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Bhaskar's philosophy as third generation systems theory, with implications for ethics and earth system stability

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ABSTRACT
Bhaskar's philosophy supports society via a process of homeostasis to resist socioecological system disintegration by developing its values and ethics in response to endogenous and exogenous change. To the contrary, positivist (first generation) and hermeneuticist (second generation) approaches to systems theory have distorted humanity's mechanism of homeostasis because, amongst other things, they disallow the use of facts to guide values/actions. Since acting on knowledge is, *ceteris paribus*, a given in Bhaskar's approach, resolving socioecological system problems involves correcting the method of homeostasis (our method of finding knowledge and acting on it) rather than correcting the consequences of the failure of homeostasis (the poorly informed action or inaction). This is reminiscent of Gandhi's approach to social transformation in which we trust the means to arrive at appropriate ends and it releases activists from having to be keepers of the moral high-ground or having to try to change people's behaviour.

KEYWORDS
Systems theory; homeostasis; system disintegration; fact/value dichotomy; Earth system boundaries; climate change

Introduction

To understand why we need to improve our approach to systems theory, it is useful to consider some of the contradictions reflected in the way that systems theory is currently formulated. To this end, we might consider a recent report that uses systems theory and computer simulations to argue compellingly that we have crossed six of the nine boundaries that regulate the stability and resilience of Earth's present-day ecosystems (Richardson et al. 2023). The researchers who wrote the report hope that their findings will provide a 'renewed wake-up call to humankind that Earth is in danger of leaving its Holocene-like state', that it may 'contribute to guiding … sustainable development' and that it will 'stimulate humankind to innovation towards a future in which Earth system stability is fundamentally preserved and safeguarded' (11). Although the authors are clear that human activity is causative of this crisis, at no point in their conclusion do they actually say that we need to change our human economies and cultures of consumption to reduce greenhouse gas emissions, reduce deforestation, reduce pollution and freshwater

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consumption. If anything, they imply a conservative approach to economy and culture with their call for sustainable *development* and *innovation*. The word 'development' is associated with the constant growth model of economics, which is untenable in a finite world (Næss and Price 2016); and the word 'innovation' implies the use of technical rather than non-technical solutions to environmental problems, since many non-technical approaches are well-established rather than innovative, such as living within one's means or living in a way that is not wasteful of energy and resources.

Despite the Richardson et al. (2023) paper having been written by 29 scientists from 12 academic institutions at the cutting edge of our contemporary movements to protect the Earth, the tragic irony is that it is remarkably similar to a paper written in the 1970s by Baes Jr et al. (1976), commissioned by the United States government. This earlier paper takes a similar tack in that, first, it explains in convincing detail the evidence for, and causes of, potentially 'catastrophic' (45) climate change. However, despite its pointing to human influence as the cause of climate change, it nevertheless does not suggest that therefore the solution is to reduce humanity's unsustainable activities. Instead, it suggests that 'first priority must be given to the study of possible climate change' (65) (yet, surely, since we already know that things are looking dire, the first priority should be to act?). It also includes the statement that 'the present state of knowledge does not warrant emergency counter-measures' (45), which seems contradictory to other of its statements such as:

> If the present predictions are anywhere near the truth, not long after the year 2000, the warming effect of increased atmospheric carbon dioxide could become conspicuous above the noise level from other causes of climate fluctuation. However, the momentum of societal fuel use patterns may make it difficult then to adjust from fossil energy to non-fossil energy quickly enough to avoid eventual severe consequences. Hence the time available for action may be quite limited. (Baes Jr et al. 1976, 65)

Note also, in this last quote, how the assumption is that the solution to the problem is non-fossil fuel energy (addresses a symptom of the problem), not a reduction in energy consumption itself (which would address a deep cause of the problem). We are now 23 years beyond the year 2000 and the warming effect has, as predicted by Baes et al. (65), become conspicuous above the noise level from other causes of climate fluctuation (IPCC 2022; Richardson et al. 2023). However, the clearest statement that Richardson et al. make in terms of future necessary activities, like the Baes et al report, remains a call for yet more data, predictions and modelling.

> There is an urgent need for more powerful scientific and policy tools for analyzing the whole of the integrated Earth system with reliability and regularity and guiding political processes to prevent altering the state of Earth system beyond levels tolerable for today's societies. In addition to more consistent collection and collation of relevant global environmental data, this will require the development of Earth system models that more completely capture geo-sphere-biosphere-anthroposphere interactions than is the case today. (Richardson et al. 2023, 11)

One might ask why Richardson et al. continue to suggest that one of the key steps to dealing with the crisis is to develop better models that can make reliable predictions; and why they remain reticent to state what needs to be done – the need to change our current modes of production and consumption – in the face of the crisis. The answer, I believe, lies in their problematic philosophy of science which is based on positivism, and which is designed for use in closed system laboratories (which climate science can never achieve). This philosophy assumes that the only valid knowledge of causation is constant conjunctions of events, known more usually in scientific circles as correlations. That scientists and policymakers tend to assume that correlations are the only basis for action is a dangerous distraction because it results in them 'fiddling while Rome burns', constantly searching for a basis for action that does not exist. In other words, these scientists are searching for absolute certainty even though all that they need, in order to act, is relative certainty, which is provided not just by their (useful if not entirely predictive) models but by logic itself. That these scientists already had enough relative certainty to act in the 1970s is clear:

> Most scientists viewing the accelerated burning of fossil fuels now agree that excess carbon dioxide will warm the Earth's surface temperature significantly. It seems very improbable that opposing factors would nicely counteract the indirect climatic and ecological changes that would follow or prevent severe economic and other social costs over wide regions. (Baes Jr et al. 1976, 1)

Evidence that the goal of predictive certainty is impossible, apart from the simple logic behind knowing that it is impossible (provided by Bhaskar 2016, 13; Bhaskar 2013), is that 50 years after the first report, the main suggestion of the second report is *still* that more research and better predictions are needed, despite massively increased computing power and sophisticated computer models. For Baes et al. (62) such prediction was likely by the mid-1980s, and yet here we are in the mid-2020s and Richardson et al. are still calling for more data, analysed with more 'reliability and regularity' (11) (that is, which is better at being predictive).

Another problem with both reports is that they assume, mechanistically, that our choices to remedy the climate crisis are similar to the choices facing a player on a pool table, in terms of choosing which ball is the most strategic to sink, where each choice is based on a cost–benefit calculation. However, our choices are more like the choices of someone in a room full of paper who switches on a powerful fan. Paper is flying everywhere, and they can choose to run after each piece of paper even whilst the next ones are being picked up and blown away, endlessly chasing after moving targets (with cost benefit analyses about which to catch first), or they can choose to switch off the fan. Of course, I am not suggesting that fixing the climate crisis is as easy as switching off a fan, but simply that the threat to ecosystems and climate cannot be approached mechanically, in fact, as far as we can tell, every 'thing' that we study cannot be mechanically explained:

> At the end of the nineteenth century, physicists widely believed that classical physics gave the general outlines of a complete mechanical explanation of the universe. Since then, relativity and quantum theory have overturned such notions altogether. It is now clear that no mechanical explanation is available, not for the fundamental particles which constitute all matter, inanimate and animate, nor for the cosmos as a whole. (Bohm 1974, 128–135)

The problematic forces that are behind climate change – related to human activity – are mentioned by the authors in both the Baes et al. and Richardson et al. articles. Nevertheless, instrumental interventions to ameliorate these problematic forces, such as alternative sources of energy, carbon sequestering techniques, and electric vehicles not only fail to address the forces of emergence creating the problem but in the open system of the world are also likely to have unintended and unforeseen consequences. An example of such an unintended consequence is the way that wind farms affect the migration patterns of reindeer (Skarin, Sandström, and Alam 2018).

This non-mechanical process, mentioned above by Bohm, by which entities, or systems, of increasing complexity maintain their integrity in defiance of entropy, is plausibly a law of the universe along with the other laws of motion, gravity, electromagnetism, and thermodynamics (Wong et al. 2023). Bhaskar (in Singh, Bhaskar, and Hartwig 2020, 219) could be said to be describing this law, as it relates to the entity that we call the mind, as follows,

> … there is the equivalence, or consistency, of (1) the way in which historically – diachronically – mind has developed out of life, which has developed out of matter: so there has been an emergence, an unfolding within the evolution of these powers; and (2) the implicitness of these powers in matter from the beginning – this must have been the case – so that pure matter is like sleeping consciousness.

This law has been named the 'Law of Increasing Complexity' by Wong et al. (2023). A key aspect of this law, which leads to the development of persistent systems, such as individual life forms (Cannon 1932), ecosystems (Lovelock and Margulis 1974) and societies (Parsons 1951), is the concept of negative feed-back, which is also called homeostasis. Although homeostasis is not the only mechanism associated with persistent systems, it is the mechanism associated with correlations between the systems and their environments which promote their persistence (Wong et al. 2023, 5).

Ethics as socioecosystem homeostasis

Homeostatic systems involve processing of relevant information and then action (a response), if necessary, to bring the system back into its (relatively or desirably) 'steady-state', which in terms of the Earth would be the Holocene (Richardson et al. 2023). There are two kinds of homeostatic information processing, one of which is the inductive 'memory' version (simple cause and effect from past experience); and the other of which is the retroductive 'non memory' version 'which requires imagination and the ability to consider counterfactuals; such abstraction allows for greater novelty generation through the generation of hitherto nonexistent, imagined versions of reality' (Wong et al. 2023, 5). The positivistic philosophy of science denies humans access to system-maintaining homeostasis because (a) it assumes that one can only act when one's inductively-derived information is reliably predictive, which is problematic because such prediction is only possible in closed systems which are rarely found in nature (b) it refuses to give scientific credibility to the retroductive version of homeostasis (related to the first point because positivism allows only for predictive inductive knowledge and thus it denies retroduction a place in the scientific cannon because the validity of retroduction cannot be ascertained by predictive criteria) and (c) it denies the move from information to action.

In other words, in addition to looking for salvation from a saviour who is never coming (prediction) and demonstrating a kind of implausible faith - magical thinking - around the efficacy of technological fixes, mainstream socioecological commentators also suffer from the problem that, so they think, science cannot provide a basis for human values. Hence, these scientists are compelled by their profession to hold back from taking the next step and suggesting what we might do to resolve the environmental crisis. This is particularly true of the Richardson et al. (2023) report, and I imagine that they might defend their report by saying that their objective was never to suggest solutions, but merely to offer information to allow others to make value-based decisions. This reticence to suggest solutions is most likely because they see themselves as objective scientists and they will have been trained to follow Hume's Law, which maintains a strict dichotomy between facts and values (Bhaskar 2016, 38). I will consider Hume's Law in more detail later in this article but suffice to say here that because of their commitment to this dichotomy, in my opinion, scientists tend to leave the debate too soon. Whilst I agree that we need an interdisciplinary and democratic approach to action with regards to the environmental crisis, nevertheless those making the decisions would benefit from the scientists taking the step of actually suggesting solutions.

Sadly, in my opinion, because of the limitations imposed on these authors by a version of systems theory still influenced by the basic tenets of positivism, these reports give actors either the excuse not to act (the idea that we don't have enough information to act) or the excuse to act to ameliorate symptoms rather than to address the causes (the idea that we can apply technological fixes without addressing causes such as energy consumption and novel chemical production). In this article, I am going to try to explain in more detail how these socioecological systems scientists have come to be faced by these limitations by explaining why their essentially positivist approach has led to their focus, at the expense of action, on prediction and the difficulties in dealing with complexity; and their lack of engagement with the underlying causes of the problem. That is, I will explain the philosophical errors – which we no longer have the luxury to entertain – that have resulted in the reports' contradictions (their desire to protect the Earth but their reticence, in the end, to do so).

I will therefore begin with the history and development of first- and second-generation systems theory, commenting on its philosophical underpinnings from a critical realist perspective. I will argue that, in terms of Bhaskar's concept of the three domains of reality, contemporary systems theory is actualist, rather than fully realist. I will then explain how a transcendental – or one could also say a deep – version of realist ontology resolves several of the contradictions that currently face systems theory and its associated complexity science. This will take me into a discussion about a topic closely aligned with systems theory, namely homeostasis, applied to ecosystems. As such, I hope to shift the philosophical underpinnings of systems theory away from its positivist (first generation) and hermeneutical (second generation) roots towards a transcendental realist (third generation) future.

A critical realist view of contemporary systems theory

Systems theory is a broad interdisciplinary field that examines the behaviour of complex systems, including biological, physical, social, and technological systems. It is therefore well suited to understanding and addressing wicked problems, such as climate change, viral epidemics, drug addiction, and homelessness; and it is for this reason that, as an educator focused on questions of sustainability and social justice, I have a particular interest in it. Although the first known work related to the field of systems theory was written in the fourth century BC by Aristotle (in 'Physics', 1941), with his exploration of the interaction of the basic building blocks of the physical world, the modern development of systems theory can be traced to the work of the biologist, Ludwig von Bertalanffy, just before World War II (Klir 1972, 1).

First generation systems theory differs from the classic (Newtonian) science-based view of the world in that it does not mechanistically regard an object of scientific investigation as a collection of isolated parts, neither does it try to understand the properties of the whole object purely in terms of these isolated parts, without considering their interactions (Mitchell 2009). It is no coincidence that systems theory was developed by a biologist and that its main proponents have come from disciplines such as climatology (see Forrester 1994; Meadows 2008), ecology (see Capra 1996; Gunderson and Holling 2002; Holling 1973), psychology (see Bronfenbrenner 1986; Csikszentmihalyi 2014), and sociology (see Bateson 1972; Luhmann 1995; Parsons 1951), given that the complexity of the subject matter of these disciplines cannot but draw attention to the inadequacies of the reductionism inherent in mainstream positivistic science.

Second-generation systems theory represents a departure from the traditional view of systems theory. It challenges the assumptions of objectivity and determinism inherent in first-generation systems theory. It acknowledges the subjective, social, and contextual aspects of systems, emphasizing the importance of multiple perspectives, dialogue, and flexibility in understanding and managing complex problems. It emerged in the late twentieth century as a response to the limitations and criticisms of first-generation systems theory. Second-generation systems theory emphasizes the social and subjective aspects of systems, positing that systems are not objective entities but rather constructs created by human perception and interaction.

One prominent approach within second-generation systems theory is Peter Checkland's (1983) (Kantian inspired) Soft Systems Methodology (SSM). SSM is a problem-solving methodology that focuses on addressing complex, ill-defined problems where there is no clear objective or consensus on the problem's definition. SSM argues that systems are inherently human activity systems and seeks to understand the different perspectives and worldviews of stakeholders involved. It emphasizes the importance of engaging with multiple perspectives, fostering dialogue, and creating shared understanding. SSM is consciously anti-ontological, as this quote illustrates:

> Thus, systems thinking is only an epistemology, a particular way of describing the world. It does not tell us what the world is. Hence, strictly speaking, we should never say of something in the world: 'It is a system', only: 'It may be described as a system'. (Of course, keeping to that rule is tedious!). (Checkland 1983, 671)

Taket and White's (1998) (Foucauldian inspired) pragmatic pluralism is another approach within second-generation systems theory. Pragmatic pluralism recognizes that there is no single universal way to understand and analyse complex systems. It emphasizes the need for multiple perspectives, theories, and methodologies to be used in concert to gain a more comprehensive understanding of complex systems. Pragmatic pluralism encourages the integration of diverse approaches, recognizing that different perspectives can provide unique insights and address different aspects of a system:

> So in adopting a position of pragmatic pluralism, we argue for … an end to theory as providing an abstract yet foundational basis for practice but not an end to theorizing as a part of a process of critically reflective practice. (Taket and White 1998, 156)

Having outlined the main characteristics of first and second generation systems theory, I will now consider Bhaskar's contribution to the field.

Bhaskar's contribution to systems theory

Bhaskar drew attention to the relevance of his work to systems theory when Mervyn Hartwig (Bhaskar and Hartwig 2010, 75) interviewed him about his book a 'A Realist Theory of Science'. Hartwig asked him what one could do with such a book, and he answered that the most obvious thing was to look into its transapplication to other contexts, amongst which he mentioned biology, sociology and cybernetics, all three of which have played a central role in the development of systems theory. In two of these three contexts, sociology and biology, Bhaskar himself carried out the transapplication of his ideas in 1979 (2014) and 1986 (2009) respectively. He also made use of certain systems theory concepts such as that of autopoiesis in his book on dialectics (Bhaskar 2008). This article is a step in the direction of the transapplication of Bhaskar's work to cybernetics, with its consideration of the question of homeostasis, which is a mechanism of cybernetics (Wiener 1948).

Most notably, the critical realists John Mingers (2014) and Anton Törnberg (2017) have attempted the transapplication of Bhaskar's philosophy to systems theory. Their work reflects the opinion, with which I agree, that Bhaskar's philosophy addresses the same problem field as systems theory and that its realist ontology, in contrast to the irrealist ontology of second-generation systems theory, can be used to ground the insights of systems theory. I also agree with Mingers (2014, 3) who explains how second-generation systems theory leads 'to a solipsistic pit from which it is difficult to escape. Every theory becomes simply another viewpoint or Weltanschauung, another interpretation of the world, no better or worse than any other'. In other words, without an ontology, both Soft Systems Theory and Pragmatic Pluralism are relativist, and thus, when action does happen, it tends to reflect the interests of the most powerful in society. This is because, if there is no force of truth behind an argument, other forces will direct it, with the most powerful forces triumphing. Nevertheless, Mingers does not think that these problems with second generation systems theory should turn us back to first generation systems theory. This is because his experience of being a business manager had shown him 'that real-world organizations were not easily and tidily fitted into mathematical models – they had social and political dimensions which were not touched by the OR techniques I had learnt' (Mingers 2014, 2)

In this article, I will not discuss second generation systems theory much further, beyond to say that its processes of democracy and its focus on subjectivity have functioned as a mechanism which has helped to make first generation systems theory seem plausible despite its patent contradictions. This is because human subjectivity involves retroductive thinking, where retroduction is the kind of logic that gives us our understandings of the real, underlying reasons for the kinds of things that we witness at the empirical level of reality, and which are denied by first generation systems theorists. Thus, by allowing people to have a voice, we in fact allow theories about deep reality in 'by the back door' so to speak and it is this process which allows systems theorists to continue without their contradictions rendering their approach unusable. An analogy for this situation is the way that, in a co-dependent relationship characterized by alcoholism, the co-dependent allows the alcoholic to continue to function; if the co-dependent were to stop their supportive role, the alcoholic would be unable to function, and it would be obvious that they have a problem (Asher 2018). Bhaskar (2016, 128) has described this process – in which 'a false belief in theory is sustained by elements of a more adequate practice' – as a 'compromise formation'.

That second generation systems theorists are conscious of this compromise formation and the way that it functions is clearly reflected in the quote above by Taket and White in which they both call for an end to theorizing (as a way to guide object/ive action) but encourage theorizing (as a part of a process of subjective critically reflective practice). Nevertheless, just as the caring attitude of the co-dependent is not in itself wrong, and is useful, even necessary, in other contexts, so many of the hermeneutical and democratic techniques developed by second generation systems theorists are useful and even necessary in the context of a functioning, democratic society. By strengthening the hermeneutical approach when it is used to give people a voice in democratic processes – that is, by giving their theories an ontology – democracy is thus strengthened and it allows communities to be involved in the maintenance of the socioecological system integrity as equal partners with professional scientists.

First generation systems theory becomes actualist

From an ontological perspective, a key development of first generations systems theory was the move, initiated by von Bertalanffy, from systems theory to *general* systems theory. The qualifier 'general' is typically dropped in contemporary usage, but there is an argument that we should keep it because it serves as a reminder that the field has moved on from the assumption that two systems are similar if the variables of one system are of the same physical nature as those of the other, to the assumption that systems theory provides the basis of an 'an analogy' between the systems, that is, it is based on a similarity in the algebraic or differential equations describing the systems involved (Klir 1972, p. 2). For instance, 'the same simple first-order differential equation can be used to describe the depreciation of industrial capital, the decay of radioactive materials, the inventory-ordering policy of a beer distributor, or the cooling of a cup of hot coffee'. First generation general systems theory is therefore a highly mathematical concept, which draws on various mathematical fields such as graph theory, linear algebra, probability theory, differential equations, control theory and network theory (Meadows 2008). These mathematical equations and theories describe events in time, that is, patterns of happenings, which follow the same or similar rules despite materially consisting of different substrates. One can say that they are not themselves empirical – we cannot 'hold in our hand' a mathematical equation – but because they describe events in relation to each other, they are therefore actual. As such, in terms of Bhaskar's transcendental realism, general systems theory is an ontological shift away from empiricism, where what is real is only what is measurable, towards actualism, where what is real includes both what is measurable and what is often not directly measurable, such as certain events in the form of relationships and patterns of happenings among measurable things (note that a relationship is technically not a measurable thing, one cannot, so to say, hold a relationship in one's hand, one can only measure the things that are in relation and theorize about the existence of the relationship itself). This shift towards actualism in systems theory enables it to move beyond atomism and predictable linear effects and allows it to discuss dynamic relationships and patterns, regularities, wholes, multi-dimensional relationships, open systems and chaos, the concepts of which have to a large extent been supplied by complexity science.

At this point, I would like the reader to stop for a moment to consider the enormous significance of this move from empiricism to actualism. Here we have the idea that one can have a general which is not made of material stuff, but rather is made of actual, causal relationships; and these relationships are able to explain, mathematically, the behaviours of different kinds of material stuff. This is a remarkably bold step because positivist scientists from Hume onwards have been 'sceptical materialists', questioning the real existence of both generals in the form of empirical things (such as the general category of cutlery) and general causal relations in the form of constant conjunctions of events (such as the correlation of smoking with lung cancer).

Nevertheless, although this step towards actualism has gained a considerable amount of respect and validation in the years since its inception, it has remained problematic from the mainstream Humean-based science point of view. This is because of the ambiguous position that Humean science takes on relations and their emergent outcomes, such as ecosystems, treating them as real in practice but denying them reality in theory (Price 2019). Take for example statements such as:

> I always shock incoming students at the orientation when I say that there is no such thing as a system out there. Systems exist as mental pictures in our minds. Saying this another way, systems thinking structures thinking about whatever entity or phenomenon we become aware of and assign meaning to. (Banathy 2013, 156)

> Ecosystem integrity is neither real nor valuable. … Any impression of 'wholeness' is an artifact of the brevity of human lives and the shallowness of our historical records. (Rohwer and Marris 2021, e411)

This irrealism about systems means that systems theorists have had to pull back on their commitment to the reality of general relations, thus decreasing their allegiance to actual reality by calling their models of relations mere 'heuristics' or 'mental models', where the adjective 'mental' can be interpreted as indicating 'of the mind' rather than 'of reality' (Dyball, Beavis, and Kaufman 2012; Levy, Lubell, and McRoberts 2018). Another way of saying this is that mainstream systems theory has no ontology for the actual part of reality which underlies the patterns and relationships that form its subject matter. This leads to the epistemic fallacy, in which questions of ontology are reduced to questions of epistemology (Bhaskar 2016, 6). Törnberg (2017, 27) describes the epistemic fallacy in complexity science thus, 'In fact, such conflation of methodology and ontology has as I see it been a central factor behind the development of what I refer to as mainstream complexity science.' (Note: Bhaskar would say epistemology rather than methodology)

However, from the perspective of Bhaskar's transcendental realism, the bold step towards actualism was not bold enough, and it would not be bold enough even if, as Mingers and Törnberg advise, it was given an ontology. This is because limiting our understanding of reality to the domain of the 'actual' results in the absence in our understanding of deeper, at times neither actual nor empirical, aspects of reality. Simply giving actualism an ontology is only a partway solution. That is, in addition to admitting the reality of relationships and events, to achieve a full understanding of emergent beings, or 'systems', requires a further step towards realism; it requires an ontology that admits as real not only the actual patterns of events (relations) among empirical (material) things but also the structures and mechanisms that underlie, and thus explain, the patterns of events among empirical things and which can continue to exist in the background, so to speak, even if at any given time they are not manifest as events, whether measurable or not (which is to say that they are transfactual, since they need not exist as 'facts'). That is, the actual does not exhaust reality. As Bhaskar explains:

> It is important to appreciate that the distinction between the domains of the real and the actual involves a commitment not just to the independent existence of generative mechanisms apart from events, or of powers (and dispositions generally) apart from their manifestation or actualisation, but also to their transfactual exercise apart from particular patterns or sequences of events or the contingent actualisation of the disposition concerned. That is to say, what is involved in the real/actual distinction is a three-tiered (powers, exercise, manifestation or actualisation), not just a two-tiered (powers, exercise = actualisation), dynamic and transfactual form of dispositional realism. This differentiates transcendental realism from other dispositional realisms currently in vogue.
> (Bhaskar 2016, 28)

One might say that, currently, systems theory is able to acknowledge that there are generative mechanisms, but it does not acknowledge that those mechanisms continue to act even if they are not currently manifest in particular patterns or sequences of events. That is, even if there is no evidence for climate change, as was the case for nearly twenty years in the 1980s, nevertheless the forces behind climate change were still at work (Price 2023). Whilst one might assume that climate scientists know this, they are not able to justify this knowledge using their Humean-based version of science that equates the validity of such knowledge with constant conjunctions of events or statistical correlations.

Thus, Bhaskar has consistently emphasized the importance of distinguishing between the domains of the empirical, the actual and the real. However, because the step from empiricism to actualism (that is, the step from systems theory to 'general' systems theory) seems so bold and radical, and because certain terms are associated with it that are also used by Bhaskar, such as complexity and emergence, there has been a tendency amongst critical realists to think that systems theory is simply talking about the same ontological reality as critical realism. That is, that the two are essentially the same, and that the only contribution that critical realism has to make to systems theory is to give it an ontology for its actual patterns and emergent aspects of reality. This is the position taken by both Mingers (2014) and Törnberg (2017).

For instance, Törnberg (2017, 30) notes some definitions of complexity which he does not challenge:

- A complex system is a phenomenon which emerges from a simple collection of interacting objects
- A complex system is one in which large networks of components with no central control and simple rules of operation give rise to complex collective behaviour, sophisticated information processing, and adaptation via learning and evolution
- Complex systems are systems that have a large numbers of components, often called agents, that interact and adapt or learn

- Complex systems and their coherent behaviours arise from competition and cooperation among the agents themselves and the overall behaviour of the system is the result of a huge number of decisions made every moment by many individual agents

Notice that, in these definitions above, it is assumed that that which interests systems theory and complexity science is that which is actualized by individual components – or atomistic agents – in terms of their behaviour or interactions. The focus is on the relationships (actual events) between atomistic things. This version of systems theory is therefore an excellent description of actualism and reflects the situation that Bhaskar warned against, namely the *actualist collapse of natural necessity* (Bhaskar 2016, 19, 31).

There are two points to be made here in terms of this collapse. First, instead of basing knowledge on empirically grounded depth explanations for things (namely natural necessity), systems theorists base it on superficial constant conjunctions of actual events and statistical generalizations of patterns of single measurements (namely behaviours of component agents) extrapolated over whole populations. Potentials and mechanisms (the critical realist real) which may exist and/or be exercised but without being empirically or actually manifest cannot be conceived of in this approach to science. Instead, contemporary versions of systems theory are focused on actual events (behaviours, such as competition and co-operation, interactions and relationships) between empirical, measurable entities. Systems theory thus moves beyond reductionism and linear causality but replaces it with atomism and patterns-based, multiple causality. To reiterate, it is actualist rather than realist.

Second, and relatedly, general systems theory approaches its understanding of this actual level of reality through complex mathematical equations and statistical formulations, which at their most complex, are used to create computer models that require vast amounts of computing power. However, to date, none of these models have managed to be predictive in a way that would satisfy mainstream philosophy of science (I am thinking here in particular of Popperian science). Whilst some systems theorists committed to this approach are aware that it is conceivable that it will never be possible to have enough computing power to create models that are able to offer useful understandings of complex systems such as climate (for example, see Mitchell 2009), others still expect that one day we will be able to use computers to predict the future reliably enough to trust it as a basis for policy decisions (Slingo et al. 2022).

It is useful to consider how one might we define complex systems if one were to assume a depth ontology that includes all three of Bhaskar's domains of reality, namely the real, the actual and the empirical. From this perspective, Bhaskar defines a complex system as follows:

> Complex systems are entities that display far greater coherence than the processes which reproduce or transform them, suggesting internal complexity; and they often disclose far less variance than one would expect a priori, suggesting inter-dependency or their binding as totalities such that the identity of the system tends to remain intact, despite intrinsic and/or extrinsic entropic forces. (Paraphrased from Bhaskar 2014, 89, the original being specific to social systems)

This definition is significantly different from the contemporary definitions provided above. Note that the other definitions reduce the complex systems to behaviour of their agents and their relationships, whilst this definition does not mention behaviours and relationships. Instead, it assumes that a complex system is a novel entity in itself, with an identity not simply reducible to, or explainable by, agents and their patterns of relationships. These entities, furthermore, exist despite entropic forces, which are not mentioned in the mainstream definitions. That is, the mainstream position is that systems do not have the status of things, with boundaries[1] (albeit permeable) distinguishing them from other things and that there is therefore no such thing as ecosystem integrity which, according to Rohwer and Marris (2021, e411) is simply an artefact of human beings' nostalgic attachment to beloved ecosystem states. To the contrary, Bhaskar is realist about complex systems: he assumes that they are fully real entities and that they would have their identities as such even if there were no humans to see them. Furthermore, despite having an identity, the integrity of which can be maintained, nevertheless systems can also change from one state (one identity) into another.

> The critical realist worldview, which includes the categories of holistic causality and totality, which depend on there being internal as well as external relations, doesn't make the mistake of denying that external relations exist, and that some things are accidents or contingencies – at least, superficially, this appears to be the case – but it rather insists that there are some things that are essential to the being of other things, and some processes that things undergo that are truly changes within their own self-identity or essential nature – their innermost being, however that's defined. (Bhaskar in Singh, Bhaskar, and Hartwig 2020, 86)

Systems therefore correspond to Bohm's version of an entity which cannot be mechanistically understood in terms of its parts and the relationships of those parts. Bhaskar's definition of complex systems thus shifts the discussion of systems theory away from mechanistic, atomistic albeit relational, actualism towards ontologically deep realism.

Depth realism takes the strangeness out of complex systems theory

There is something fantastic, incredible, and strange about the things that populate systems theory and complexity, such as fractals, the butterfly effect, strange attractors and the strong role given to chance. However, these things only seem weird or strange because current versions of systems theory do not allow for the possibility that transfactual, deep structures and mechanisms exist; to use an analogy, if one can see what the conjurer is doing behind the scenes, the event taking place becomes less magical in that it no longer defies common sense (yet it can still be breath-takingly, awe-inspiringly impressive). For example, the Fibonacci sequence is a general mathematical formula found throughout nature; and contemporary systems theorists go no further than to describe it as a mathematical curiosity. However, from the perspective of a depth ontology, systems theory is permitted to consider that this mathematical formula is most likely simply the result of the transfactual way that molecules tend to efficiently arrange themselves – because of the nature of physics as it plays out in terms of their structure and the structures in the context in which they find themselves – to form fractal shapes, crystals and spirals (Rehmeyer 2007). This is not unlike the general, transfactual principle that we use whether packing suitcases into a car or sandwiches into a lunch box, in which the real, general principle of maximizing space remains the same, despite the different actual materials and contexts, and that real principle exists even when we are not actually packing cars or lunch boxes. Similarly, the butterfly effect does not seem so incredible when one realizes that there are transfactual structures at play that can have a global reach, such that, in our globally 'hot' modern societies, 'butterfly effects may reproduce tomorrow in Leicester a transformation today in Tokyo' (Bhaskar 2008, 341). Furthermore, it only seems like things happen by chance, or that things are chaotic, if one cannot see the underlying structures and mechanisms behind any event.

> So we have these three characteristic properties of stratification: openness or mishy-mashiness, multiplicity and complexity – so much so that people have regarded the world as chaos. It's true that it is a world of chaos, but it is not completely chaotic and can be grasped at a certain level. If you look at the streets of India from a Western's point of view, it would seem to be chaotic irregularity, but there are certain laws and principles which actually govern that chaos. Each level will have principles and laws specific to it but to find the order that explains any one being or any one structure at a superficial level, you have to go to a deeper structure … (Bhaskar 2008, 341)

Similarly, the so-called 'strange attractors' (Ruelle and Takens 1971) are not strange at all when one realizes that there is a natural necessity to the existence of certain trends in nature, whether these are trends in the size class of finch beaks (Weiner 1994) or the characteristics of human organizations (Senge 2006; Wheatley 2011). As Miramontes (2014, 143) explains, 'Randomness should be admitted as the mask we use to cover our lack of knowledge. Biology would gain a lot of understanding in the real meaning of its object of study if it accepts that behind what we call Randomness there are natural laws acting.'

Ontologically deep systems theory avoids action repression

There are at least two ways in which Bhaskar's version of systems theory avoids the action repression of first and second generations systems theory, where first generation systems theory endlessly deflects acting until a future time of (unachievable) certainty and second-generation systems theory is too relativist to arrive at satisfactory guidance for action.

Firstly, a deeply realist version of systems theory liberates scientists from having to validate their theories, such as the theory about climate change, by achieving predictability. As we can see in both the Baes et al. and Richardson et al. papers, the absence of predictability results in their noble calls for more information, and more predictability, with the implication that acting before this information is at hand is problematic. Bhaskar (2013, 131) explains that they are 'embarrassed' by the non-availability of 'Humean causal laws' (correlations, predictability) and thus 'inevitably (they) fall back on the idea that our explanations are sketches to be filled out in the fullness of time'. However, when it comes to acting to address the environmental crisis, we do not have the luxury of the 'fullness of time' and there is a strong possibility that such information is impossible to achieve in non-linear dynamical open systems, which are constantly in flux, and which are strongly sensitive to initial conditions (the butterfly effect). Fortunately, as already explained, it is possible to know about the way that things work sufficiently to guide action, without the requirement of constant conjunctions of events which are neither necessary nor sufficient, for understanding causal mechanisms in open systems (Bhaskar 2016, 13; Bhaskar 2013). Furthermore, and relatedly, first and second generation systems theorists argue that system solutions should 'take into account the interconnectedness of our major problems' and not just consider the problems in a reductive way. However, such interconnectedness, modelled using state of the art mathematics is overwhelmingly complicated. To the contrary, third generation systems theory argues that we can greatly simplify the knowledge that we need to act. It merely (!) requires that we should take into account the structures and mechanisms behind the connections between things, leading to action that can be based on fairly simply general principles (which is not so overwhelming and therefore action-repressing). As Holling says about his approach to systems theory, for which Bhaskar's philosophy underlabours, the aim is to simplify complexity because 'Behind the great complexity of socio-economic processes beats the heart of a simple operation' (Holling in Gunderson and Holling 2002, 4).

Ontologically deep systems theory allows us to change our values

Secondly, a deeply realist version of systems theory liberates humanity from the self-imposed limitation on our ethical behaviour that we cannot use facts to guide our actions and that therefore scientific facts should not be allowed change our values (for an example of this limitation, see Biesta and Burbules 2003, 18). This ability to find or know truth in order to act and thus survive is not the prerogative of humans. As Charles Sanders Peirce (CP 5.591) explained, 'But if you are going to think every poor chicken endowed with an innate tendency towards a positive truth (to identify a grain as food and then to eat it), why should you think that to man alone this gift is denied?' One might wonder why Peirce would think that some people believe that humans are less endowed than a chicken when it comes to being able to use knowledge to guide their actions. This is because of Hume's Law (mentioned earlier) which perplexingly suggests that there is no relationship between our facts (knowledge) and values (which direct our action), branded the 'fact-values dichotomy'. It is based on the conviction that there is no way to derive an 'ought' from an 'is' (Bhaskar 2016, 38). That Hume's Law should have found fertile ground in the scientific community is remarkable since, patently, the relationship between knowing and acting is woven into the nature of life itself, so that recognizing environmental signals such as the presence of food or comfortable temperatures is something that even the simplest life forms can do. Indeed, it is something that can happen at the sub-individual level of life forms too, for example, the homeostatic system of the human body is based on being able to recognize changes in the body's physiology and to respond accordingly. Misreading a situation can result in threats to survival, such as the way that a body's misreading of a particle as foreign when it is not, can lead to autoimmune conditions. Phrases such as 'homeostasis' and 'environmental signals' connect this discussion to questions of systems theory, and one of the main points that I want to make in this article is that Bhaskar's ethics, based on his version of moral realism, is nothing less than the mechanism of homeostasis and evolution applied to our socio-ecological system integrity.

Bhaskar's ethics is neither dictatorial nor teleological

However, Bhaskar's denial of the fact value dichotomy does not shift us back to a preHumean innocence in which science appears to dictate ethics to us, whilst nevertheless veiling the presence of values so deeply held in our way of seeing the world that they seem somehow innate, such as was assumed by Kant in the seventeenth century with his idea of 'the moral law within me' (Bhaskar in Singh, Bhaskar, and Hartwig 2020, 252). Currently, this preHumean innocence, when it is found in contemporary contexts, results in a deeply conservative attitude towards values, based on a kind of eternal and unquestionable 'moral law', which must be provided either by some external source, usually religion or social norms (Elder-Vass 2019; Porpora 2019; Vandenberghe 2019) or some internal source such as God, or, for the atheistically inclined, evolution, in terms of the natural survival instinct (Sayer 2019). To the contrary, Bhaskar's systems-based, homeostatic approach to ethics starts with human values and then checks that they are appropriate given both the facts of the situation and one's goal of flourishing, where one's own wellbeing is dependent on the wellbeing of others (Bhaskar 2016, 134). That is, we need to *forget the moral law* in the sense of Kant's abstractly universal moral laws (Hartwig in Bhaskar 2016, 253 note 68), whilst at the same time strengthening the mechanism by which we find moral laws. Since acting on knowledge is, *ceteris paribus*, a given in Bhaskar's approach[2], resolving socioecological system problems involves correcting the method of homeostasis (our social method of finding 'environmental signals' that indicate the best way to act) rather than correcting the consequences of the failure of homeostasis (the misguided action or inaction based on misguided ethics and/behaviours). This is reminiscent of Gandhi's non-instrumentalism in which we fearlessly trust the means to arrive at appropriate ends. 'For me it is enough to know the means. Means and ends are convertible terms in my philosophy of life' (Gandhi 1924, 424).

Bhaskar's systems-based approach to ethics also avoids the self-righteous focus on people's behaviour, the 'telling' of people what to do, because it assumes that, given the correct information, we will tend to act appropriately (always keeping in mind the caveat of *ceteris paribus* – all thing being equal. It shifts the ethical commentary away from aiming to change people's beliefs and associated behaviours, towards aiming to change the homeostatic mechanism that gave them the wrong information (the wrong moral truth) that lead to their ethical error in the first place:

> Moral truth is obtained by: initially checking that one's beliefs about one's object/ive[3] are not false, with the aim of removing intra-discursive error; followed by negatively valuing the extra-discursive entity or entities (ills, such as ill health or social structures) which constrain achieving discursive truth and, ceteris paribus, positively valuing actions to remove the problematic extra-discursive entity or entities (Bhaskar 2009, 182–194).[4]

This systems-based, homeostatic approach is a significant advance on our current understanding of ethics. As an environmental educator who has always felt uncomfortable with the role of 'keeper of the moral high ground' and the need to 'change behaviour' (as if I somehow knew what was best for everyone and the world), this approach gives me a sense of personal relief. In practical terms, it requires that environmental educators put their energy into changing neither individual nor corporate behaviour, but rather the problems that restrain the full attainment (to the best of our ability) of truthful knowledge about our situation and the free and fair distribution of this knowledge to all stakeholders. For instance, I assume that a first step would be the achievement of independent presses, of independent research institutions and of trustworthy sources of information, along with the formation of strong, citizen-based democracies that ensure that, on the basis of interdisciplinary, up-to-date and accessible information, humans have the power to guide humanity towards protecting its ecosystems.

Conclusion

Theoretically, the transcendental realist philosophy of Roy Bhaskar allows us to potentially redefine many well-known concepts associated with complexity theory, such as chaos, randomness, chance, homeostasis, fractals, and strange attractors in terms of their underlying explanations rather than (only) their mathematical descriptions. Practically, Bhaskar's philosophy gives us permission to act to protect our Earth from climate change and other environmental threats, even though we cannot achieve accurate predictions of what the future holds in terms of these threats. Furthermore, if we assume, with Bhaskar, that reality is layered and includes empirical, actual and deep aspects, it becomes apparent that we need to avoid instrumentalist approaches to addressing environmental threats. Whilst instrumental interventions can, at best, offer short-term relief, they also risk unintended consequences. Furthermore, on their own they are insufficient because they do not deal with the deep structural forces that are behind the emergence of the environmental crisis. A welcome consequence of the Bhaskarian systems-based version of ethics – which I have redescribed as the mechanism of socioecological homeostasis – is that it releases us from having to self-righteously tell people what to do and/or trying to change their behaviour. Instead, it suggests that we should focus our activities on absenting problems which constrain our achievement of discursive truth, such as problematic social structures (for example the absence of a free and fair press or the absence of independent research institutions). One of the problems that constrains the achievement of discursive truth is the mainstream assumption that science ought to be based on Hume's philosophy, and it is this problem that I try to absent in this article.

Notes

1. For a more comprehensive treatment of the implication for boundaries see Karim Knio (2023), in this special issue of Journal of Critical Realism.
2. For more about Bhaskar's move from knowledge about reality to action, see his ontological-axiological chain, which he calls 'explanatory critique' (Bhaskar 2009). For a summarised version of explanatory critique see Price (2019). The strong relationship between knowing and acting in complex – or wicked – systems has been noted by Rittel and Webber (1973, 161) who state, 'To find the problem is thus the same thing as finding the solution; the problem can't be defined until the solution has been found'; although for their statement to be adequate we must incorporate the *ceteris paribus* (all things being equal) clause. This means that in practice, since usually all thing are not equal, different action options will have to be considered in terms of their relative advantages and disadvantages.
3. Note that Bhaskar joins objects and objectives together here when he writes 'object/ive'. The implication is that the process of knowing about objective reality is intertwined with the process of knowing our objectives (leading to action to achieve those objectives).
4. Some may object that Bhaskar 's assumption that it is possible to falsify beliefs is not value-neutral because it assumes that we should value truth, making him guilty of that which he critiques, namely that there is some Kantian-like base-line moral law. In defence of this objection, he writes, 'It might be objected that 'P is false' is not value-neutral. But if it is not value-neutral, as is indicated by the prescriptive component involved in truth claims, then the value-judgement 'P is false' can be derived from premises concerning the lack of

correspondence or mismatch of object (O) and belief (P). Moreover, as assuming that such judgements are intrinsic to any factual discourse we are nevertheless able to infer from them, together with explanatory premises, conclusions of a type which are not intrinsic to every factual discourse (that is, we can negatively value the source(s) of false information, such as a system of social relations, accounting for the mismatch in reality between the belief P and what it is about O; and positively value action rationally directed at removing, disconnecting or transforming the source(s) of false consciousness and as such) we do have a transition here that goes against the grain of Hume's law, however it is supposed to be interpreted or applied. On the other hand, if 'P is false' is value-neutral, then the inferences to 'P ought not to be believed (CP)' and 'Don't believe (act upon) (CP)' certainly seems inescapable.' (Bhaskar 2009, 124) (CP = *ceteris paribus*).

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