DOOMED?
ENTROPY, ECOLOGY, AND LIVING WITH INTEGRITY

John Daniels

TEMPLE ETHICAL FUTURES

William Temple Foundation

Doomed? Entropy, Ecology and Living with Integrity

John Daniels

Temple Ethical Futures: Book 5

Sign up for our free newsletter at williamtemplefoundation.org.uk

Follow us on Twitter @WTempleFdn

Cover image from OpenVerse

Author

Rev’d Prebendary Dr John Daniels is an Anglican priest, currently living in Ludlow, Shropshire. Until recently he served as Local Ministry Officer and Warden of Readers in the Diocese of Hereford, and he continues to teach as an associate tutor with Cuddesdon: Gloucester and Hereford. Long ago, before ordination, he completed a PhD in Earth Sciences and these days his interests lie in exploring points of mutual illumination between theology and thermodynamics, ecology and complexity theory.

Editors' Introduction

In this Temple Tract, the author expands on the contemporary significance of two fundamental biophysical principles, namely the Maximum Entropy Production Principle and the Maximum Power Principle.

During the age of cheap, plentiful fossil fuels these have underpinned human societies' tendency to deplete resources and produce accumulating wastes at ever-increasing rates. As a result the human species has overshot the long-term carrying capacity of the planet. Applying the adaptive cycle, a concept originating in the field of ecological research and widely applied elsewhere, to this phenomenon leads to the conclusion that the inevitable consequence will be a simplification or collapse of the prevailing order, either spontaneous or planned. However the study of ecological systems shows that simplification need not mean terminal disaster. Here another notion is borrowed from the field of ecology, that of the integrity of a system, or its identity across time. Over time, all systems pass through stages of growth, consolidation, simplification and re-organisation; the question is, will the system maintain an integrity, or identity, across these changes? And, if so, which identity?

The Tract ends with a reflection on our current predicament based on Paul Ricoeur's conception of narrative identity as promise-keeping. According to which story should we understand this predicament? By which notion of integrity should we now look to live? How does it relate to the Christian Gospel, and in particular the idea of a God who reveals himself as one who makes and keeps promises?

Ryan Haecker, Series Editor

Contents

Introduction

Change and decay in all around I see;
O thou who changest not, abide with me.

Sung at every FA Cup final since 1927, *Abide with me* also remains a favourite hymn at funerals for obvious reasons. Its writer, Henry Francis Lyte (1793-1847), was himself dying of tuberculosis when he wrote these words. They articulate memorably that sense of inevitable degeneration which we sometimes have about the world around us and, as the years pass, about our own bodily lives too. When we read in Romans 8 about creation's subjection to futility and bondage to decay, we know intuitively what St Paul is on about. Private Frazer of *Dad's Army* put it succinctly: "we're doomed".

For the scientist and the engineer this all boils down to the Second Law of Thermodynamics: any energy transformation process in an isolated system must result in a decrease in the energy available for doing useful work. In other words, every time energy changes form we end up a little nearer thermodynamic equilibrium and, at equilibrium, no further useful work is possible. Although, according to the First Law of Thermodynamics, the total *quantity* of energy is always conserved, the *quality* of energy, in terms of its capacity to do useful work, can greatly vary. The highest quality energy is the most ordered, and so has the greatest useful work capacity. That is why the Second Law is often expressed in shorthand form as 'entropy must always increase', where 'entropy' simply means disordered (or useless) energy.[1]

Entropy must always increase. But is that the whole story? *Pace* Lyte, Frazer and even St Paul, if it were then entropy would have triumphed long ago, and we wouldn't be around to lament its progress. The point is that the Second Law, as expressed above, applies to *isolated* systems only, whereas the Earth system, of which we are a part, is far from isolated in this sense. The contrast between the intense heat of the sun and the intense cold of outer space keeps us far, far from thermodynamic equilibrium; and, far from equilibrium, the principles underlying the Second Law lead to very different outcomes – decay and death, certainly, but life and growth too.

However it also turns out that, in regions like this, far from equilibrium, systems will tend towards steady states in which the rate at which entropy is produced, or order destroyed, is highest. This is the Maximum Entropy Production Principle (MEPP),[2] and it would seem to pose a major problem for a world where ecosystems have been brought to the brink of collapse as a result of ballooning entropy production by human beings. If the key to ecological sustainability is the reduction of human impact on the planet, then surely *reducing* energy consumption – and so entropy production – is essential. But, on the face of it, the MEPP, a law of nature, seems to condemn us to just the opposite. Doomed after all, therefore?

This tract is an exploration of this awful possibility. In Chapter One I shall discuss the MEPP more fully alongside the Maximum Power Principle, deriving from the field of biology, which also turns out to have a bearing on these matters. In Chapter Two I shall move to ecology and a discussion of the adaptive cycle of exploitation, conservation, release and reorganisation in ecosystems, comparing this with the life-cycle in organisms. This provides a basis for asking whether human

1 See Victor Court, 'Energy capture, technological change and economic growth: an evolutionary perspective', *Biophysical Economics and Resource Quality 3* (2018), pp. 1-27.

2 There is debate as to whether the MEPP should be considered a far-from-equilibrium manifestation of the Second Law or a separate law in its own right. See Jian D.L. Yen et al, 'Thermodynamic extremization principles and their relevance to ecology', *Austral Ecology 39* (2014), pp. 619–632; Rod Swenson, 'Autocatakinetics, evolution, and the Law of Maximum Entropy Production: a principled foundation towards the study of human ecology', *Advances in Human Ecology 6* (1997), pp. 1-47.

societies are best understood as superorganisms, and for introducing the notion of ecosystemic integrity. In Chapter Three I shall give attention to the integrity-defining stories by which humans live, considering two very different narratives which propose diverging attitudes towards where we stand with regard to the adaptive cycle of the human-dominated global ecosystem at this point in time. Finally, in the Conclusion, I shall offer some theological reflections on the main themes which have emerged, along with a response to the simple question: are we doomed?

Chapter One:
A World of Extremes

Henry Francis Lyte got it half right. Our world, though very much characterised by change, is by no means in thrall to decay. Or, rather, while some organisms and ecosystems are decaying, others are simultaneously springing up to take their place. But is there a pattern, a rhythm to this bittersweet ebb and flow? Ecologists have found that indeed there is. In fact there are several, closely interwoven, which together describe the evolution of living systems. These patterns can best be seen as a set of extremes, and two of the most fundamental will be described here.

The first to be identified was the Maximum Power Principle (MPP), expounded by Alfred Lotka in the early 1920s.[3] This states that evolution favours those organisms which harness energy flows to do useful work at the fastest rate. Let us define our terms. Energy, here, is simply the ability to cause change, or to do work. And since power, in turn, is defined as the time-rate at which work is done, Lotka's principle can also be expressed as: evolution favours the most powerful. Unsurprising perhaps, stated thus, but by no means trivial.

However, whenever work is done not all the energy consumed can be put to effective use by the organism or machine involved. This is because all work involves overcoming some kind of resistance, such that some energy is inevitably lost, or wasted, ultimately as heat. So, when work is done, the total energy consumed is always the sum of (a) the energy actually involved in performing useful work and (b) the energy wasted. Moreover, the ratio of wasted energy to total energy consumed increases in proportion to the rate at which work is done; that is, faster work rates tend to be associated with greater inefficiencies.

Thus, in any given system, optimal power production will lie at some point intermediate between zero and the highest possible work rate for that system. As every driver knows, a car will initially accelerate rapidly as the engine rev rate increases from zero. But beyond a certain optimal rev count the ability of the engine to accelerate further starts to decline, even though you put your foot to the floor: the rev counter will continue to climb, the car will continue to accelerate, but ever more slowly. More and more energy is being expended, but less and less of that additional energy is performing useful work in moving the car.

How one drives will therefore tend to reflect the size of one's fuel budget: if money is no object I can cheerfully zoom around with my foot to the floor; but if I'm counting the pennies I won't exceed the optimal, that is, the most fuel-efficient, speed. Likewise, in – and only in - a competitive environment of constrained energy resources, evolution will favour those organisms which can tap that energy most efficiently - the equivalent of driving at the optimal speed. Whereas, when energy is plentiful, efficiency is irrelevant and evolution will favour those organisms which can tap gross energy at the fastest rate – the equivalent of putting your foot to the floor. The MPP captures both of these conditions. As Lotka put it, evolution "proceeds in such direction as to make the total energy flux through the system a maximum compatible with the constraints".[4]

Whether used to perform useful work or simply wasted, all the energy tapped by a system ends up in some relatively degraded, disordered form. This dissipated energy may be broadly termed entropy. Physicist and engineer Hans Ziegler's seminal work in the 1960s gave rise to another

3 Alfred Lotka, 'Contribution to the energetics of evolution', *Proceedings of the National Academy of Sciences 8* (1922), pp. 147-151. See also Enrico Sciubba, 'What did Lotka really say? A critical reassessment of the "maximum power principle"', *Ecological Modelling 222* (2011), pp. 1347-1353.

4 Lotka, p.149.

fundamental principle, one describing the rate of such total dissipation: 'thermodynamic processes in far-from-equilibrium conditions tend towards steady states at which they dissipate energy and produce entropy at the maximum possible rate'. This Maximum Entropy Production Principle (MEPP) has been variously derived and named by several authors independently, and has been shown to apply in a variety of contexts – climatology, oceanography, biology, etc.[5] In fact the MEPP has been postulated to apply to all natural systems, both biotic and abiotic, which operate in steady states far from thermodynamic equilibrium, including what theoretical biologist Stanley Salthe terms *ecosocial systems*, that is, ecosystems dominated by human activity.[6]

The implications of the MEPP are momentous. It asserts that, whether we like it or not, it is a law of nature that, while they remain far from equilibrium, systems will tend towards steady states which degrade energy, and so produce entropy, fastest, regardless of how much, or how little, of that energy is expended in doing useful work. Life itself can even be defined as a means of optimising entropy production. Axel Kleidon describes life in these terms:

> the means to transform many aspects of planet Earth to states even further away from thermodynamic equilibrium than is possible by purely abiotic means. In this perspective pockets of low-entropy life emerge from the overall trend of the Earth system to increase the entropy of the universe at the fastest possible rate.[7]

On this understanding, life is made up of highly ordered, low entropy structures, the price nature pays *locally* in order to increase the *overall* rate of entropy production in the universe;[8] just as, though it will cost me in fuel to drive to the out-of-town superstore to do my shopping, because prices are so much cheaper there, overall, I'll still end up better off.

So you and I are entropy machines. Are we then not doomed? Doomed to convert useful fuel into useless waste, and so produce entropy, at the fastest possible rate? And not only doomed, but also the unconscious architects of our doom, and that of our world?

Were the universe an isolated system then yes, you could certainly argue that. But it isn't. In the words of Stanley Salthe, "the universe is way out of equilibrium and getting even more so all the time".[9] Ultimately this is because the universe is expanding, as it has been ever since the Big Bang. And this expansion shows no signs of slowing down – to the contrary, the expansion is accelerating.[10] This means that, on the macro-scale, the universe is departing further and further from thermodynamic equilibrium.

As entropy machine and as expression of the MEPP, life can therefore be seen as nature's rather modest attempt to restore the balance. Yet, provided the dark energy causing universal acceleration continues to exert the influence it does today, there is no danger that life's task will ever come close to completion.[11]

However closer to home, within the confines of planet Earth, the local situation is currently rather different. As we will see further in the next chapter, our ecosocial system has lately organised itself

---

5 See Court, 'Energy capture, technological change and economic growth: an evolutionary perspective', pp.7-8 for an overview. Note that the MEPP does not apply in transient or near-equilibrium conditions.

6 Stanley N. Salthe, 'Infodynamics, a developmental framework for ecology/economics', *Conservation Ecology 7* (2003) *3,* http://www.consecol.org/vol7/iss3/art3

7 Axel Kleidon, 'Life, hierarchy, and the thermodynamic machinery of planet Earth', *Physics of Life Reviews 7* (2010), pp. 424–460.

8 Eric D. Schneider and James K. Kay, 'Life as a manifestation of the second law of thermodynamics', *Mathematical and Computer Modelling 19 (*1992), pp. 25-48.

9 Salthe, 'Infodynamics'.

10 Tamara Davis, 'Relax, the expansion of the universe is still accelerating'. (2016) https://theconversation.com/relax-the-expansion-of-the-universe-is-still-accelerating-6769 [accessed 11 February 2023]

11 Ichiro Aoki, 'Entropy Principle for the evolution of living systems and the universe - from bacteria to the universe', *Journal of the Physical Society of Japan 87* (2018). https://www.researchgate.net/publication/328290681

so as to dissipate a particular, finite set of exceptionally low-entropy fuels, and so produce a set of intermediate entropy wastes which tend to accumulate within the finite immediate terrestrial environment. The analogy of driving a car is again useful: if I put my foot to the floor I will get to my destination more quickly than if I'd been in less of a hurry. I will also run down the tank more quickly, since fuel will be injected into the engine at a faster rate than the machinery can process, so that the excess, unburned fuel will simply get expelled through the exhaust pipe along with the various combustion products – that is, the unburned fuel does not produce useful work but is instead simply wasted. The difference is that, for the Earth system as a whole, there is no exhaust pipe. Instead, we end up having to live with the wastes we produce.

All this is because, in a resource-rich environment, evolution, as per the MPP, has favoured activities which optimise the *rate* at which these low-entropy energy sources are degraded, rather than the *thoroughness*, or efficiency, of that degradation.[12] Such is the combined effect of the MEPP and the MPP when resources are plentiful.

Our current ecosocial system, then, tends to behave rather like a boy-racer who has just passed his driving test. As Alfred Lotka noted a century ago, in a resource-rich environment evolution, via the MPP, will favour those organisms which can harness energy at the fastest rate, however inefficiently. As resources become increasingly scarce, evolution will generally start to favour more efficient processes. But our ecosocial system is different. Efficiencies will not suffice to compensate for the exhaustion of finite, non-renewable resources. Neither will they necessarily deal with the problem of accumulating, intermediate entropy wastes: the universe may be expanding, but the current human-configured Earth system is not, which presents a problem.

Clearly, something must be done. But what, exactly? In a world governed by the MEPP and MPP, can a deliberate, pre-emptive decision to transition to a lower entropy production regime work? Won't attempts to do so get out-competed in the short term by recalcitrant sections of global society which continue to put their foot to the floor and so drag the rest of us down with them? There are reasons to fear that, like it or not, we are locked into a pattern of development which can only lead to a single, uncongenial destination.

The next chapter will explore this urgent question further by looking at patterns of development in ecosystems and organisms in order to see whether hope is possible for our ecosocial system after all – and if so, what kind of hope.

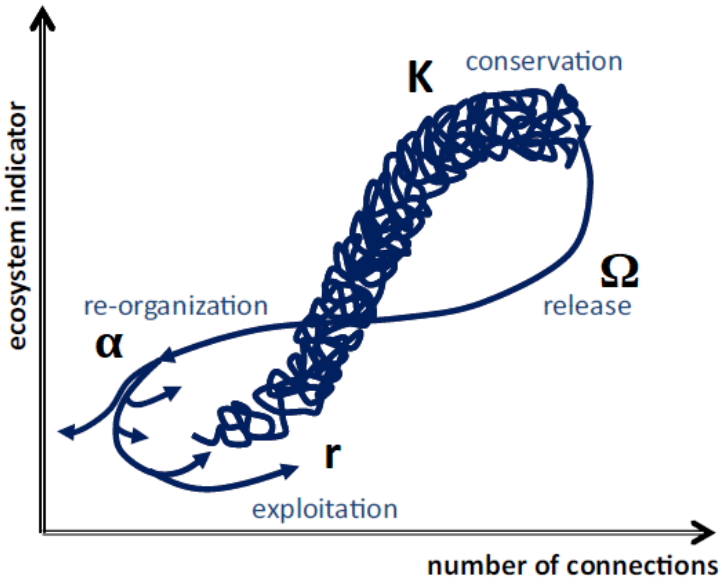
12 Salthe, 'Infodynamics'.

Chapter Two:
Adapt – or Die

The year 2019 witnessed the death of arguably the most influential ecologist of his generation: C.S. Holling, or 'Buzz', as he was more commonly known.[13] Credited with introducing into ecology the idea of 'resilience', the capacity of a system to 'bounce back' when disturbed, Holling's defining contribution was possibly the idea of the adaptive cycle of ecosystem development.

Based originally on fieldwork observations of spruce budworm outbreaks in the coniferous forests of the Pacific north-west, Holling proposed that ecosystems in general exhibit cycles consisting of four developmental stages: exploitation, conservation, release (or collapse) and reorganisation.[14]

This 'lazy eight' pattern has been taken up, adapted and applied extensively within and beyond the field of ecology. A modified version is reproduced in the following diagram, which stylistically illustrates how the values of various ecosystem indicators such as usable energy storage and biodiversity vary in relation to the total number of internal and external connections pertaining to that system.[15]



The background to Holling's work was an earlier conception of ecological succession which related the number of individuals in a population to the rate of population growth (r) and the carrying capacity of the environment (K).[16] At immature stages, systems are dominated by small, fast-growing species - so-called r-strategists, while later, at the climax stage of development when systems have reached their carrying capacities, they become dominated by relatively large, slow-

13 Stephen R. Carpenter and Garry D. Peterson, 'C.S. 'Buzz' Holling, 6 December 1930 – 16 August 2019' in *Nature Sustainability* 2 (2019), pp 997-998.

14 C.S. Holling, 'The resilience of terrestrial ecosystems: local surprise and global change' in *Sustainable Development of the Biosphere*, W.C. Clark & R.E. Munn, eds (Cambridge: Cambridge University Press, 1986), pp 292–317.

15 Benjamin Burkhard, Brian D. Fath and Felix Müller, 'Adapting the adaptive cycle: hypotheses on the development of ecosystem properties and services', *Ecological Modelling* 222 (2011), pp 2878-2890.

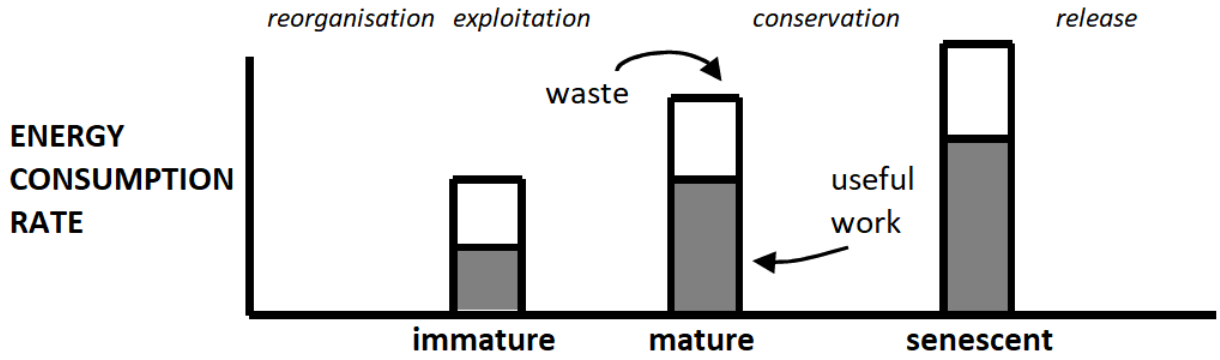
16 Key contributions here include those of Pierre-FrançoisVerhulst (1804-1849) and F.E. Clements (1874-1945).

growing species – so-called K-strategists. During this development process the number and intricacy of connections increases, as do interdependencies between system components.

Holling qualified this simple trajectory by positing that since all ecosystems are prone to disruptions, both exogenous and endogenous, some of these will eventually precipitate a relatively rapid system simplification, or collapse, during which connections between components are lost. This is the release, or Ω, phase. Eventually the disconnected components will begin to re-connect and the process of system development starts afresh – the reorganisation, or α, phase. Note the left-pointing arrow in the diagram at this point: this represents how, depending on contingent circumstances, reorganisation may lead to the development of a wholly different ecosystem configuration instead of the recapitulation of the previous one.

Inevitably, the Maximum Power and Maximum Entropy Production Principles mentioned in the previous chapter are very much at play during this process. When resources are plentiful relative to the number of individuals, competition between individuals will favour those which can access resources (however inefficiently), and so grow, at the fastest rate, i.e. r-strategists. However as a system approaches its carrying capacity, competition will favour those which can tap increasingly scarce resources most efficiently, i.e. K-strategists.

Thus as a system grows and develops the overall rate of energy consumption, and so entropy production, increases (MEPP), while at each point along this trajectory the rate at which energy is harnessed to perform useful work is maximised relative to the resource base available at that point, as Lotka proposed (MPP). This amounts to an increase in metabolic efficiency (i.e. the ratio of useful work to waste) as the system matures, and is illustrated in the following diagram.[17]



Holling's work on the adaptive cycle therefore suggests that there is a sense in which all ecosystems are doomed, if only temporarily: eventually a large enough perturbation will come along which overcomes the system's resilience, pushing it beyond conservation into release. Indeed, any attempts to artificially extend the conservation, or climax, phase must prove self-defeating:

> Because systems are moving constantly through adaptive cycles on numerous linked temporal and spatial scales, every conservation phase will ultimately end. The longer a system remains in the conservation phase (or is kept artificially there by management measures, e.g., by nature conservation or subsidies paid for certain economies), the smaller are the external or internal shocks needed to end this phase and to initiate a release phase.[18]

17 Adapted from Stanley N. Salthe, 'The Natural Philosophy of Work', *Entropy 9* (2007), pp. 83-99.
18 Burkhard et al, 'Adapting the adaptive cycle', p. 2879.

Ecosystem - or Organism?

So much for ecosystems. But does something akin to the adaptive cycle hold for organisms too? On the face of it, ecosystems and organisms differ in several ways. An organism captures, stores and mobilises energy in a remarkably coordinated and efficient manner in order to maintain a degree of homeostatic stability unknown among ecosystems. This stability confers a distinct, well-defined identity upon it. And unlike the components of an ecosystem, the components of an organism cannot live independently but rather only as organs (from the Greek *organon*, 'tool') with highly specific functions. In fact the organ exists only in order to serve the organism of which it is a part.[19] The most consequential difference, however, is simply this: an ecosystem may adapt indefinitely, but all organisms eventually die. This is the price the organism pays for possessing a distinct identity: it can only depart so far from a homeostatic trajectory without ceasing to function altogether.

Despite these differences, ecologists have persistently sought to explore points of functional continuity between ecosystems and organisms. The position of some early ecologists, who viewed ecosystems as putative organisms, has long since fallen out of favour, this perspective having even been inverted by certain more recent figures such as Stanley Salthe, who has suggested that organisms be viewed instead as a subset of ecosystems.[20]

Even so, is there a point at which an ecosystem of individuals may be considered effectively as an organic whole which subsumes the identities of its constituent parts? Shifting the discussion from organisms and ecosystems in general to human collectives in particular, John Gowdy and Lisi Krall have radicalised this question by interpreting post-Neolithic revolution human societies as superorganisms.[21] In this respect, they argue, humans have much more in common with other ultrasocial animals such as ants and termites than they have with their fellow primates.

Gowdy and Krall here draw on an earlier definition of an ultrasocial collective as a highly integrated social whole characterised by full-time division of labour (in particular, specialists who gather no food but who are fed by others), information sharing regarding food and danger, and a self-sacrificial attitude towards collective defence. Invariably, the results of ultrasociality are hierarchical social organisation, explosive population growth, ecosystem domination and the surplus-orientated exploitation of natural resources.

To the extent that our ecosocial system functions as a superorganism, is there a risk that, like any organism, its days are numbered? Gowdy and Krall think so. The human superorganism, they insist, is jeopardising the entire terrestrial ecosystem:

> We are in the grip of an impersonal self-organising system within which [individual] humans and essential elements of the natural world are expendable… Unless we can figure out how to dismantle the superorganism, human society seems destined to crash or end up in a Brave New World dystopia.[22]

For others, however, the problem with our current ecosocial system is that it is not sufficiently organismic. In her prolific writings, the late Mae-Wan Ho drew on the thermodynamics of the organism as a model for a sustainable ecosocial system. What makes the organism special is its highly developed capacity to capture and store useful energy under conditions of overall energy flow. An organism, she explains, is "full of cycles", that is, countless nested cycles which span multiple space- and time-scales. From the viewpoint of faster cycles, slower cycles function as stored energy. Consequently, energy release occurs in a cascade of tiny steps which, as such, are

19 Evelyn Fox Keller, 'Ecosystems, organisms, and machines', *Bioscience 55 (*2005), pp. 1069-74.
20 Salthe, 'Infodynamics'.
21 John Gowdy and Lisi Krall, 'The ultrasocial origin of the Anthropocene', *Ecological Economics 95* (2013), pp. 137-147.
22 Gowdy and Krall, 'The ultrasocial origin of the Anthropocene', pp. 145-6.

highly efficient. This amounts to an internal hierarchy of locally near-equilibrium regimes which are nonetheless, overall, far from equilibrium with the environment in which the organism is set.[23] In this way the MEPP is obeyed at the macro-level, but does not apply at the near-equilibrium micro-level.

The key to achieving a sustainable and growing economy is to reproduce such a nested dynamical system on a societal scale, Ho argues. She cites the traditional farming practices of the Pearl River delta in south-east China as an example of this, in which much of the waste from one agricultural cycle becomes a resource for another in a gradual trickle-down between trophic levels. Moreover, "[t]he more cycles incorporated, the more energy and standing biomass are stored within the system, the greater the productivity of the farm and more farmers and farm workers supported".[24]

In stark contrast, says Ho, our existing global system operates more like a hurricane (or the boy racer referred to in the previous chapter), lacking the closed cycles required to retain resources and maintain durable ecosocial structures. This is a consequence of the rate at which resources are consumed relative to the rate at which the non-human environment can process and recycle the wastes produced. The point here is that although both organisms and hurricanes obey the MEPP (as they must), hurricanes – and our fossil-fuel society – demonstrate how "the hastier the work, the less complete the dissipation".[25] And herein lies our dilemma, since, as Brian D. Fath writes,

> Structure that is created off one-time injections of energy will not be sustainable. On the output side, the unwanted by-products (wastes) generated by the system processes cannot accumulate in a way that interferes with future functioning of the system. In ecosystems this is usually accomplished by linking processes such that the output from one becomes a useful feedstock, or input, to another. Through this constant recycling, material resources do not accumulate in a deleterious fashion. Already, one can see the obvious failings of current human society in terms of sustainability. Our energy sources are largely coming from non-renewable fossil fuels and the large quantities of uncoupled and unprocessed wastes cause impacts ranging from eutrophication, acid deposition, climate change, ocean acidification, and photochemical smog, to name a few.[26]

In other words, since the Industrial Revolution ecosocial systems have grown rapidly, but under two serious constraints. On the input side, initially plentiful fuel supplies are, ultimately, limited. On the output side, large amounts of relatively high grade wastes are produced. Since these often cannot be easily degraded further they constitute pollution of various kinds, accumulating in the environment and inhibiting the function of the ecosocial systems which produced them.

Considerations like these are summarised in the notion of the Ecological Footprint, which is the equivalent amount of land needed to both produce the resources consumed by a region and absorb the waste products of that consumption. Relative to the actual biocapacity of the Earth, it appears that since 1970 the human population as a whole has been in ecological overshoot, living beyond its means.[27]

So is our ecosocial system best seen as an all-consuming superorganism? Or is it not organismic enough in its mode of operation? Looked at through the lens of the adaptive cycle, a few brief comments can be offered.

---

23 Mae-Wan Ho and Robert E. Ulanowicz, 'Sustainable systems as organisms?', *Biosystems 82* (2005), pp. 39-51.

24 Mae-Wan Ho, 'Circular thermodynamics of organisms and sustainable systems', *Systems 1* (2013), pp. 30-49.

25 Stanley N. Salthe, 'Maximum Power and Maximum Entropy Production: finalities in nature', *Cosmos and History 6* (2010), pp. 114-121.

26 Brian D. Fath, 'Systems ecology, energy networks, and a path to sustainability', *International Journal of Design & Nature and Ecodynamics 12* (2017), pp. 1-15.

27 Ecological Footprint Network, https://data.footprintnetwork.org/#/countryTrends?cn=5001&type=BCtot,EFCtot [accessed 3 March 2022]

While Gowdy and Krall argue plausibly that both agrarian and fossil-fuelled societies share the common imperative of surplus production, they fail to acknowledge the extent to which agrarian societies operate within a relatively fixed energy budget determined by the rate of incidence of solar radiation as mediated via various physical and biological processes. Agrarian societies therefore typically inhabit the conservation (K-) phase of the adaptive cycle, living as efficiently as possible on the edge of what can be achieved within the energy budgets enabled by contemporary technology.

Fossil-fuel societies by contrast are better understood as exploitation (r-) phase phenomena, since the total energy flux accessed by the human population has increased by an order of magnitude since 1800.[28] In such a resource-rich environment the MPP will select for those configurations which can harness energy at the fastest rate, however inefficiently. By extension it will also select for those configurations which can adapt most readily to changing circumstances and new exploitation opportunities. This includes flexibility regarding social and occupational roles, which is an arrangement quite at odds with the settled dispensations typical of both agrarian societies and termite colonies.

Ho's organismic vision of a sustainable future, by contrast, arguably amounts to a K-phase, neo-agrarian society. While there is no doubt much to be said in its favour, it too cannot evade the effects of thermodynamic extremisation conditions. Although more ecologically sustainable than fossil-fuel societies, agrarian societies too are subject to disruption and (partial) collapse – consider, for example, a series of poor harvests. As noted above, in contrast to ecosystems, all organisms eventually die. The more developed a system becomes, the more intricately its parts interwoven, the more brittle it becomes and vulnerable to collapse.[29] Nothing lasts forever. Some cycles simply last much longer than others and so give the impression of permanence from the viewpoint of more rapid cycles. This phenomenon, as we have seen, is basic to Ho's description of the nested thermodynamics of the organism. And while actual organisms strive to reproduce prior to inevitable death, it is not clear what reproduction would mean for Ho's idealised organismic society.

Health – or integrity?

At this point we do well to note the distinction between an ecosystem's health and its integrity. Ecologists commonly talk in terms of the health of an ecosystem, despite that term originally denoting the absence of disease in an organism. An example of an ecosystem which would commonly be considered unhealthy is one in which eutrophication has set in, that is an over-enrichment issuing in the reduction of biodiversity. Though 'unhealthy', such a system can nonetheless be relatively stable, functioning well enough on its own terms for some time. The concept of *integrity* is intended to capture what is missing here, and offers a necessary complement to that of health in assessing the status of systems which follow the logic of Holling's adaptive cycle:

> Ecosystem health mostly addresses how well the system is functioning at the present moment. Integrity [however] applies to a broader time horizon and includes the ability of the system to deal with unforeseen circumstances in the future. Integrity encompasses a system's entire trajectory of past and future configurations. The direction in which a system is headed (its telos) is not only an integral element of its integrity, it can also impart a legitimacy to ethical considerations of how society should interact with the system.[30]

Integrity, then, relates to "a system's entire trajectory of past and future configurations", its identity across time. To be meaningful, this must refer to some normative, that is, historically-specific,

28 Marina Fischer-Kowalski and Helmut Haberl, 'Social metabolism: a metrics for biophysical growth and degrowth' in J. Martinez-Alier and R. Muradian, eds, *Handbook of Ecological Economics* (Cheltenham: Edward Elgar, 2015), pp. 100-138.

29 Joseph A. Tainter, 'Social complexity and sustainability', *Ecological Complexity 3* (2006), pp. 91-103.

30 Robert E. Ulanowicz, *Ecology, the Ascendent Perspective* (Chichester: Columbia University Press, 1997), p. 126.

range of variations.[31] Such a range can scarcely be specified on narrowly scientific grounds, but rather presupposes a culturally-informed perspective, that is, one informed by a particular ethical position.[32] In other words, the notion of integrity only makes sense when applied to specifically ecosocial systems.

Some would take this to imply that the *telos* of the terrestrial ecosystem lies simply in the utility which non-human entities and processes happen to afford human beings – the 'ecosystem services' which they provide.[33] This notion at least has the virtue of cohering with the insights of Holling and others whereby we "must conclude that there is no ecologically 'better' state within an entire ecosystem",[34] and also with the realisation that, in any event, abandoning 'nature' to a human-free, arcadian idyll is a pipe-dream. From such a frankly anthropocentric viewpoint, the non-human world exists merely to serve the contingent, and largely economic, interests of (some) humans.

Unsurprisingly, others have questioned the adequacy of the political and ethical assumptions inherent in the very idea of ecosystem services.[35] Some might even go so far as to claim that human domination since the Neolithic and, more urgently, the Industrial Revolutions, amounts to an eutrophication episode of inevitably limited duration. Regardless, posing the question of ecosystemic integrity entails the further question of the *telos* of the ecosocial enterprise as a whole.

If integrity has to do with identity across time, one way of understanding this is by means of narrative categories, specifically what Paul Ricoeur described as *ipse* (selfhood)-identity as opposed to mere *idem* (sameness)-identity.[36] The *ipse*-self does not imply a fixed or unchanging identity but rather one which is inherently temporal and relational. Integrity, or self-constancy, then becomes a matter of remaining true to oneself and to others even as one changes in other respects, establishing **an identity which transcends time by keeping one's word, by fulfilling promises**. Integrity as virtue is bound up with notions of responsibility and accountability, and so with the roles which humans, both individually and collectively, find themselves called to play.[37]

Living with integrity as the human components of an ecosocial system would therefore mean being true to one's prior commitments as implied by one's role within that system. Consequently 'making room for nature' can mean neither the arbitrary manipulation of, nor a simple retreat from, the non-human. The question rather becomes: what *is* the human role, and what commitments follow from that role? The answers will depend on the larger narrative according to which human identity is understood, and I will return to this in the next chapter.

Relevantly, the language of narrative, of finding the right story, seems to be becoming more and more prominent in accounts of how we chart a future for our ecosocial system. For example, in a substantial, multi-disciplinary appraisal of our current predicament, N.J. Hagens writes:

> [J]ust as we discovered that we live in a heliocentric world, and that we evolved, we now begin to see that we are part of a biologically emergent Superorganism which is de-facto eating the planet. If we figure that out, what new pathways might it open up? Our biology is

31 Thus, in global perspective, the Holocene epoch has been proposed as providing one such normative range of variation; see Peter Bridgewater et al, 'Ecological Integrity: a relevant concept for international environmental law in the Anthropocene?', *Yearbook of International Environmental Law 25* (2015), pp. 61–78.

32 As argued in effect by Yasha Rohwer and Emma Marris, 'Ecosystem integrity is neither real nor valuable', *Conservation Science and Practice* (2021). https://doi.org/10.1111/csp2.411

33 Robert Costanza et al, 'Twenty years of ecosystem services: how far have we come and how far do we still need to go?', *Ecosystem Services 28* (2017), pp. 1-16.

34 E.J.S. Hearnshaw, R. Cullen and K.F.D. Hughey, 'Ecosystem health demystified: an ecological concept determined by economic means' in *Proceedings of the Economics and Environment Network Conference 4–6 May 2005* (Canberra: Australian National University, 2005). http://een.anu.edu.au/progpap.html

35 Vijay Kolinjivadi, 'Avoiding dualisms in ecological economics: towards a dialectically-informed understanding of co-produced socionatures', *Ecological Economics 163* (2019), pp. 32-41.

36 Paul Ricoeur, *Oneself as Another* (London: University of Chicago Press, 1992).

37 Ricoeur, *Oneself as Another*, p.165.

> not going to change – but our culture and our economic system could. How will we use the coming financial/energy recalibration to move towards a slower, wiser, less damaging system? What sorts of responses would be beneficial? What sort of new stories do we need?[38]

Regardless of whether we find the superorganism metaphor helpful, Hagens's observation regarding the contrast between the immutability of our biology on the one hand and the relative plasticity of our cultural identities on the other is very pertinent. We need a story about ourselves, about what it means to live with integrity as parts of an ecosocial whole, at this seemingly critical juncture. In the next chapter I will set out two very different possible stories by which we might seek to live, and offer a preliminary Christian reflection on these.

38 N.J. Hagens, 'Economics for the future – beyond the superorganism', *Ecological Economics 169* (2020). https://doi.org/10.1016/j.ecolecon.2019.106520

Chapter Three:
Living with Integrity

In the last chapter we noted how, according to Holling's adaptive cycle, an ecosystem – and, by extension, an ecosocial system - is always in a process of becoming. How then are we to judge whether any given change represents a change for the better or for the worse?

This is where the notion of integrity comes in. Integrity is a system's overall defining trajectory, and whether or not a given change is consistent with the integrity of a system will depend on the choice of narrative framework by which the system is understood.

So in what does the integrity of our ecosocial system consist? In this chapter I want to consider two very different narratives which project two very different *teloi*.

A Good Anthropocene

"As human beings and social animals, we are storytelling creatures".[39] So begin the World Economic Forum's Klaus Schwab and Thierry Malleret in their recent *The Great Narrative: For a Better Future*. The book in fact draws on a 'constellation' of narratives deriving from interviews with fifty of 'the world's foremost global thinkers and opinion makers', arranged so as to 'coalesce around one central story'. What are the main elements of this story?

Technology is the central theme, the authors going so far as to describe it as "our greatest hope". The environmental and social challenges which confront us at this juncture are considerable, but the speed of technological progress is such that solutions are readily forthcoming.

Net zero greenhouse gas emissions by 2050, as required by the Intergovernmental Panel on Climate Change in order to stand a better than 66% chance of global mean temperatures remaining within 1.5ºC of pre-industrial levels, are within reach thanks to continuing advances in renewable energy technologies, combined with the deployment of carbon capture, usage and storage facilities during the fossil fuel phase-out period.

Indeed, sustainability is presented as the new route to success in business. Nature is no longer to be seen as a burdensome externality but rather as an economic asset and a "prominent investment theme".[40] According to the authors, more than half of global GDP depends on nature or, more specifically, the services it provides. This underlies the exhilarating grand narrative of a "big new future" centred on green growth, "successful, equitable and profitable", all the while remaining within "the safe operating space of a stable planet".[41]

And what does a happy ending look like, according to this story? Those familiar with Schwab's earlier writings will not be surprised to discover a frankly transhumanistic goal: the fusion of the physical, biological and digital domains in a Fourth Industrial Revolution which is already beginning to bring about fundamental changes in human identity. The field of synthetic biology, a prime example of this revolution, is currently "awash with capital and ideas", while other prominent

39 Klaus Schwab and Thierry Malleret, *The Great Narrative: For a Better Future* (Geneva: WEF, 2022), p.8.
40 Schwab and Malleret, *The Great Narrative*, p. 89.
41 Johan Rockström, quoted in Schwab and Malleret, *The Great Narrative*, p. 39.

components include artificial intelligence, the internet of things (and of bodies), the 5G network and groundbreaking new materials such as graphene.[42]

While Schwab and Malleret concede significant risks associated with these developments, theirs is a basically cheerful account, a kind of ecomodernism in which high-tech sunlit uplands stretch ahead as far as the eye can see. But is such a vision of endless progress compatible with the adaptive cycle described in the previous chapter? Implicit in this great narrative is a denial of limits to human economic expansion whereas, as we have seen, a central idea in ecology is that every system has a finite carrying capacity. Commenting on various ecomodernist responses to the ecological crisis, Armin Grunwald notes a common 'growth of limits' premise, that is, the assumption that human ingenuity will always find a way of effectively expanding the Earth's biophysical carrying capacity: was Malthus not proved wrong long ago?[43] Schwab and Malleret's explicit faith in technology as "our greatest hope" illustrates this perfectly.

Other ecomodernist accounts are equally sanguine about our present ecosocial trajectory: consider the Breakthrough Institute's *An Ecomodernist Manifesto,* which asserts that any fixed boundaries to human consumption "are so theoretical as to be functionally irrelevant".[44] Solar radiation incident on the Earth exceeds human energy demand by orders of magnitude, while 'proper management' means that we need never run out of agricultural land to feed a still growing population. *Accelerating* technological change is what's needed, further intensifying resource acquisition in certain areas while simultaneously radically decoupling human activity from dependence on other ecosystems, so as to permit a residual, unexploited non-human world. As Grunwald observes, such a 'good Anthropocene' envisages a re-pristinised 'nature' juxtaposed alongside an artificial human technosphere – a vision wholly compatible, one imagines, with the transhumanistic fruits of Schwab's Fourth Industrial Revolution.

Avoiding a Ghastly Future

Needless to say, not all narrations of our future trajectory are so optimistic. For example, a group of seventeen concerned scientists published a 2021 paper entitled 'Underestimating the Challenges of Avoiding a Ghastly Future' in which they state that the "scale of the threats to the biosphere and all its lifeforms - including humanity - is in fact so great that it is difficult to grasp for even well-informed experts", and lament "the lack of appreciation of the enormous challenges to creating a sustainable future".[45]

The same year also saw the publication of a particularly forthright and contentious argument for a radical change of direction in order that a ghastly future be avoided. In 'Through the Eye of a Needle: An Eco-Heterodox Perspective on the Renewable Energy Transition', Megan Seibert and William Rees concur with Schwab and Malleret at least in this, that human beings are natural storytellers. But there the agreement stops. For, they point out, even when told by scientists and other experts, such stories need not be anchored in reality. Specifically, the story according to which the ecological crisis can be solved by means of technology alone "is little more than a disastrous shared illusion".[46]

---

42 Schwab and Malleret, *The Great Narrative*, pp. 128-132.

43 Armin Grunwald, 'Diverging pathways to overcoming the environmental crisis: a critique of ecomodernism from a technology assessment perspective', *Journal of Cleaner Production* (2016), doi: 10.1016/j.jclepro.2016.07.212

44 John Asafu-Adjaye et al, *An Ecomodernist Manifesto* (2015). https://thebreakthrough.org/manifesto/manifesto-english [accessed 11 February 2023]

45 Corey J.A. Bradshaw et al, 'Underestimating the challenges of avoiding a ghastly future'. *Frontiers in Conservation Science* 1:615419 (2021). https://doi.org/10.3389/fcosc.2020.615419

46 Megan K. Seibert and William E. Rees, 'Through the eye of a needle: an eco-heterodox perspective on the renewable energy transition'. *Energies 14* (2021), 4508. https://doi.org/10.3390/en14154508

According to this viewpoint, techno-optimists like Schwab and Malleret and the authors of *An Ecomodernist Manifesto* make a basic error in assuming that the core challenge facing humanity is anthropogenic climate change. In fact, the problem is much broader and deeper: ecological overshoot. As we saw in the last chapter, this term, deriving from the Ecological Footprint analysis of which Rees was a pioneer, refers to how the overall consumption demands placed on the ecosphere by humans exceed the ecosphere's ability to (re-)generate the required resources and to absorb the waste products of that consumption.[47]

Overshoot has been enabled by the strictly *temporary* availability of certain forms of 'natural capital', most particularly fossil fuels. Renewable energy cannot provide adequate substitutes, since although the energy sources are in themselves relatively abundant and either periodic or quasi-continuous (sun and wind), the technologies required to capture and utilise them are not renewable. Specifically, renewable energy technologies depend on finite metal and mineral resources; resource extraction and processing is typically ecologically damaging and associated with poor working conditions; and the electrification of the entire economy, presupposed by ecomodernists, is replete with still daunting, if not insoluble, technical challenges. In Paul Ricoeur's terms, during the hey-day of cheap, plentiful natural resources we made promises to ourselves based on the assumption that this cornucopia would last forever. If it turns out that those assumptions are false then the promises lapse and our very identity, our *ipse*-self, as moderns collapses with them.

If technology won't suffice to save us, then what will? Seibert and Rees urge that our best hope involves "a managed contraction of the human enterprise… [with] many fewer people consuming far less energy and material resources than at present". This in turn "will require a paradigmatic shift in society's socially constructed values, beliefs and assumptions" – in other words, the articulation of a different story by which to live. A truly sustainable society will involve a return to a largely agrarian pattern of life, but even this will only be viable for a human population much smaller than that of today – as few as one billion, perhaps, just one-eighth of the current level.

Such comments regarding population will inevitably make many readers feel uneasy, not least when the authors use terms like 'plague outbreak' to refer to the rapid growth in human numbers seen since the fossil fuel subsidy began to be tapped in earnest two hundred and fifty years ago. Yet this term is repeated by Rees in another recent article in which he characterises humans as "archetypal K-strategists", that is, species which expand their populations until carrying capacity constraints start to exert negative feedback.[48] The fossil fuel subsidy has suspended this feedback mechanism, leading to a huge, rapid increase in carrying capacity. In line with the Maximum Power Principle, this in turn has promoted r-strategies of prolific, prodigal growth. However this increase, Rees argues, can only be temporary. And it is not just that humans will have to adjust to a carrying capacity which is no longer growing; rather, the even greater challenge will be to manage a progressively shrinking capacity as the fossil fuel interval draws to a close.

This is not the place to offer a scientific appraisal of 'Through the Eye of a Needle',[49] though we should note two things in passing: first, the undisputed scholarly standing not only of William Rees but also of those seventeen others whose plea for radical action to avoid a ghastly future was also based in part on the overshoot thesis; and, secondly, in contrast to the ecomodernist representatives cited above, the substantive thermodynamic and ecological principles on which Seibert and Rees's arguments are founded. Regarding the latter point, the risks posed by attempts to artificially extend

47 Mathis Wackernagel and William Rees, *Our Ecological Footprint: Reducing Human Impact on the Earth* (Philadelphia: New Society Publishers, 1996). See also https://www.footprintnetwork.org/our-work/ecological-footprint/

48 William E. Rees, 'Ecological economics for humanity's plague phase'. *Ecological Economics 169* (2020), 106519. https://doi.org/10.1016/j.ecolecon.2019.106519

49 The article caused quite a stir in the pages of the journal *Energies*, leading eventually to an apology from the Editor in Chief: Enrico Sciubba, 'Editorial note from the EiC'. *Energies 15* (2022), 889. https://doi.org/10.3390/en15030889

the conservation phase of an adaptive cycle, as noted in the previous chapter, seem particularly relevant.

My main purpose here however is to draw attention to how two such different narratives – ecomodernist and Neo-Malthusian - can be woven around the scientific and technological facts describing the current moment. Maintaining and promoting the integrity of our ecosocial system requires the adoption of some story or other. And this story cannot be simply 'read off' the facts (even assuming these were uncontested): the story must always have an irreducibly supplementary character, going beyond the bare facts themselves.[50]

Promises Fulfilled

If stories give meaning by supplementing the bare facts, and so delineate the integrity of a system, how does the Christian Gospel frame the moment in which we find ourselves? What vision of living with integrity can Christians offer?

In pondering questions like these we must start by appreciating the context in which they are posed. For ecomodernists the Gospel is simply surplus to requirements, since we already have a saviour in technology. Technology, as integral to a technocratic 'stakeholder capitalism', is humanity's route to a re-invigorated period of expansion in which we colonise and monetise the hybrid physical-biological-digital territories uncovered by the Fourth Industrial Revolution.

According to the ecomodernist story, the end of the conservation phase of the present adaptive cycle can serve – by implication and with minimal disruption – as a springboard for a new exploitation phase. With this transhumanistic happy ending in view, the Christian story can only appear more archaic and irrelevant than ever.

In stark contrast, Gowdy and Krall's account of post-Neolithic humanity, as a hierarchical superorganism dominating the entire ecosystem in sole service of surplus production and to disastrous effect, pours cold water on technocratic ecomodernist optimism. Yet, if some kind of hierarchy is inevitable in any society more sophisticated than that of hunter-gatherers, then it might be worth asking whether all hierarchies are, in fact, the same, and here the Gospel has something to say. For example, the divine mandate to the human in Genesis 1:28 may be based on domination, but domination, as lordship, may take on qualitatively different forms.

For the Christian, *Jesus* is *Dominus.* What difference does this make? Walter Wink famously distinguished between the kingdom ruled by Christ and what he calls the Domination System, that is, the various political and economic regimes which typify the world as we know it.[51] If the kingdom in which Jesus is Lord can be viewed as a superorganism at all, then it is geared not towards economic surplus as such but rather towards a rich harvest of the fruits of the Spirit – a *qualitative* goal which incorporates the quantitative dimension without being subordinated to it. And in a kingdom in which *Jesus* is Lord, greatness consists in excellence in service.[52] Thus, in the same way that a hierarchy organised according to excellence in service need not issue in demeaning exploitation, so also may surplus be characterised primarily as abundance of joy, joy in enough, celebrating the most humble provision as gift to be freely shared.

John Milbank's essay 'Liberality Versus Liberalism' further develops the theme of the redemption of hierarchy.[53] Milbank concurs that the technocratic, liberal-capitalist world-order is as profoundly

50 John Daniels, *Stories about Bodies: Complexity Theory, Energy and the Emergence of Ethics*. Temple Tracts: William Temple Foundation, 2021. https://williamtemplefoundation.org.uk/temple-tracts/

51 See for example Walter Wink, *Engaging the Powers* (Minneapolis: Fortress Press, 1992).

52 Mark 10: 35-45.

53 John Milbank, 'Liberality versus liberalism' in *The Future of Love: Essays in Political Theology* (London: SCM, 2009), pp. 242-63.

hierarchical, unequal and excluding as anything produced by traditional agrarian societies. However he radicalises this critique by pointing out how the liberal bias for 'democratic' process, and the assent of a majority, over truth promotes the manipulation of the views of the majority by skilled, influential minorities. Manipulation is easiest when basic emotions such as fear are at stake. This is of a piece with liberalism's implicit creation myth - 'in the beginning was the threat'. Fundamental to the role of the liberal state therefore is that it protect its people from threats, be they real, supposed or indeed self-generated. This entails the exclusion of the potentially threatening; which, in turn, (ironically) promotes uniformity and the suppression of real diversity.

The unprecedented control measures imposed by governments in response to the COVID-19 pandemic have made this argument seem more plausible now than it may have appeared before 2020; and with some talking of possible future climate lockdowns, who knows what the future might have in store.[54] In any event, Milbank presents liberalism as inherently excluding in character, although this derives less from elitism as such than from the skilful deployment of an instrumental rationality by an elite uncommitted to transcendent truth.

If a hierarchical, technocratic liberal-capitalism is found wanting, then a hypothetical radical egalitarianism – presumably akin to Gowdy and Krall's desideratum - fares no better under scrutiny. For it falsely presupposes a standard definition of the human - "the freely choosing and contracting autonomous thirty-one-year-old", as Milbank memorably puts it.[55] What is missing here is an account of the role played by time. Egalitarianism projects a merely spatial, atemporal vision of human life, whereas in fact (as per the adaptive cycle) each person is always in a process of coming to be and passing away: different life stages and conditions entail a variety of differing social roles. By contrast, egalitarianism proposes a naïve, homogenising picture of the individual as the fit young adult and, in so doing, fails to grasp hierarchical differences that emerge within the social body as inevitable, fluid and, above all, necessary for the common good.

On Milbank's account, then, hierarchy as such is not the problem; what matters is the *nature* of the hierarchy. Technocratic hierarchies are absolute spatial hierarchies of fixed power: one can climb the ladder of power only by displacing someone else. The exercise of power here is all about usefulness (for some), and not the sharing of excellence. By contrast, a spiritually authentic hierarchy is part and parcel of the person's journey through life in the company of others. A pupil may in due course overtake a master, and yet there should be no jealousy on the part of the (for now) senior figure of the potential of the (for now) junior, because excellence is intrinsically shareable.

Who sits at the pinnacle of, and so legitimates, such an authentic hierarchy anyway? On a Christian understanding this must be God the creator. Human lordship necessarily remains secondary to this, as Adam's role as God's tenant-farmer shows.[56] The consequences of eliminating God from the picture are comprehensive: the human story becomes almost unrecognisably different, with the loss of role as cultivator/keeper making the honouring of commitments implicit in that role meaningless. Human narrative identity, or *ipse*-self, is at best radically transformed; at worst it disappears altogether. All that can remain is the assertion of a putative technocratic divinity by some humans, married to their unqualified, spatial hierarchical domination of the rest of creation, human and non-human alike, the latter now reduced to a mere manipulable 'nature'.[57]

Whether we have in prospect a technocratic, post-industrial future or one which, by design or perforce, has reverted to a neo-agrarianism, the question of society's organising narrative appears

54 Mariana Mazzucato, 'Avoiding a climate lockdown' (2020) https://www.project-syndicate.org/commentary/radical-green-overhaul-to-avoid-climate-lockdown-by-mariana-mazzucato-2020-09. [accessed 11 February 2023] On the exploitation of public fear for the purpose of social control, see Kees van der Pijl, *States of Emergency: Keeping the Global Population in Check (*Atlanta: Clarity Press, 2022).

55 Milbank, 'Liberality versus liberalism', p. 249.

56 Genesis 2:15.

57 See John Milbank, 'Out of the greenhouse' in *The Word Made Strange: Theology, Language, Culture* (Oxford: Blackwell, 1997), pp.257-267.

unavoidable. Assuming that radical changes of some kind lie ahead we may anticipate that, as new systems eventually reorganise out of the fragments of the old, there will be plenty of different stories competing to shape how people understand what has just happened and the nature of the task which lies ahead. In such a situation a Christian reading of events will be but one among many competing narratives.

Competition is of course evolution's *modus operandi.* Evolution is a cruel mistress, famously securing the survival of the fittest only. And studies have shown that evolution is less bothered about truth than it is about proximate usefulness.[58] Rather as the MPP only selects the most efficient performance when resources are scarce, so also comportments which prize truth over and against arbitrarily desired short-term results may only prevail under certain conditions. This being so, the truth of the Gospel does not guarantee that people will be persuaded to adopt it as a story by which to live. Truth, and the skills necessary to acquiring it, only count when the costs of not knowing the truth are high and immediately apparent. So we can have no assurance that those who declare Jesus as Lord will visibly prevail over those who live by very different stories, any more than did their Lord himself or his pre-Constantinian Church.

Yet: **the victory of the cross lies not in the preferential evolutionary selection of a Christian ethos but in the apparently inexplicable persistence of the Gospel despite its seeming rejection**.[59] The long centuries of Christendom have perhaps made it natural for us to think of the Church and its message in terms of the adaptive cycle's conservation phase, stretching on, unchanging, into eternity. In truth, the content of the Gospel itself – Christ's life, death and resurrection - mirrors the contours of the adaptive cycle **as a whole**. There may be times in which the Church flourishes visibly as an actor within the larger ecosocial whole. There may equally be ages when it is consigned to a marginal, subaltern role. There may even be times when it is persecuted to the verge of extinction. But at all times the victory of the cross is shown in the same way, by the simple re-telling and re-enacting of the Gospel as abiding metanarrative of the practices which render its articulation possible whatever the circumstances.

This, surely, is where a distinctively Christian understanding of living with integrity is brought into relief. Consider, by contrast, an otherwise commendable secular account, such as that offered by Richard Heinberg in his book *Power: Limits and Prospects for Human Survival.*[60] Very aware of the potentially disastrous consequences of the MPP, Heinberg postulates a countervailing "optimum power principle, defined as the tendency of natural and human systems to sacrifice some measure of power in the present so as to maximise power over a longer period of time".[61] It is in the embracing of the latter, and its accompanying *ascesis*, that Heinberg places his hopes.

There are two difficulties here. The first is that Heinberg's putative optimum power principle seems to replicate the outcome already predicted by Lotka's MPP in resource-constrained situations, when the virtues of efficiency and the long-term perspective ruthlessly assert themselves. There is then no need to postulate a further, 'salvific' principle of optimum power consumption – as resources become scarce, evolution will soon weed out the profligate.

And this process of weeding out cannot but be painful. Here lies the second, and theologically significant, limitation of Heinberg's account. If Seibert, Rees and others are correct, the transition from today's gung-ho, fossil-fuelled exploitation regime to some form of quasi-sustainable and lower-powered future can only come about via an intermediate collapse of some kind. The pain of

58 'We find that veridical perceptions can be driven to extinction by non-veridical strategies that are tuned to utility rather than objective reality.' Justin T. Mark, Brian B. Marion & Donald D. Hoffman, 'Natural selection and veridical perceptions', *Journal of Theoretical Biology 266* (2010), pp. 504-515.

59 1 Corinthians 1: 18-25.

60 Richard Heinberg, *Power: Limits and Prospects for Human Survival* (Gabriola Island, BC: New Society Publishers, 2021).

61 Heinberg, *Power*, p. 260.

collapse may be mitigated to a degree, but by no means wholly avoided. In other words, the only path to resurrection lies via the Cross. This awareness may be nascent in Heinberg's account, but the Gospel serves this uncomfortable truth neat. In doing so it offers hope, of course, but a hope which does full justice to the cost of getting from where we are now to where we should be.

Amid the likely pain and disorientation of collapse we see again the value of Ricoeur's notion of narrative identity as faithfulness across time, though on this occasion applied to God's *ipse*-self as revealed to God's people. God's promises to this people run like a golden thread through the scriptures, from Noah to Abraham to Moses to David to Jesus. As Zechariah, once he had rediscovered his voice, prophesied:

> Blessed be the Lord the God of Israel,
> who has come to his people and set them free.
> He has raised up for us a mighty Saviour,
> born of the house of his servant David.
> Through his holy prophets God promised of old to save us from our enemies,
> from the hands of all that hate us,
> to show mercy to our ancestors,
> and to remember his holy covenant.[62]

Covenant (*berith*) defines this relationship through all its ups and downs, not as a contract hammered out between notional equals, nor yet as peace treaty imposed by victor upon the vanquished, but as gift freely bestowed and grace abundantly given. The identity of God's people then derives from God's own identity as promise-keeper, however surprising the forms which such covenant-faithfulness may take. This narrative identity underpins a vision of the world's "entire trajectory of past and future configurations" which in turn provides a distinctively Christian account of what it means to live with integrity.

62 Luke 1:68-72.

Conclusion

Lord, now lettest thou thy servant depart in peace, according to thy word;
for mine eyes have seen thy salvation.

Far from being in thrall to decay, planet Earth is awash with life. Miraculously, we get order for free, but on the condition that we destroy order elsewhere as fast as possible. This is the Maximum Entropy Production Principle, which all life, including human life, is bound to obey. And, for thousands of years, humans have been more than content to do so without coming anywhere close to exhausting the spontaneous, regenerating bounty of the universe.

But some two hundred and fifty years ago things changed. Humans started to capture and exploit the order contained in a new, unprecedentedly rich, set of energy sources, thereby increasing both the sizes of populations and their degree of organisation in previously unimagined ways. This cornucopia has only two drawbacks: first, this set of energy sources is finite; second, some of the wastes produced in the process of capturing their order for human use are undermining the very civilization which their production has made possible.

Planet Earth is awash with life. But all instances of life – organisms, and the ecosystems which they constitute and come to depend on - end eventually. The adaptive cycle marks out four stages on the journey of life, and there are reasons for believing that human civilization may have reached that stage where, for life to continue, the familiar, current structures which have given shape to the life we know may first have to unravel. In this respect, our current way of life is indeed doomed.

Not everyone agrees. Some believe that the same technological nous which enabled people to capture the order of fossil fuels can enable us to transition rather seamlessly into a new phase of exploitation as we reach the end of the fossil fuel age. We simply have to accept that what we mean by life, and by being human, need to change in the process. Others regard this as mere fantasy, urging that we deliberately plan a return to a pre-fossil fuel regime, with many fewer people living much simpler, harder lives.

What is at stake here is nothing less than the integrity of life. By what story, by what vision of the world's "entire trajectory of past and future configurations", should we seek to live at this point in history? Those who wish to take seriously their kinship with the non-human world, and so the MEPP and the adaptive cycle, but who also understand integrity through a story about a crucified carpenter, will eschew both optimism and fatalism.

Ultimately, we are neither divine nor doomed. Who 'we' are is part of a story much bigger than any individual human life, and even the life of any civilization. This story evokes an identity founded not on the persistence of the same but on the fulfilment of promise. The priest Zechariah celebrated that fulfilment in song. The devout and righteous Simeon saw it with his eyes and held it in his arms: God's salvation, conveyed through a life, a death and resurrection, revealing that God keeps his word, and inviting us to share in it.

Knowing that we share in that salvation, wherever the adaptive cycle might next lead us as individuals and the ecosocial system of which we are parts, we, like Simeon, can move onwards in peace.

Bibliography

John Asafu-Adjaye et al, *An Ecomodernist Manifesto* (2015). https://thebreakthrough.imgix.net/AnEcomodernistManifesto.pdf

Corey J.A. Bradshaw et al, 'Underestimating the challenges of avoiding a ghastly future', *Frontiers in Conservation Science* 1:615419 (2021). https://doi.org/10.3389/fcosc.2020.615419

Victor Court, 'Energy capture, technological change and economic growth: an evolutionary perspective', *Biophysical Economics and Resource Quality* 3 (2018), pp. 1-27.

John Daniels, *Stories about Bodies: Complexity Theory, Energy and the Emergence of Ethics*. Temple Tracts: William Temple Foundation (2021). https://williamtemplefoundation.org.uk/temple-tracts/

John Gowdy and Lisi Krall, 'The ultrasocial origin of the Anthropocene', *Ecological Economics* 95 (2013), pp. 137-147.

Lance H. Gunderson and C.S. Holling, eds, *Panarchy: Understanding Transformations in Human and Natural Systems* (London: Island Press, 2002).

N.J. Hagens, 'Economics for the future – beyond the superorganism', *Ecological Economics* 169 (2020). https://doi.org/10.1016/j.ecolecon.2019.106520

Richard Heinberg, *Power: Limits and Prospects for Human Survival* (Gabriola Island, BC: New Society Publishers, 2021).

Mae-Wan Ho, 'Circular thermodynamics of organisms and sustainable systems', *Systems* 1 (2013) pp. 30-49.

Alfred Lotka, 'Contribution to the energetics of evolution', *Proceedings of the National Academy of Sciences* 8 (1922), pp. 147-151.

John Milbank, 'Out of the greenhouse' in *The Word Made Strange: Theology, Language, Culture* (Oxford: Blackwell, 1997), pp.257-267.

John Milbank, 'Liberality versus liberalism' in *The Future of Love: Essays in Political Theology* (London: SCM, 2009), pp. 242-263.

William E. Rees, 'Ecological economics for humanity's plague phase'. *Ecological Economics* 169 (2020), 106519. https://doi.org/10.1016/j.ecolecon.2019.106519

Paul Ricoeur, *Oneself as Another* (London: University of Chicago Press, 1992).

Stanley N. Salthe, 'Infodynamics, a developmental framework for ecology/economics', *Conservation Ecology* 7 (2003). http://www.consecol.org/vol7/iss3/art3

Stanley N. Salthe, 'The Natural Philosophy of Work', *Entropy 9* (2007), pp. 83-99.

Stanley N. Salthe, 'Maximum Power and Maximum Entropy Production: finalities in nature', *Cosmos and History 6* (2010), pp. 114-121.

Klaus Schwab and Thierry Malleret, *The Great Narrative: For a Better Future* (Geneva: WEF, 2022).

Megan K. Seibert and William E. Rees, ‘Through the eye of a needle: an eco-heterodox perspective on the renewable energy transition’, *Energies* 14 (2021), 4508. https://doi.org/10.3390/en14154508

Joseph A. Tainter, ‘Social complexity and sustainability’, *Ecological Complexity* 3 (2006), pp. 91-103.

Robert E. Ulanowicz, *Ecology, the Ascendent Perspective* (Chichester: Columbia University Press, 1997).

Mathis Wackernagel and William Rees, *Our Ecological Footprint: Reducing Human Impact on the Earth* (Philadelphia: New Society Publishers, 1996).

Walter Wink, *Engaging the Powers* (Minneapolis: Fortress Press, 1992).

Jian D.L. Yen et al, ‘Thermodynamic extremization principles and their relevance to ecology’, *Austral Ecology* 39 (2014), pp. 619–632.

William Temple Foundation

Thank you for reading.

‘Temple Tracts’ are short, free-to-download books from the William Temple Foundation, presenting engaging analysis on key debates in religion and public life.

Find out more and download the other books at:

williamtemplefoundation.org.uk/temple-tracts

Sign up for our free newsletter at williamtemplefoundation.org.uk
Follow us on Twitter @WTempleFdn