silva' is a new kind of prayer book, a glorifying of the trees and enjoying them forever, which was the chief end of his life."[15] "There would not have been a sustainability movement," according to Jeremy Caradonna, "without John Evelyn, Jean-Baptiste Colbert, Hans Carl von Carlowitz, Jean-Jacques Rousseau, Thomas Malthus […] and countless other men and women who developed ecological thinking."[16] John Bellamy Foster concurs, adding that Evelyn's works serve to remind us that Enlightenment conceptions of nature were not as vulgar as sometimes supposed.[17] The seventeenth-century scientific revolution of which he was a pre-eminent figure was not only associated "with a new conception of the domination of nature but also with a new materialist understanding of nature — one in which human beings were not simply the center of God's universe and could not simply dominate nature at whim, but rather were compelled to develop a sustainable relation with the natural world." Grober, similarly, hails *Sylva* as a seminal text in the modern sustainability discourse, in that it is about preserving resources to enable human consumption but transcends a purely managerial approach to nature — the Cartesian view of nature as an object to be subjugated, as advocated in the same era, for example, by Colbert.[18]

Grober reads *Sylva* as a "plea for responsible management of renewable resources," rooted in "an ethics for a provident and responsible society," as contrasted with two rival strategies for the achievement of continuous prosperity: "to import natural resources that were becoming scarce at home from the entire globe," and "to substitute other raw materials for any threatened by shortages." For many of Evelyn's contemporaries, then, "colonialism, plus technical innovation, became the key to a future at whose end we have arrived

[14] Evelyn 1664b ONLINE? See also Richard Grove, *Green Imperialism* and Richard Grove (1997) *Ecology, Climate and Empire: Colonialism and global environmental history, 1400-1940*, The White Horse Press.
[15] Thoreau, in Worster 1994, 87
[16] Caradonna, 2014/2016, 138
[17] Bellmay Foster, 1999, p.186
[18] Grober 2012, p.68

today."[19] Such contrast as there may have been, however, was more blurred than this formulation would suggest.

Who was Evelyn, and what social forces did he represent? He was heir to a fortune that "his grandfather had accumulated under James I and Charles I through his royal monopoly on saltpeter," an essential ingredient (with sulfur and charcoal) of gunpowder.[20] Evelyn senior had "forcibly ransacked stables, barns, dovecots, pigeon houses in search of potassium nitrate," and his son's sensitivity to silvicultural over-exploitation was doubtless informed by the problems encountered by his father in sourcing sufficient quantities of wood for charcoal production. Evelyn's career included positions in public service, too, as an armaments administrator and a naval functionary. He spoke for the modernizing Anglican nobility who sought to uphold the traditional structure of English hierarchy despite — or indeed through — their embrace of the thrusting new spirit of enterprise and "improvement." Thus, although Evelyn was a courtier and a devoted Royalist and Cavalier who fought for Charles I in the English civil war and dedicated *Sylva* to Charles II (and was indeed "on terms of intimacy with all the Stuart kings"[21]), he would on occasion pay visits to the "honest and learned" Anglo-Prussian agronomist Samuel Hartlib, "a public spirited and ingenious person, who had propagated many useful things and arts"[22], despite Hartlib's close connections with Cromwell and the Commonwealth. Together with other Hartlib associates, Evelyn founded the Royal Society — he coined its name, he was its Secretary in the early 1670s, and *Sylva* was the first book to bear its imprimatur.

A utilitarian streak runs throughout *Sylva*. Its author was a modernist: he sought to transform the world through the application of knowledge — to "inlarge the Empire of Operative Philosophy," in his words.[23] But *Sylva* is not simply a manual for silvicultural improvement and for addressing an immediate crisis of resource depletion. It is also and above all a handbook for the English landed gentry. In providing silvicultural advice it simultaneously guides them in the arts and artistry of governance and affirms their role as arbiters of taste and discernment, confirming their natural right to rule. That the text is adorned with quotations from the poets, botanists and improving landowners of the glittering empires of antiquity — the likes of Theophrastus, Virgil, Cato, Pliny, and Columella — is suggestive of its ambit and ambition. One of Evelyn's goals is to encourage

[19] Ulrich Grober, *Sustainability: A Cultural History*, trans. R. Cunningham (Green Books, 2012), 69-70.
[20] Linebaugh, 2008, p.90
[21] Sydney Carter (1953) 'John Evelyn: A Study in Royalist Piety,' *The Churchman,* Vol 67 No 4, p.228
[22] In Evelyn's words (1818 [1640-1706])
[23] Evelyn 1664b

his fellow aristocrats to raise their game and become "industrious planters."[24] Instead of frittering their time and money on hunting, or racing dogs and horses, they should turn to silviculture, an altogether more rewarding enterprise, aesthetically and financially.

If *Sylva's* target audience was the modernizing gentry, it also carried a message for the state. Specifically, it addresses the monarch as himself a landowner, propounding "proposals for the planting and improvement of his Majesty's forests."[25] More generally, it notes, where trees are "cherished and orderly dressed, what a commodity [arises] to the owner, *and the Commonwealth*."[26] *Sylva's* modernity, however, is apparent above all in its appeals to the state to manage the nation's forests. In order to conserve timber, Evelyn proposes the creation of an office of state, "accountable to the Lord Treasurer, and to the principal officers of his Majesty's Navy." Its remit would be to inspect and manage "all the woods and forests in his Majesty's dominions," ensuring for example "that such proportions of timber, &c. were planted and set out upon every hundred, or more of acres," surveying "the growth and decay of woods, and of their fitness for publick uses and sale," and reporting on these findings in order that any "defect in their ill governing may be speedily remedied."[27]

What is noteworthy here is that sustainability is articulated with broader social projects; it is linked to a particular matrix of forces. In this, Evelyn's work reveals two points. First, it shows that, even in the seventeenth century, European elites were aware that the natural environment, especially natural resources, is subject to deterioration and despoliation. Evelyn was concerned in particular about deforestation, the loss of soils, and air pollution.[28] Second, although environmental concerns are evident, sustainability was not really 'about nature' so much as it was about managing natural resources in a way that benefits resource owners (landowners) and the monarchical state (of which the gentry functioned as its main pillar). Evelyn's sustainability agenda was designed to empower the state, and to serve the interests of the state and ruling elites; it was associated with money-making, self-interest and power.

For Evelyn, a Tory modernizer, the ethos of sustainability required the delegation of responsibility for the management of nature-society relations to the state. He was a pioneer of the principle that the state's role is to ensure sustainability, in the sense of regulating the conditions of production in order that capital can appropriate them, while limiting its

[24] Darley 2006, p.182
[25] Evelyn 1664b ONLINE
[26] Evelyn 1664b ONLINE
[27] Evelyn 1664b
[28] In addition to his work on air pollution and deforestation, see John Evelyn, "Discourse on Earth, Mould and Soil" (1675).

excesses.[29] But states are not neutral. They serve some groups at the expense of others. In Evelyn's day, the state was wedded to the interests of the great landowners and merchants—his own milieu. Accordingly, while *Sylva* delegates overarching responsibility for forest management to the state, immediate responsibility — and reward — is accorded the class of great landowners. Evelyn's project is saturated with a perspective on land and natural resources that apprehends them through the lens of ownership and profitability.[30] His aim, in Peter Linebaugh's summary, "was to make an inventory of English trees in terms of their use values, and to convey this knowledge from commoners to commercial, scientific, and military markets."[31]

Evelyn's agenda of top-down sustainability existed in antagonistic relation to common-use rights and local customs of resource management.[32] He favored enclosures (that is, the privatization of land), and sharply criticized the bias of England's laws "in favour of *Custom*" as being "indulgent," a regrettable sop aimed at "the satisfying of a few clamorous, and rude Commoners."[33] In order to "gratifie the quaeries of the honourable the principal officers and commissioners of the Navy" (i.e. to supply more wood for shipbuilding), Evelyn advised that enclosure of woodland "would be an excellent way." But, he warned, "the people, viz. foresters, and borderers, are not generally so civil and reasonable, as might be wished; and therefore to design a solid improvement in such places, his Majesty must assert his power, with a firm and high resolution to reduce these men to their due obedience."[34]

Sustainability, for Evelyn, was above all an imperial mission, and *Sylva* was born of militarism. In the mid-seventeenth century England's admiralty was troubled by a looming shortage of timber. This concern was increasing, but not new—a full century earlier, the government had ordered "an inquiry into timber wastage and deforestation."[35] But from the 1640s onward several developments spurred an unprecedented demand for iron and timber: trade growth and the agricultural revolution (with soaring demand for iron tools), as well as the Cromwellian revolution that precipitated a rapid naval build-up.[36] By the 1660s, some

[29] On this in general, see Razmig Keucheyan (2016) *Nature is a Battlefield: Towards a Political Ecology*, Polity.
[30] Wood 2003; di Muzio 2015
[31] Linebaugh 2008, p.90
[32] Cf. Vicky Albritton and Fredrik Albritton Jonsson (2016) *Green Victorians: The Simple Life in John Ruskin's Lake District*, University of Chicago Press, p.11.
[33] Evelyn, quoted in Wood 1984, p.61
[34] Evelyn 1664b
[35] Cipolla 1977, p.180
[36] Brinley Thomas, quoted in di Muzio 2015, p.72

reports warned that England did not have enough wood to produce the iron required for armaments.[37]

It was in this context that Henry Oldenburg, secretary of the Royal Society, commissioned four experts to look into the timber crisis.[38] One was Evelyn; his response was *Sylva*. It begins with a warning: "There is nothing which seems more fatally to threaten a weakening of this famous and flourishing nation [than the] decay of her wooden walls" — the depletion of the navy's material substance.[39] "Forest culture," accordingly, should be "vigorously encouraged and promoted" in order to ensure "a competent advance of the most useful timber for the building of ships."[40] Landowners must roll up their sleeves, for modern war is total war, fought with ordnance made of wood, and from charcoal-forged iron. "Our forests," Evelyn intones, "are undoubtedly the greatest magazines of the wealth and glory of this nation; and our oaks the truest oracles of its perpetuity and happiness, as being the only support of that navigation which makes us fear'd abroad, and flourish at home."[41]

Evelyn's manifesto for English naval expansion was made at greater length some years later, in *Navigation and Commerce* (1674). It credits England's "flourishing" and its ascendancy "over the rest of the World" to its "glorious, and formidable Navy." Penned as the preface to a projected history of the Dutch wars, the juncture at which England usurped the Netherlands as Europe and the Atlantic's hegemonic power, *Navigation and Commerce* urges England to consolidate its supremacy over the oceans and thereby over the planet as a whole. "A Spirit of Commerce, and strength at Sea to protect it," it argues, "are the most certain marks of the Greatness of Empire," for "whoever Commands the Ocean, Commands the Trade of the World, and whoever Commands the Trade of the World, Commands the Riches of the World, and whoever is Master of That, Commands the World it self." The book is a paean to the conquerors of the Old World — Roman imperialists, and "the Exploits, and glorious Atchievments" of the Crusaders — and of the New World: the Spanish conquistadores, Francis Drake (who "terrif[ied] the whole Ocean, sack'd St. Iago, Domingo, and Cartagena and carried away with him incredible Booty"), and all those hearty European settlers busy with the "Planting of Colonies."[42] Evelyn himself, as an appointed member of the Council of Plantations and Trade, played a prominent role in England's colonial and

[37] For example the Marquis de Seignelay, cited in Tim di Muzio (2015) *Carbon Capitalism: Energy, Social Reproduction and World Order*, Rowman & Littlefield, p.66.
[38] Grober, 2012
[39] Evelyn 1664a ONLINE
[40] Evelyn 1664b ONLINE
[41] Evelyn 1664b ONLINE
[42] Evelyn 1674 ONLINE

commercial expansion.[43] He was keen to ramp up the profitability of England's slave plantations by expanding the area of the Caribbean to be given over to non-native species such as nutmeg, and he cast longing silvicultural eyes toward the forests of New England, where, thanks to abundant biomass energy (and the absence of the undergrowth of common rights, custom and political interest that were proving so refractory in England[44]), numerous iron mills had been constructed. Felicitously, Evelyn's ecological beliefs—notably that deforestation in North America (and in England's other temperate colonies, such as Ireland) was beneficial, making previously "gloomy tracts" healthy and habitable[45]—chimed with his imperialist agenda. To manage England's forests sustainably, given the necessity of naval expansion, required land grabs abroad, and the appropriation of what Jason Moore calls "Cheap Nature"—here, in the shape of New England timber.[46] Evelyn enjoined his countrymen to emigrate to North America, for with their "surfeit of the Woods *which we want*" (for our own iron mills), England's American colonists were well positioned to supply iron to the mother country. This would allow its forests to recover even as its navy expanded, and would, in turn and above all, enable Charles II to become "the great sovereign of the ocean [and] free commerce."[47] The consequences for the sustainability of the colonial forestry barely entered Evelyn's field of vision.[48]

In several ways, this brief survey has shown, Evelyn's sustainability doctrine was lashed to an immeasurably larger social project: English imperialism. Its scientific wing centered on the Royal Society. Together with his good friend (and fellow Royal Society founder) William Petty, Evelyn promoted the idea that England's colonies represented vital sources of raw materials, to be exploited in order to enhance the competitiveness of England's industries and navy.[49] He channeled what one historian has described as the "aggressive will to possess and alter land" which flourished first in England and its settlement colonies and culminated in the globe-transforming land rush of the nineteenth century.[50] In his writings and in his practice as an imperial functionary, Evelyn fashioned

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[43] At the council, "Cold exchanges about slaves, human 'commodities,' as they were termed, traded by the Africa Company like cocoa beans, were minuted dispassionately alongside mundane discussions of premises, duties and appointments and the reports from Jamaica, New England or Surinam" (Darley 2006, p.247).

[44] Grove, Richard (1995) *Green Imperialism: Colonial expansion, tropical island Edens and the origins of environmentalism, 1600-1860*, Cambridge University Press, p.57.

[45] Grove, Richard (1995) *Green Imperialism: Colonial expansion, tropical island Edens and the origins of environmentalism, 1600-1860*, Cambridge University Press, p.58.

[46] Moore 2015; see also Lessenich 2016

[47] Evelyn 1664b ONLINE

[48] In the two centuries after the colonists arrived, North America "lost more woodland than Europe had lost in 1000 years." David Nye quoted in Tim di Muzio (2015, p.88).

[49] Wood 2003, p.85

[50] John Weaver (2003) The Great Land Rush and the Making of the Modern World, 1650-1900, McGill-Queen's University Press, p.43.

links between the conservation of timber in England, its cultivation in colonial settlements ("plantations," in the parlance of the time), the manifest destiny of the English nation, and its monarch as ruler of the waves and champion of commerce.[51]

Thoreau was mistaken. Trees were not the chief end of Evelyn's life. They were a means to an end. And all of this would have profound implications for how the concept of sustainability would take shape in Europe and North America. Since the seventeenth century, sustainability has been tied up with the interests of capital ("sustained profit") and the needs of the state — institutions that continue to stamp their agendas upon environmental theory and practice up to the present day.

**Harmony through Tooth and Claw**

In the temperate and forested lands of England and New England, Mike Davis points out, "energy flows through the environment in a seasoned pattern that varies little from year to year. Geology is generally quiescent, and it's easy to perceive natural powers as orderly and incremental, rarely catastrophic. Frequent rainfall is the principal geomorphic agency, and the landscape seems generally in equilibrium with the vector of forces acting upon it." A conception of nature as essentially harmonious characterized the emerging "imperial" ecological viewpoint — the hub of which in England was the Royal Society — as well as the "Arcadian" view, which was more concerned with the wellbeing of nature. The "canonical evocations" of rural England and New England, the Reverend Gilbert White's *Natural History of Selborne* (1788) and Thoreau's *Walden* (1854), Davis continues, "were microcosmic celebrations of nature's gentle balance (even as Thoreau sounded the tocsin against the potentially catastrophic environmental threat of the industrial revolution)."[52] This gradualist view of the natural process was molded by Charles Lyell "into one of the great dogmas of Victorian science." The earth, in Lyell's conception, appeared and worked much the same in the past as it does in the present. It is a conservative, moderate and orderly system characterized by "slow processes that unfold over time at even, predictable rates."[53] His was

[51] Rogers 2005, p.299
[52] Davis 1998, p.15
[53] Stephen Jay Gould (1988) *Time's Arrow, Time's Cycle: Myth and Metaphor in the Discovery of Geological Time*, Penguin, p.105; (Ghosh 2016, p.26). A related sensibility arose in literature too. The novel facilitated a new kind of "narrative pleasure compatible with the new regularity of bourgeois life," in which the imagined cosmos is rationalized, converted into "a world of few surprises … and no miracles at all." Franco Moretti, quoted in Ghosh 2016, p.25. See also Terry Eagleton (1990) *The Ideology of the Aesthetic*, Blackwell.

a vision, in short, of a world "in constant motion, but always the same in substance and state."[54]

The conception of nature as balanced and self-regulating, Fredrik Albritton Jonsson proposes in *Enlightenment's Frontier,* found itself mirrored in an image of the market economy. Taking inspiration from Isaac Newton's model of a (mostly) self-regulated physical order, and foreshadowed by Evelyn's friends (William Petty) and acquaintances (Dudley North, John Locke) and, a generation later, by Bernard Mandeville and Richard Cantillon,[55] the vision of the market economy as *by nature* balanced and self-regulating reached its apotheosis in the thinkers of the Scottish Enlightenment, and in Joseph Townsend's *Dissertation on the Poor Laws* (1786). For David Hume and Adam Smith and their liberal followers, "nature served as a handmaiden for exchange in a double sense. They looked to the natural world for a model of self-regulating balance that justified their own faith in market exchange. At the same time, they championed the market as the best means of managing the balance of nature." They did not hold up conservation as a strategic necessity and assumed that nature was a cornucopia that could be extensively exploited, without real ramifications, in the progressive state of capital.[56]

The parallels are striking. Conceptions of markets, the sustainability of the natural resources, and the Newtonian idea of the law-bound physical universe were conceived alike as more or less self-regulating and mutually reinforcing "natural" systems that only periodically required some kind of external intervention to reconstitute the proper order — whether that intervention came from God, the state, or an enlightened expert class. Moreover, these ideas were used to reinforce, legitimate, and explain one another.

In this regard, Townsend's work was seminal. He explained the workings of the market economy in terms of natural law, invoking the allegory of goats and dogs on a deserted island to argue that, the suffering of individual goats notwithstanding, when considered from the perspective of the available resources nature's laws of predatory competition result in harmonious equilibrium. In human society, by extension, economic behavior rests upon a biological basis and should be modelled as such: market competition establishes "balance" — notwithstanding the suffering of the poor — in exactly the manner of competition between goats and dogs in an island ecosystem.[57] "It is with the human species," as he put it, "as with all other articles of trade without a premium; the demand will

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54 Stephen Jay Gould (1988) *Time's Arrow, Time's Cycle: Myth and Metaphor in the Discovery of Geological Time*, Penguin, p.105

55 I develop this point in Dale (2015) and (2017).

56 Jonsson 2013, p.3.

57 Townsend (1971 [1786])

regulate the market."[58] Townsend's *Dissertation,* Philipp Lepenies has remarked, was tremendously influential in "fostering a belief in the superiority of self-regulating markets and in warning against outside interference in the market mechanism." Its originality consisted in its argument that it is not human beings but nature that makes markets, with nature governed by atomistic competition and markets behaving according to "natural laws" that "should not be tampered with."[59] In other words, Townsend was a pioneer of *social naturalism*, an approach that assumes the workings of the social order can be boiled down to natural laws.[60]

With Townsend, and still more with Robert Malthus and David Ricardo, a sense emerged of the economy as an institutionally distinct sphere which, though supported by the state, could and should be generally left to its own devices. These authors, Karl Polanyi argues, "established the modern concept of a separate autonomous economic system, governed by economic motives, and subject to the economic principle of formal rationality." In their work the "substantive" aspects of economic life were reduced to "the postulates of population (Malthus) and diminishing returns of the soil (Ricardo)."[61] Malthus, in positing a tendency of population growth to outstrip the available food supply, a conflict that emerges directly from the basic drives of hunger and sex, was attempting to set political economy upon a naturalistic basis. The new conception was of economic behavior as resulting "from the boundlessness of man's wants and needs, or, as it is phrased today, from the fact of scarcity."[62] Ricardo shared this Malthusian perspective and applied it to the theory of differential rent: rent is determined by the differential fertility of units of land and not, as Smith had supposed, by their absolute fertility.[63] For Ricardo, the declining natural fertility of land as the margin of cultivation approaches represented the ultimate barrier to progress. For this reason, one can regard him as a theorist of ecological limits to production.[64] Yet Ricardo's marginalist theory, applied to land valuation, was to be generalized later by neoclassical economists, as I show below, in a process that elided nature as a subject of economic inquiry.

The conception of market exchange founded on a benign natural order, both regarded as models of spontaneous stability and self-regulation, enabled Smith and his successors in the tradition of classical political economy, in the words of Jonsson, to develop

[58] Townsend, in Lepenies 2014, p.451
[59] Lepenies 2014, p.447
[60] Block and Somers 2014, p.228
[61] Karl Polanyi, in Dale *Karl Polanyi: A Life on the Left* (2016). 230
[62] Ibid.
[63] Clarke, 1982
[64] Caradonna, *Sustainability*, 75

"a universal model of growth that could be extended across the British Empire from New Jersey to Bengal." On this assumption, the basic problem of economic development "consisted in mastering the state rather than the natural order."[65] This is one of many examples of Enlightenment thinkers carrying the concept of nature and natural law into other domains of life, subtly making social and economic changes appear as naturally given. It is no coincidence, argues Jonsson, that this universalist vision of nature-economy harmony flourished in a particular agro-climatic regime, of intensive cereal production and animal husbandry in England and Lowland Scotland. That said, this strategic use of nature was controversial and even in these regions it did not go unchallenged. For a "loose constellation of natural historians, agricultural improvers, and conservative landowners, […] the natural order was too complex or fragile to be left unregulated." In Germany, cameralists did not take the stability of natural economies for granted, and focused on vulnerabilities of supply.[66] It was here, in the eighteenth century, that the origins of the term sustainability may be traced, in the concept of sustained-yield forest management, the calibrating of timber harvest to the rate of new growth. In this conception, science, backed by benign regulation, would ensure a judicious balance between biological and economic growth, providing the basis for rising revenues for landowners and a stable order for society.[67]

**The Invention of Scarcity**

It is perhaps no accident that the same period that saw the coining of 'sustainability' [*Nachhaltigkeit*[68]] also saw the advent of sustained economic growth. In Europe, the 'long nineteenth century' was the first to see rapid economic and population growth become the norm. In previous centuries, per capita output growth had crawled along at roughly 0.1 percent per annum; that figure soared in the nineteenth by an order of magnitude. In mid-eighteenth century Britain, when Adam Smith published *Theory of Moral Sentiments,* the notion that continuous "material progress" was possible and desirable was beginning to take hold, and the first treatise that set as its explicit goal the theorization of economic growth was the same author's *Inquiry into the Nature and Causes of the Wealth of Nations*. For the classical economists, growth was perceived as ultimately self-limiting. Capitalist

[65] Fredrik Albritton Jonsson (2013) Enlightenment's Frontier: The Scottish Highlands and the Origins of Environmentalism, Yale UP, p.49
[66] Jonsson 2013, p.3
[67] Worster 2009 [1993], p.137
[68] The English words "sustainability" and "sustainable" only entered the language in the twentieth century. Prior to that, the German term was generally used (or other descriptors of the same concept). Of note, however, is that the first recorded use of "sustainable" was in an economics dictionary of 1965 that used the term "sustainable growth." See Caradonna, *Sustainability*, 7.

economies would follow a parabolic growth rate — it would eventually level out and decline. At the same time, however, they were the first to take growth as a core concern and to theorize its causes. Against older traditions that associated luxury with excess and greed, philosophers such as Hume and Smith reconceived need and desire as "conceptually indistinguishable"; they deemed it impossible "to separate, morally or conceptually, needs and luxuries."[69] Desire was, in a sense, naturalized, and was seen to stimulate demand, which in turn spurs trade and the creation of wealth, further exciting the proliferation of desires. In parallel with this circle of desire ran another (and more potent) one, according to which trade encourages the development of the division of labour, enabling specialization that yields productivity gains and market expansion. This was the engine of self-sustaining growth discussed by Smith in *Wealth of Nations.* That treatise takes growth for granted (in Smith's lexicon, the "progress of opulence"). It does not elaborate a conception of growth as it is understood today — a sustained and potentially infinite increase in per capita income and living standards.[70] Rather, its originality consists in its account of the mutual influence of technical, commercial and moral progress, and their integration into a comprehensive theory of growth. For Smith, economic growth, although not endless, is self-reinforcing in its dynamics, and it is good. In these assumptions, he was followed by Ricardo and Malthus.

There exists a widespread belief that the classical economists concerned with scarcity were growth sceptics, that they pioneered the modern idea of sustainability. Malthus is the classic case. In *Sustainability,* Robert Goodland proposes that "a notion of economic sustainability was firmly embodied in the writings of T. R. Malthus."[71] In *Sustainability*, Kent Portney cites a voluminous literature that traces "the essential seeds of sustainability to ideas put forth by Malthus."[72] In *Sustainability,* Peter Jacques refers to Malthus as "sustainability's Godfather,"[73] while in *Sustainability: A History,* Caradonna credits Malthus with having developed an "ecological" approach to the question of economic growth.[74]

The reason Malthus takes center stage in the history of sustainability is his emphasis on scarcity and the risk of overshoot. Given that the contradictory outcomes of the drives for food and sex ensure that "absolute scarcity" is an inherent feature of human society, there will always be a mass of poor people. By absolute scarcity I refer, following Herman Daly, to a quantitative relationship between the requirements of human beings and available

[69] Lasch 1991, p.52
[70] Friedman 2006, p.47
[71] Goodland (2009 [1995]), p.213
[72] Portney 2015, p.5
[73] Peter Jacques (2015) *Sustainability*, Routledge, 67.
[74] Caradonna, *Sustainability*, 73.

resources, as contrasted with relative scarcity, denoting situations of choice among desired alternatives. Taking the limited availability of land and population pressure as givens, Malthus theorized his version of the law of diminishing returns. As population expands, food production per agricultural laborer tends to decline, bringing starvation to the poor and lower population growth, tendencies that combine to decrease the rate of economic growth. Starvation, alongside war and disease, figure as "positive" checks on population growth, but "preventive" checks (e.g. sexual abstinence) can produce a similar outcome with less suffering.

Malthus' admirers express surprise that his views encounter hostility, and muse that this must be due to the critics' "anthropocentrism" and their subscription to an "ideology of Progress [which] must be indefinite or not at all."[75] Yet, when reading Malthus, one searches in vain for any challenge to anthropocentrism or to the ideology of progress or, for that matter, to the exploitation of the earth's resources. Although he made his name by castigating the utopian perfectionism of radicals, for him the future did not preclude a "gradual and progressive improvement in human society,"[76] and he could "easily conceive" of substantial growth of population and of its welfare.[77] He partook of the consensus of his time and milieu, that humanity was on a path of progress from savagery to civilization; he shared not only Smith and Ricardo's enthusiasm for economic growth but also their assumption that land is nature's "free gift" to capital and their belief that nature's principal function is to furnish raw materials for human consumption (at least by the rich).[78] Although the production of food for a growing population faces constraints in the supply of available land, manufacturing, in Malthus' view, faces no such limitations. The raw materials it requires exist "in great plenty," and as demand grows, the necessary supply is inevitably called forth. Underlying Malthus' economic theory (and Ricardo's too), John Weaver points out, was "an expansionary vision" in which the modernization of land tenure and land taxation would "coax landlords and tenant farmers to make improvements that would produce more," thereby raising living standards and propelling the British state to martial success.[79] Malthus held that a country could cheerfully "go on increasing in riches and population for hundreds, nay, almost thousands of years,"[80] and that the happiness of a country's population depends not on its poverty or wealth, or it sparseness or density, "but

[75] Curry 2011, p.201
[76] Levin 1966, p.104
[77] McNally 1993, p.82
[78] Worster 1994, p.53; Bellamy Foster 2000, p.177
[79] John Weaver (2003) The Great Land Rush and the Making of the Modern World, 1650-1900, McGill-Queen's University Press, p.26.
[80] Malthus 1989 [1803], pp.43, 437

upon the rapidity with which it is increasing, upon the degree in which the yearly increase of food approaches to the yearly increase of an unrestricted population."[81] For Malthus, in the judgment of Giorgios Kallis, population growth "was not a problem, but a goal: a happy nation for Malthus is one that its numbers are increasing as much as possible." Happiness "is the degree to which the population of a country approximates a geometric rate of growth, which for Malthus is the natural rate of growth."[82] Limits were a challenge, to be sure, but one that could be overcome or greatly forestalled.

Like his fellow Anglican (and Surreyite) John Evelyn before him, Malthus justified his political-economic hypotheses with reference to God and natural science. But whereas Evelyn struggled to navigate a path between "religious orthodoxy, which assumes the world to be unique, and progress in science, which suggested to him that there was a multiplicity,"[83] for Malthus the relationship was simple. In his theology, the Supreme Being's cardinal command is that mankind fully cultivate the earth. It was his "fervent belief," observes Don Worster, "that man must obey the command of Jehova to multiply and replenish the land and to achieve mastery over it."[84] The deity-decreed laws of nature operate in fulfilment of this plan. Indeed, the contradiction between population growth and food supply itself betokens the cunning of Providence, for it is ordained by divine-natural law precisely to spur progress. Malthus's view of working people places extraordinary emphasis upon their sloth, which he saw as a regrettable drag on the accumulation of capital, and he railed against measures, such as the poor laws, that risked alleviating poverty thereby lessening the motivation to work among the lower orders. At bottom, Malthus' law of population is a divinely fashioned whip to spur human beings, naturally indolent as they are, to develop civilization.

His preoccupation with scarcity notwithstanding, Malthus was also troubled by abundance, in the restricted sense of the overproduction of goods relative to effective demand. Alongside Simonde de Sismondi, he was an early theorist of underconsumption as a major cause of economic crisis, although, unlike his Swiss contemporary, his proposed remedy consisted in augmenting the spending power of the classes of unproductive consumers — aristocrats, bureaucrats, parsons and their ilk.[85] The power to consume should be withheld from the lower classes in the name of controlling the pressure of population on resources, while the upper classes should consume as heartily as they can in order to sustain

[81] Malthus 1798, quoted in Kallis 2016.
[82] Kallis. 2016.
[83] Darley 2006, p.141
[84] Worster 1994, p.151
[85] Malthus 1836, pp.413-414

aggregate demand. The thrust of Malthus's political economy was unambiguous: the market should function as a disciplinary mechanism to enforce scarcity upon the poor and channel abundance to the rich.

Malthus was writing during the final act of the centuries-long historical drama in Britain that saw a regime of custom, with large tracts of common land, replaced by a regime based on absolute private property. In the countryside around his parsonage, ordinary people were being "literally excluded by fences enclosing the common lands that had sustained them for centuries."[86] Scarcity was being *produced,* in the form of their welfare needs, and it is this that formed the basis of the moral panic whose flames Malthus was so eager to fan. Rather than theorize the construction and distribution of scarcity, he sought instead to naturalize it by locating its cause solely and exclusively in purportedly "natural" facts: the sloth and fertility of working people and the constrained supply of cultivable land. In this way, scarcity came to be seen as the inevitable condition of economic life on which the self-regulating market was based. Remove it and you remove the fear of hunger that spurs the laborers to work and to adhere to Christian prescriptions of thrift and sexual abstinence. Malthus's genius was to conscript the new discovery, scarcity, to his normative and deeply reactionary political program. He did so by postulating it as a force of nature.

Although he chopped and changed his theoretical framework, famously making swingeing revisions to his *Essay,* Malthus stuck doggedly to his core manifesto: inequality is eternal; the distribution of resources should be left to the market; consumption of the poor must never be subsidized by the public purse. Through his position at the East India Company he taught a generation of future administrators of the British Empire about the menace of overpopulation and the futility of charity; they implemented his principles around the empire — in India on a genocidal scale.[87] [[He participated in "the British sanitization of imperial activity, away from the slave-trading and land-grabbing model of new worlds and toward an exploitation that, in contrast, parasitically attached itself to existing populations."[88]]] At home, Malthus provided an economic-liberal apology for free-market capitalism as it was consolidating in early nineteenth century England, and a neo-conservative defense of private property and social inequality as these were facing challenges from 1789-inspired radicalism and nascent socialist and anarchist currents. In opposition to these movements, his arguments served to bolster and reinvent "the elite fashion of identifying the poor's

[86] Boal 2010 ONLINE

[87] Pearce 2000; Mike Davis (2001)

[88] Alison Bashford and Joyce Chaplin (2016) *The New Worlds of Thomas Robert Malthus: Rereading the "Principle of Population"*, Princeton University Press, p.10.

plight as their fate by using mathematics to explain why the killings troubling his society were unavoidable. The oppressed were recast as sacrifices, and those who scapegoated them as upholders of society."[89]

Of particular salience to my argument is that Malthus' approach melded discourses of scarcity, natural law, and the use, distribution and conservation of natural resources. By appealing to the natural "facts" of scarcity and human egotism he sought to yoke the authority of natural science to an otherwise eminently contestable chain of reasoning: that the contradiction between the infinitude of human wants and the limits of the land gives rise to economic life; that individuals invariably seek as large a share of nature's feast as possible, necessitating private property; and that relative valuations differ, leading individuals to exchange on markets, ergo economic activity is to be understood as the striving of individuals to maximize utility by minimizing labour expended and maximizing profit. Markets, private property, and utilitarianism, according to this logic, are ordained by natural law.[90] These arguments translated into policy prescriptions — notably the 1834 Poor Law Amendment — and simultaneously steered the nascent discipline of political economy onto a positivist and utilitarian track. Malthus played a seminal role in elevating scarcity to the axiomatic, naturalized status that it thenceforth enjoyed, in successively modified forms, in the works of John Stuart Mill and, later, in the neoclassical orthodoxy. As the founding father, with Ricardo, of a successful "social movement from above," one that, following its 1834 breakthrough, achieved hegemony and provided the script for a new mode of governance, Malthusian ideas acquired "common sense" status.

With the advent of neoclassical economics, scarcity divided into its absolute and relative forms. As discussed above, the former denotes the actual use or existence of a resource in relation to requirements, the latter refers to the alternative uses of resources in relation to competing wants.[91] This distinction underpins the philosophical and policy differences between the Malthusian and neoclassical traditions. Malthusians emphasize the natural limits of resources, set great store by population control, and tend to a pronounced skepticism toward technological remedies. This is the reading of Malthus that has most influenced the economics of sustainability. For the neoclassical tradition, scarcity plays a role not so much in its methodology and substance but in the definition of the subject matter of economics (the science of resource allocation among competing goals in a situation of scarcity) and as a "legitimizing device for the general application of the technical apparatus

[89] Lohmann 2005, p.95.
[90] Matthaei 1984
[91] Daoud 2010

and formal deductive methods of mainstream economics."[92] Nonetheless, its underlying tone carries an unmistakably Malthusian ring. Common to Malthus and his neoclassical successors are the unquestioned assumptions that scarcity, being the outcome of the contradiction between the infinity of society's wants and the finitude of productive potential at its disposal, is natural, essential to the human condition, and the driver of the economic process. Common to both is the assumption that needs and wants are not socially constructed but "givens," rooted in the hedonism of individual consumers. Malthus held that needs are fixed in human nature, while neoclassical economics, in reducing consumption to a relationship between the abstract "household" and the world of objects, implicitly denies their sociality.[93] By framing scarcity as an inherent characteristic of resources, Adel Daoud (2010) and Steve Rayner (2010) have each argued, Malthus and neoclassical economics alike ignore the social construction of scarcity and the possibility of "states of abundance and sufficiency," and, in so doing, they naturalize the failure of societies to provide for the needs of their populations.[94] Scarcity comes to function as a rationale for inequitable allocation, for the justification of skewed access to control over finite and limited resources, and for the diversion of attention away from causes of poverty and inequality that may implicate powerful groups.[95]

**The Jevons Paradox and the Paradox of Jevons**

For Evelyn and Malthus, as supporters and functionaries of the British Empire, the concern for the sustainability of natural resources was bound up with questions of the provision of land and labour for the imperial machine. In the nineteenth century its supply of resources was amply assured. Thanks to empire and the "imperialism of free trade," Britain's economy was liberated from reliance on the produce of its own fields and forests.[96] As the economist William Jevons put it in 1866, "the plains of North America and Russia are our cornfields; Chicago and Odessa are our granaries; Canada and the Baltic are our timber forests, Australia contains our sheep farms, and in Argentina and on the western prairies of North America are our herds of oxen; Peru sends her silver, and the gold of South Africa and Australia flows to London; the Hindus and the Chinese grow tea for us, and our coffee,

[92] Fine 2010, p.81
[93] Matthaei 1984
[94] Adel Daoud (2010) and Steve Rayner (2010)
[95] Mehta 2010
[96] Gallagher and Robinson 1953

sugar and spice plantations are all in the Indies. Spain and France are our vineyards, and the Mediterranean our fruit garden."[97] A century before the term "ghost acres" was coined, Jevons had its sense clearly in mind.

Worried by the prospect of British imperial decline, Jevons undertook an investigation of its energy basis: coal. His *The Coal Question* has been characterized as "an extended exercise in Malthusian projection."[98] He adapted Malthus' method vis-à-vis population to resource use in general. Jevons' *Coal Question* represented the culmination of what Albritton Jonsson describes as a debate between "catastrophists" and "cornucopians," inspired by the new realities of sustained economic growth and fossil-fueled machine production.[99] Was industrialism a solid and lasting phase of history in which technological ingenuity would overcome all obstacles, or a precarious moment, heavily reliant on a diminishing resource? The latter perspective was articulated, already in 1789, by a Welsh mining engineer, John Williams. He announced the beginning of peak coal—a forecast, notes Jonsson, that was remarkable "for its precocious recognition of the centrality of mineral energy to the British economy," and for its catastrophic predictions.[100] Coal's exhaustion would bring an end to Britain's "prosperity and glory." Britain's towns would become "ruinous heaps for want of fuel," its factories would fail and its trade flows would dry up. Its inhabitants would be forced to live, "like its first inhabitants, by fishing and hunting."[101] Government action to sustain the nation's coal reserves, Williams, concluded, was imperative. Jevons expanded upon this idea and used extensive economic data to show that the fossil-fueled good times could not last forever.

On the "cornucopian" side of the debate there was for example the physician and inventor Erasmus Darwin. His *Economy of Vegetation* (1791) saluted "the revolutionary potential of coal" while *The Temple of Nature* (1803) celebrated humanity's capacity to create a new artificial world and imagined Britain's landscapes transformed, "with hydraulically engineered rivers and teeming cities filled with vast skyscrapers."[102] But the high priests of machine fetishism were Charles Babbage and Andrew Ure, as well as the Scottish economist John Ramsay McCulloch. Machinery has overwhelmingly beneficial effects, argued McCulloch in 1821, for its introduction in one sector "necessarily occasions an equal or

[97] Jevons, in Hardin 1995, p.134
[98] Mayhew 2014, p.135
[99] Jonsson, (2013).
[100] Ibid, p.167. Compare Adam Smith's *Wealth of Nations*, published only a decade earlier, which was blind to the importance of fossil fuels.
[101] Ibid, p.174).
[102] Jonsson 2014, p.161

greater demand for the disengaged labourers" in another.[103] His *Principles of Political Economy* (1825) declared that "there are no limits to the bounty of nature in manufactures," and that the nation's coal stocks of the nation were "inexhaustible."[104] Another significant figure was a government commissioner, John Leifchild. His *Our Coal and Our Coal-Pits; the People in them, and the Scenes Around them* begins with a comparison of coal with gold. The author relishes the assonance of the two words, their contrasting symbolism and their shared connotation with wealth. Yet if one is "the apparent representative of the country's wealth, the other [is] its real representative," and whereas hordes of prospectors are lured by gold all over the world, "the true gold diggings are at home" — in Durham, Fife, and Yorkshire. "The true source of wealth," in short, "is coal."[105] It is indispensable for "civilized communities." It supplies the steam power that spins the wheels and moves locomotives. It gives Britain "incalculable commercial advantages," underpinning "our prosperity as a nation, and possibly our supremacy." If it were ever to run out, future historians of empire "would date the decline and fall of the vast dominion of Britain from the period when her supplies of mineral fuel were exhausted and her last coal-field worked out!" But that dreadful vision, Leifchild (1853) hazards — against the catastrophists —, will surely not arrive for a millennium or more.

This was the debate into which Jevons intervened. In 1863 he penned a tract on gold that presents the element as "one of the last things which can be considered wealth," and two years later published his anxiety-wracked paean to coal. *The Coal Question* (1865) hails the black stuff as "the mainspring of modern material civilization, […] a Promethean gift" that his fellow Britons had bestowed upon the world. He voices concern that the depletion of its coal supplies will lead to Britain's industrial decline and consequent loss of imperial dominance, and deploys Malthusian metaphors in proposing that "geometric" increases in population and the constraints on output growth would result from "arithmetic" increases in food supply and diminishing returns on investment.[106] The equation on which the book rests is that the geometric growth of population and industry will run into the buffers of "a fixed amount of material resources."[107] Of course, writing during an epoch of rapid growth, Jevons (1865) recognized the degree to which the Malthusian equation could be stretched. In contrast to the agricultural produce that was Malthus' subject, "the new applications of coal are of an unlimited character," and this had enabled the "unchecked course of discovery and

[103] McCulloch, in Tribe 1981, p.118.
[104] McCulloch, in Jonsson, 2014, p.163
[105] Leifchild 1853, pp.11-24.
[106] Peart 1996, p.33.
[107] Jevons 1865.

growth" in the use of coal.[108] Jevons conceded that although "continuous multiplication" — he is referring to population, manufacturing output and trade — "is seldom long possible, owing to the material limits of subsistence, […] up to the present time our growth is unchecked by any such limits, and is proceeding at uniform or rising rates of multiplication." Indeed, "the rate of multiplication is in recent years many times as great as during preceding centuries." However, this growth will inevitably hit the buffers of resource limits. "We cannot long maintain our present rate of increase of consumption," Jevons concluded. Within a century, "the check to our progress" will become perceptible.[109] This argument about the limits of fossil fuels is one of the main reasons that Jevons is still cited approvingly by sustainability economists. He prefigured theories of energy security and resource exhaustion, including the question of peak oil. In extending Malthus' 'geometric vs arithmetic' model to energy sources and raw materials, Jevons developed an approach that was to re-surface in the 1970s under the rubric 'limits to growth.'

The other reason he is still remembered is for the paradox that bears his name. One seemingly obvious solution for coping with the finitude of resources would be to effect improvements in the efficiency of steam engines and furnaces -- surely this would lead to a reduction in the rate of depletion. Paradoxically, however, the opposite occurs. After James Watt introduced his coal-fired steam engine, an improvement upon Newcomen's earlier design, Britain's coal consumption soared. Watt's innovation made coal a more cost-effective energy source, and this helped pave the way to steam.[110] As the steam engine was adopted in a broader range of industries, this increased total coal consumption even as the quantity of coal required for any particular application decreased. Efficiency improvements, Jevons observed, tend to increase overall fuel use. It was "the very economy" of the use of coal that led to its more rapid consumption. "To see how this paradox arises" was simple.

> If the quantity of coal used in a blast-furnace be diminished in comparison with the yield, the profits of the trade will increase, new capital will be attracted, the price of pig-iron will fall, but the demand for it increase; and eventually the greater number of furnaces will more than make up for the diminished consumption of each. And if such is not always the result within a single branch, it must be remembered that the progress of any branch of

[108] Ibid, ONLINE
[109] Ibid, ONLINE
[110] For other factors, see Malm 2016.

> manufacture excites a new activity in most other branches, and leads indirectly, if not directly, to increased inroads upon our seams of coal.[111]

Rapid growth in the use of coal, Jevons warned, would lead to the need to dig deeper mines and extract poorer quality coal. And unlike land, which, under pressure to feed a growing population, may "continue to yield for ever a constant crop," a coal mine, "once pushed to the utmost will soon begin to fail and sink towards zero."[112] This, then, was the Jevons paradox: it is a fallacy to believe "that the economical use of fuel is equivalent to diminished consumption. The very contrary is the truth … No one must suppose that coal thus saved is spared – it is only saved from one use to be employed in others."[113]

What practical conclusions did Jevons draw? He initially considers alternatives to coal, but dismisses them as equally subject to depletion (such as oil) or relatively inefficient, such as solar (the use of which he predicted), wind, water and tidal power. A conversion to renewable sources would leave Britain unable "to compete with nations enjoying yet undiminished stores" of fossil fuels. This left the inevitability of industrial and imperial decline, for "the cost of fuel must rise, perhaps within a lifetime, to a rate injurious to our commercial and manufacturing supremacy; and the conclusion is inevitable, that our present happy progressive condition is a thing of limited duration."[114] Realistically, therefore, the only alternatives were to allow industrial growth to proceed apace, only to see it decline rapidly at a later date, or to reduce its growth in the present in order to string out the inevitable demise. Jevons preferred the former, for, "in fearlessly following our instincts of rapid growth we may rear a fabric of varied civilization, we may develop talents and virtues, and propagate influences which could not have resulted from slow restricted growth however prolonged."[115]

For ecological economics, the Jevons paradox has proved important in furthering an understanding of the parallel trends toward greater energy efficiency and energy consumption. The paradox highlights the absurdity of relying on technological efficiency improvements alone as a pathway to a sustainable society -- in a capitalist framework, technological improvements tend to increase the rate of overall throughput, because relative unit costs are lowered, freeing up capital for alternative uses. The real paradox, however, is that Jevons sought to lock society into structures that are susceptible to his paradox. Not

[111] Jevons 1865, ONLINE
[112] Ibid, ONLINE
[113] Ibid, ONLINE
[114] Ibid., ONLINE
[115] Ibid., ONLINE

only did he contribute to the fetishism of coal, with his claim that it could not be replaced as an energy source by oil or renewables, but his concern with resources was purely with their extraction and not at all with ecological sustainability. He showed no concern for

> the environmental problems associated with the exhaustion of energy reserves. He even failed to address the air, land, and water pollution that accompanied coal production. … Indeed, there was in Jevons no concern for nature as such. He simply assumed that the mass disruption and degradation of the earth was a natural process.[116]

Nowhere did he seek to explain the drive for accumulation, focusing only on its promethean consequences. His framework was thus ill-equipped, argue Foster, Clark and York, "to deal concretely with issues of accumulation and economic growth."[117] Increases in population, manufacturing industry and the demand for coal were all, in his view, simply the product of a Malthus-style "Natural Law of Social Growth." Viewing capitalism as a natural phenomenon, "he could find no explanation for continuously increasing economic demand, other than to point to individual behavior, Malthusian demographics, and the price mechanism."[118] Hence he was unable to situate his paradox as the product of a specific economic system, one that tends systemically to increase the throughput of energy and natural resources on the macro scale, even as technological innovation improves efficiency at the micro scale.

Jevons' paradox remains a valuable insight. But the other Jevons paradox is equally significant for the history of sustainability. His concern for resource depletion, and even his awareness of the limitations of efficiency improvements, meant little or nothing, from an ecological vantage point, given the system of competitive accumulation in which he invested his undying faith. This same paradox remains central to the institutionally most significant variant of the sustainability discourse, sustainable development. Ever since the 1980s, when it gained support from the United Nations, sustainable development policies have sought to limit pollution and the exploitation and degradation of nature, but on the basis of

[116] Bellamy Foster, Clark, and York 2010, ONLINE
[117] Ibid., ONLINE
[118] Ibid., ONLINE

underlying socio-economic relations and mechanisms that ensure their continuation at unsustainable levels.[119]

**The Elision of Nature and the Naturalization of Growth**

In the late nineteenth century, economic theory underwent a transformation and a division. The transformation was in value theory, and in a redefinition of the scope of economics as the hypothetical behavior of rational individuals in conditions of scarcity. The new value theory held "marginal utility," rather than cost of production (as Smith had it), to be the determinant of exchange value. The utility theory of value had been adumbrated by earlier theorists, such as Jeremy Bentham and his friend Joseph Townsend (as a matter of record, the first individual to be called a utilitarian), and also by Malthus and Jean-Baptiste Say. To this, Jevons and his contemporaries added the notion of diminishing marginal utility. According to this concept, as Ismael Hossein-Zadeh explains, "the utility derived from the use or consumption of a commodity diminishes with every additional unit consumed." Although Jevons' addition of the idea of marginal utility to the received utility theory of value was simple and straightforward, "it nonetheless proved to be instrumentally a very important notion in neoclassical economics. For, the term 'marginal' was soon extended to other economic categories such as marginal cost, marginal revenue, marginal propensity to consume, and the like; thereby paving the way for the application of differential calculus to economics. By introducing the notion of marginalism into utilitarian economics, Jevons had found a way in which the utilitarian view of human beings as rational, calculating maximizers could be put into mathematical terms."[120]

The new understanding of the scope of economics jettisoned the classical economists' concern with social structure, and generalized Malthus' concern with scarcity into a methodological principle. The division was in method, such that two aspects of the method of the classical economists were taken in different directions, one toward "hard science," the other toward inductive social science. The classical economists had been ambivalent in their disciplinary self-definition. Adam Smith and John Stuart Mill, for example, attempted to put political economy on a scientific footing, yet regarded it as inextricable from the other social sciences and from ethics. In the late nineteenth-century divide in economics, one branch, institutionalist economics, followed the "morals" and "politics" path. The other direction

[119] See the essays in Iris Borowy and Matthias Schmelzer, *History of the Future of Economic Growth: Historical Roots of Current Debates on Sustainable Degrowth* (Routledge, 2017).
[120] Ismael Hossein-zadeh 2014 ONLINE

was taken by marginalism, which branched into the neoclassical and Austrian traditions. The neoclassical tradition in particular modelled the newly reconstituted discipline upon natural science. Whereas earlier economists, notably the physiocrats, had regarded economics as the physiology of society, neoclassical economists tended to see the world "as a smoothly functioning machine," one that could be adequately modelled with mathematical equations.[121] It is no coincidence that Jevons and the French economist Léon Walras, both of whom developed marginal value, were originally trained as natural scientists. Jevons likened the notion of value in economics to that of energy in mechanics, and depicted marginal utility as analogous to gravitational force. He envisaged the mind of the economic agent as balancing the forces of pleasure and pain, so that exchange could be depicted as a balance, "using the analogy of a lever in equilibrium."[122] Walras maintained that "the pure theory of economics is a science which resembles the physic-mathematical sciences in every respect."[123] Carl Menger, although averse to the mathematicization of his discipline, nonetheless conceived of economics as dealing in definite laws, those that condition the economic activity of human beings and which are "entirely independent of human will."[124] The inspiration from natural science lay not with its subject matter (the material world), but with its methods, and especially the relationship between the presumed rational agent and the objective natural world. As Phillip Mirowski has shown, the neoclassical economists invoked physical conservation principles (of matter, of energy) "to argue that physical science dictated that production did not really exist in a physical sense, thus absolving the new economics from having to deal with the questions of material production processes that had so occupied the classical economists."[125] Thus Jevons, in *Principles of Economics,* proposed that although "we speak familiarly of creating wealth" this expression means only that we create "utility."[126] The same point is echoed in Alfred Marshall's influential textbook of the same name:

> Man cannot create material things. In the mental and moral world indeed he may produce new ideas; but when he is said to produce material things, he really only produces utilities; or in other words, his efforts and sacrifices result in changing the form or arrangement of matter to adapt it better for the

[121] Ormerod 1994, p.45.
[122] White 1994, p.205.
[123] in Mirowski 1989, pp.217-18.
[124] Menger 1950, p.48.
[125] Mirowski 1989, p.289.
[126] Jevons, 1905 [1882 ONLINE

> satisfaction of wants. All that he can do in the physical world is either to readjust matter so as to make it more useful, as when he makes a log of wood into a table; or to put it in the way of being made more useful by nature, as when he puts seed where the forces of nature will make it burst out into life.[127]

Unlike the classical economists, who brought the production of wealth as well as its distribution (and, correspondingly, social structure) into the frame, the subject for marginalism is exchange alone. The natural world does not have any meaning or value in this system and, in a sense, market capitalism is merely one of many natural phenomena in which humans participate. It is in markets that human beings express their desires, and markets, in the absence of deliberate human intervention, automatically produce the most efficient outcomes. Marginalist economics in this sense is the disciplinary avatar of pure exchange value. Its practitioners abstract the analysis of exchange relations from the concrete character and conditions of production of the commodities whose price movements they model, from the historically specific relations of production and from the institutional matrix that they entail, revealing an interplay of economic forces that are homogenous, reversible, and quantitatively unlimited. Indeed, they saw this as their scientific accomplishment.

The vantage point of marginalism is the aggregate decisions of individual consumers, each making rational economizing decisions in a situation of scarcity. Whereas Smith, whose concern was with the creation of wealth in terms of the production of goods, conceived of labour as the source of value, Menger, by contrast,

> is concerned with the issue of maximizing satisfaction, so he looks for the natural foundation of exchange not in terms of labor or of natural propensities, but rather in the calculation people make, in a context of scarcity and individual property, that they would rather have something that someone else has than all or part of something in their own possession.[128]

In these ways, Nicholas Xenos argues, neoclassical economics systematized the scarcity postulate -- it "discovered what the eighteenth century had invented: a universal

[127] Alfred Marshall, *Principles of Economics*, 1890, ONLINE
[128] Xenos 1989, p.73.

condition of scarcity."[129] The tendency to what has recently become known as "economics imperialism" is inscribed within this. Neoclassical economics appears to restrict its scope by limiting it to scarcity situations, but in reality "it expects, in Menger's version, that more and more goods will enter the realm of scarcity (and hence become economic) through a constant growth in human needs. As civilization advances, therefore, scarcity situations will become generalized, and along with it the applicability of economic science."[130]

With the partial exception of Jevons, whose theory of value was pedigree marginalism but whose theory of production was classical (centered on dynamics of population and natural resources, their limits, and the eventual decline of growth), the marginalists shifted the focus of economics further away from the causes and consequences of growth and from society's interaction with nature. Following its subjectivist re-theorization, value found itself abstracted from labour and from nature. Surplus value disappeared from view, through the attribution of the entire revenue to productive factors, according to their marginal productivity. Natural resources, likewise, were elided, by means of new categories such as "decreasing marginal utility and productivity, and by denying 'that they are a different factor from capital' at all."[131] Once elided, nature was then reintroduced into economics, not as its basis but merely as an issue area, with its appropriate sub-discipline, environmental economics.[132]

The relevance of marginalism to questions of sustainability lies not only in the elision of nature but also in the naturalization of economic growth. Relative to their classical forebears, marginalist economists paid scant attention to economic change. Insofar as they did, it was assumed to be gradual, non-disruptive and equilibrating. Following Say, they conflated wealth with exchange value and took the clearing of markets as a given, obliterating at a stroke both the role of nature in the process of wealth production and the problem of economic crisis. The categories they introduced, such as decreasing marginal utility, served to assimilate natural resources to the category of capital.[133] Rather than theorize the causes and conditions of economic growth, they developed a static general equilibrium analysis of the allocation of factors of production — how a given quantity of resources can be allocated most efficiently among individual consumers and firms.[134] With

[129] Ibid., p.69.
[130] Ibid., p.71.
[131] Koch 2011, p.18.
[132] Richard Lane (2014) 'The nature of growth: The postwar history of the economy, energy and the environment,' D.Phil. thesis, University of Sussex; John Barry (2012) *The Politics of Actually Existing Unsustainability: Human Flourishing in a Climate-Change, Carbon-Constrained World*, OUP, p.143.
[133] Koch 2011.
[134] Ormerod 1994, p.42.

regard to policy, the assumption was that economic efficiency, and by extension economic growth, would be promoted by leaving business to its own devices. Hardly a line, Heinz Arndt has suggested, "is to be found in the writings of any professional economists between 1870 and 1940 in support of economic growth as a policy objective."[135]

Yet if mainstream economists in the late nineteenth century paid little overt attention to explaining economic growth, and many were inclined to criticize growth-oriented industrial policy, it would be erroneous to assume that they did not contribute to the development of the growth paradigm. Indeed, crucially for our purposes, some of the economists who have had the biggest impact on the history of sustainability economics, notably Jevons, were as much part of this paradigm-formation as anyone. In doing so, these economists made three assumptions. First, they took growth as a given, as the natural end of a market economy, and championed the proposal that it is not merely wealth but, in Jevons' phrase, "*growing* wealth that makes a happy and prosperous country."[136] Second, they redefined economic activity as an essentially quantitative field. In this, Jevons was the pioneer. It would not be a travesty of his economic theory to summarize it as "Bentham + mathematics." Essentially, Jevons holds that *all* economic decisions can be reduced to expressions of pleasure seeking and pain aversion, i.e. utility and disutility (with labour assumed to be pain, and consumption assumed to be pleasure). Thus reduced to a utility spectrum, economic behavior is rendered quantifiable and subject to treatment as mathematical formulae. "Being concerned with quantities," as Jevons put it, economics is necessarily "mathematical in its subject."[137] His *Theory of Political Economy* was the first English text that "discussed all prices in terms of 'the laws of supply and demand' and explained all economic actions in terms of marginal utility, using the calculus and geometry."[138] Third, they contributed to the ideological affirmation of capitalism, the social system of which the growth paradigm is an organic ideological accompaniment.[139] They "naturalized" capitalism, conceiving it as the telos of human nature: capitalist norms and institutions manifest the imputed behavior of the rational individual, and therefore represent the "end of history." Their insistence that the market be left to its own devices provided sanction for the growth imperative. In their understanding, economic growth, once initiated, becomes "automatic and all-pervasive, spreading among nations and

[135] Arndt 1978, p.13.
[136] Jevons 1865, ONLINE
[137] Jevons (1866), ONLINE
[138] White 1994, p.197; See Jevons, (1871)
[139] Gareth Dale 2012.

trickling down among classes."[140] Paradoxically therefore, some of the most influential thinkers whose work has been appropriated by the modern sustainability movement were central figures in justifying the very growth-based, unfettered, industrial capitalism that seemingly elicited the sustainability movement in the first place.

## Conclusion

The centuries under discussion in this chapter witnessed a transformation in society's understanding of nature. God was gently elbowed aside by natural science, and the natural world was re-imagined as a law-governed realm. Stupendous intellectual advances were achieved — from Newton's physics and Linnaeus's taxonomy to Watt's steam engine and a thousand other technological inventions. These same centuries also saw the rise of capitalism, centered in North-West Europe and its colonial and post-colonial appendages, accompanied by a set of inter-related ideological moves: the theorization of "the economy" as a distinct, law-governed sphere, the justification of "self-interest" and the burial of earlier suspicions of avarice, the conceptualization of both nature and the market economy as essentially balanced and benign, the justification of capital accumulation and the delegation to the state of responsibility for its management and for the suppression of its excesses, and the justification of colonial expansion by reference to the colonizers' superior ability to "improve" the soil (with improvement often understood as short-term yield and monetary profit).

The period 1650 to 1900 also witnessed the development of a discourse on sustainability, and it becomes clear that this concept is more in line with the intellectual and imperial developments of the period than is often supposed. Although the world of sustainability today is complex and contested, the roots of the concept and the movement lie with thinkers who were concerned principally with industrial and colonial expansion, the wellbeing of the state and social elites, and "the economy" as a law-governed mechanism. "As odd and unsavory as it may seem," in Caradonna's words, "sustainability traces its roots primarily to imperialists who cared *very little* about nature or social justice and *very much* about state power, industrialization, and profit."[141] Indeed, sustainability emerged from the same cultural milieu that viewed markets, akin to the physical universe, as a law-

[140] Nugent and Yotopoulos, quoted in Hettne 1983, 248.
[141] Caradonna, *Sustainability*, 45. For an alternative slant, see Richard Grove *Green Imperialism.*

bound sphere. In a sense, the concern for nature has increased in recent decades, but "dealing with nature" to ensure growth and economic might is altogether consistent with the concerns of Evelyn, Carlowitz, Malthus, Jevons, and many others in the pantheon of sustainability.

The naturalism of such political economists as Malthus or Ricardo has led some to suppose that they were ecologically minded. But, as I have argued in this chapter, nothing could be further from the truth. They used scarcity, limits, and diminishing returns to naturalize the prevailing economic system, and to edge nature out of the subject matter of economics, a process that reached its apotheosis with the marginalist revolution of the late nineteenth century. Resources such as fuels or soils were a concern, but the economic system they favored was about not ecological sustainability but sustained wealth creation.

Thanks in part to fossil fuels and the ghost acres of the colonies, and to the application of science to processes of production, a sharp increase in output per worker was achieved. One consequence was a rapid increase in pollution — both visible (soot, etc.) and invisible (the first significant and "sustained" signs of anthropogenic global warming can be dated to the mid nineteenth century[142]), which spurred a variety of forms of nineteenth-century environmentalism (above all, aristocratic anti-industrialism). Another consequence was concern for resource depletion. Paradoxically, as Jonsson puts it, "the fear of limits emerged precisely at the moment when Enlightenment ideology and industrialization began to make sustained economic growth imaginable."[143] This was particularly so in the nineteenth century. It saw an increasing concern with resource scarcity, and with scarcity per se. Yet, in the same moment, the natural world was evacuated from the discipline of economics. The apotheosis of this process was neoclassical economics, with its myth of the infinite substitutability of resource inputs. And yet, as this chapter has demonstrated, this myth was not born in the late nineteenth century. It had a pre-history. It was foreshadowed in the work of earlier economic theorists, notably Malthus and Ricardo, and indeed in the utilitarianism of that seventeenth-century so-called theorist of sustainability, John Evelyn. He envisaged nature as a utilitarian commodity, to be managed for the common good, understood as landowners' power and English empire.

Sustainable development and green growth, the attempts to manage the natural realm in a manner compatible with an economic system governed by the imperative of capital accumulation, have a centuries-long pre-history. "All that is new in the Brundtland

142 Worland 2016
143 Jonsson 2013, p.4

Report" and many other similar documents, as Don Worster puts it, "is that they have extended the idea *to the entire globe.* Now it is Planet Earth, not merely a beech forest, that is to be managed by trained minds, an eco-technocratic elite."[144]

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144 Don Worster (2009 [1993]), p.139

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