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The polycrisis and the uncertainty possibility space

Bruno Charbonneau[1] and Alexandre Giguère[2]

[1]Department of Humanities and Social Sciences, Royal Military College Saint-Jean, Richelain, QC, Canada and [2]Department of Science, Royal Military College Saint-Jean, Richelain, QC, Canada

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Corresponding author:
Bruno Charbonneau;
Email: bruno.charbonneau@cmrsj-rmcsj.ca

Abstract

Non-technical summary. At the heart of the polycrisis debate is the struggle to grapple with both the scientific and political uncertainties of the Anthropocene. The struggles over what to do about the polycrisis are thus found at the intersection of science and politics. We must approach the polycrisis as simultaneously a scientific and political challenge. To do so we propose that the polycrisis project adopts the methods of decision-making under deep uncertainty as a way to integrate and encourage collaborations between the scientific and policy worlds.

Technical summary. The polycrisis concept points to the interaction of multiple global crises and, arguably, to the difficulties in grasping the current moment with conceptual clarity. While Lawrence et al. emphasize the causal relations between crises in multiple global systems to define and operationalize the concept, we argue that they underestimate the politics of knowledge claims about the polycrisis, from the concept's performative function, from the normative claims it enacts or enables, and from the program of action that it carries or implies. We argue instead that at the heart of the polycrisis debate is the struggle to grapple with the (deep) uncertainties – both scientific and political – of the Anthropocene. Polycrisis is found operating at the intersection of science and politics where claims to scientific knowledge and political value, and scientific and political judgements, collide. Dealing with the uncertainties of the polycrisis is thus a matter of scientific methodological conundrum and a matter of political judgement and decision. We then propose that the polycrisis research program adopts decision-making under deep uncertainty methods to reach its objectives of improving policy outcomes, but also to better navigate what we call the uncertainty possibility space of the polycrisis.

Social media summary. The polycrisis is a struggle to grapple with the uncertainties of the Anthropocene which demands a new policy approach.

1. Introduction

In the leading article of this issue of *Global Sustainability*, Michael Lawrence, Thomas Homer-Dixon, Scott Janzwood, Johan Rockström, Ortwin Renn, and Jonathan F. Donges propose a conceptual framework and research program around the term 'polycrisis'. They argue that the concept captures the intuition that the world's crises are interconnected and must be addressed together, but also that it needs a precise framework and research agenda to 'help scholars generate actionable insights into the world's interwoven crises'. They develop a research program that emphasizes 'the causal mechanisms that entangle multiple global systems and that appear to be generating near-simultaneous global crises' (Lawrence et al., 2024a).

There is much value and potential in such a polycrisis project. We share the necessity and urgency of it. Yet, in practice, not only is it difficult to track all the causal mechanisms but the translation of any understanding of such mechanisms into actionable or policy-relevant knowledge might be the bigger challenge, notably as the practice of policymaking introduces inherent political uncertainties. Political uncertainty is the result of a combination of scientific uncertainties (unsolved scientific problems, unknown or incomplete data and knowledge, ambiguous interpretation, etc.) and uncertainties about political action (the consequences of a decision or action, of the decision-making process and of the underlying value judgements).

In this article, our engagement with the attempt by Lawrence et al. (2024a) to analyze the polycrisis emphasizes uncertainty as a space-time of possibilities, as a space-time of decision-making, where science and politics meet to judge what to do about the polycrisis. We believe that the study of the polycrisis highlights the growing importance and consequences of uncertainty, that uncertainty is inevitable and that the interface between the uncertainties of science and politics must therefore be at the heart of the analysis.

Most importantly, we argue that the polycrisis research program needs to be more aware of or explicit about what it means to engage in politics and policy through the polycrisis framework. In their effort to formalize a scientific project that will lead to 'actionable insights', Lawrence et al. (2024a) seem to underplay or underestimate three aspects: (1) the politics of the polycrisis

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debate; (2) the centrality, significance, and impact of the polycrisis being *in and of the* Anthropocene; and (3) the inevitability and consequences of (deep) uncertainty for both science and politics.

After our discussion of the concept, we propose that the polycrisis research program adopts an approach that combines scientific and political judgements, which can find inspiration from decision-making under deep uncertainty (DMDU) methods. These methods emphasize the need to work at the nexus of science and politics, where the management of uncertainty is a practice where claims to scientific truth and claims to political values can collide, and where scientific and political judgements intersect, compete, or combine over what to do about the polycrisis. Polycrisis is precisely interesting and useful, and its potency for policy substantial and transformative, when and where it does not take the science/policy distinction for granted, and when and where it calls into question the basis of our scientific and political judgements – this is the uncertainty possibility space that the polycrisis research program should inhabit and navigate.

2. The politics of (the) polycrisis

What is the research question or policy problem that the concept of polycrisis frames? Broadly speaking, polycrisis seeks to understand the interaction of multiple global crises or systemic risks, and the emerging properties generated by these interactions. For Lawrence et al. (2024a), polycrisis should be specifically concerned with the global crises 'that significantly degrade humanity's prospects', although they recognize that polycrisis can occur at different scales, from local to global.

Yet, beyond what it aims to describe and to comprehend, polycrisis also expresses the conceptual difficulties in clearly grasping the contemporary moment of intertwined crises, their complexity, and the levels of uncertainty involved (Davies & Hobson, 2022; Tooze, 2022). At the risk of oversimplification, the polycrisis debate is about three issues: (1) the definition of the term itself and its usefulness as a conceptual framework; (2) its potential as an analytical tool for policy or specifically for crisis management; and (3) the implicit or explicit politics that the concept conveys. The three issues overlap and inform each other.

The debates about the concept of polycrisis revolve around two main positions that very much rest on the article that one finds in front of it – on whether one talks of *a* polycrisis or *the* polycrisis. The first, polycrisis as potentially plural, sees the concept as, simply put, a situation of multiple crises, perhaps interdependent, perhaps not. The concept's complexity theory roots are hard to miss, but the divergent ways in which it has been used in popular media has instead given it the aura of the newest buzzword (Drezner, 2023). In this context, it is not surprising that the concept is perceived by some as redundant, as a slogan or buzzword that expresses nothing new or useful. In the words of historian Niall Ferguson, the polycrisis is 'just history happening' (cited in Reid, 2023). To explain, and to go beyond, this limited understanding, Adam Tooze argues that the concept is necessarily based upon a more or less explicit philosophy of history (Tooze, 2023). For Tooze, polycrisis refers to the abnormal coincidence of disparate shocks, of course, but it is more than a situation of multiple crises: it is an emergent situation where the whole is more, and potentially more dangerous, than the sum of its parts. Moreover, the prefix 'poly' draws attention to 'the diversity of challenges without' specifying causal links, without 'a single dominant contradiction or a single source of tension or dysfunction' (Tooze, 2022).

Perhaps most importantly for Tooze, the concept of polycrisis suggests that we have every reason to believe that we are at a dramatic historical moment that needs us 'to rethink and resituate inherited categories of social analysis and political philosophy in light of contemporary development' (Tooze, 2022). The particular conditions of our time can be summed up in the concept of the Anthropocene. And while this concept is also subject to debate (Chandler et al., 2021), it expresses the need to combine, on the one hand, traditional analyses that reveal the limits of capitalism and of the international state system and, on the other, analyses of the transformation of the Earth's systems resulting from climate change, biodiversity loss, and pollution, and the speed at which these changes are occurring. In short, the Anthropocene introduces geological time into human affairs and thus constitutes *the* polycrisis. It is this position – that *the* polycrisis expresses a singular or particular historical moment – that we adopt in this article and defend in the next section.

The two positions – polycrisis as 'just history happening' or as a moment of systemic and uncertain transformations – are not mutually exclusive and easily overlap in practice, although the normative project they propose might not be compatible. One element of the conceptual dispute is about whether the concept of polycrisis can go beyond the claim that multiple global crises are intertwined and help us understand how they can or might amplify each other, create feedback loops and cascading effects, blur lines between cause and effect, and generate emergent properties. To also avoid the fate of the empty buzzword and transform it into a 'conceptual framework and research program that enables us to better understand the causal linkages between contemporary crises', Lawrence et al. define 'a "global polycrisis" as *the causal entanglement of crises in multiple global systems in ways that significantly degrade humanity's prospects*' (Lawrence et al., 2024a, p. 1, 4; italics in original). Crisis is here understood 'as a sudden (non-linear) event or series of events that significantly harms, in a relatively short period of time, the wellbeing of a large number of people' (Lawrence et al., 2024a, p. 4).

Lawrence et al.'s (2024a) definition takes the multiple polycrisis approach, although they acknowledge the particularities of the Anthropocene as the call for papers for this special issue made clear (see our next section). This combination makes for an ill-defined engagement with the politics and policy of the polycrisis. In trying to define polycrisis for use as a conceptual framework and research program, their explicit objective is to make it relevant for policy, 'to improve policy outcomes', and to guide us into the 'tumultuous future'. They conclude by suggesting to governments and policymakers that they should work on crisis interactions, not on siloed crisis management; that they should address the architecture of global systems, not prioritize responses to events; and that they should exploit 'high-leverage intervention points' (Lawrence et al., 2024a). While they are certainly aware of the entwining of knowledge and power (see a later publication: Lawrence et al., 2024b), they nevertheless seem to ignore or distance themselves from the politics of knowledge claims about the polycrisis, from the concept's performative function, from the normative claims it enacts or enables, and from the program of action that it carries or implies. After all, while the polycrisis 'begets a model of crisis management' (Hames, 2022), it does not tell us anything about what future this management should enact or serve. Polycrisis can serve the status quo under claims of 'just history happening', provide analytical and therapeutic support for making sense of 'the current crisis moment' (Tooze, 2022), or support social movements and counter-hegemonic

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alternatives of the future (Albert, 2024). As Lähde (2023) put it in the context of the polycrisis debate, 'However much care is taken to define them [concepts], no conceptualisation is immune to cooptation for radically different uses'.

It seems to us that polycrisis is inevitably found operating at the intersection of science and politics, where claims to scientific knowledge and political value and scientific and political judgements meet and at times compete. The back and forth between proponents of polycrisis – like Adam Tooze, or Kate Mackenzie and Tim Sahay (2022), to name but a few who think the polycrisis is transformative and a characteristic of our epoch – and its opponents – like Daniel Drezner and Noah Smith who argue it is only a buzzword or 'just history' – is more than a debate over global crises. The debates are reflections of the material and intellectual struggles over normative claims and emerging properties, over the radical potential of the term to express the possibilities of political life under current (and future) conditions. As Robert Cox (1981) famously put it in the context of International Relations scholarship, 'theory is always for someone and for some purpose'. Different definitions of the term polycrisis carry, convey, enact, or enable/disable (competing) judgements and possibilities. For instance, the current logic of the term 'crisis' can be useful as a tool for promoting stability, 'a predominantly conservative modality, seeking to stabilize an existing structure within a radically contingent world' (Masco, 2017). (Naomi Klein [2007] made a similar point in her book *The Shock Doctrine*, arguing that global neoliberal élites and institutions exploited national crises [disasters or upheavals] to establish controversial and questionable neoliberal policies while citizens were too distracted by the crisis to resist or respond. Thanks to Tom Deligiannis for the comparison to Klein.) The backlash against the concept of polycrisis can be understood in this way: a recognition that the concept of *poly*-crisis is a reappropriation of both the concept of crisis and the practice of crisis management and thinking, carrying radically new and transformative possibilities (adapted for and under the conditions of the Anthropocene). As such, the polycrisis is analogous to the claim that the 'centre cannot hold'; or as Walker (2018) puts it, 'Perhaps it is fair to say that under contemporary conditions, things seem to be especially elusive precisely where and when the international no longer works as a plausible response to those prior problems'.

There is thus a significant tension between polycrisis as a concept of scientific inquiry and as a contested rallying point in current political struggles. At the heart of the polycrisis debate is the struggle to grapple with the transformation of the world; with change, with the elusive, the emerging, the apparent lack of direction and resolution, and thus with the uncertainty of the Anthropocene and what to do about it. Uncertainty is both the analytical and scientific challenge and the site of politics where and when decisions are made, and actions are taken. In uncertainty, one finds a scientific limit, but also political possibilities.

Dealing with uncertainty is thus a matter of scientific methodological conundrum and a matter of political judgement and decision. This intertwined fate of science and politics must inform all efforts at navigating *the* polycrisis. But before we focus on uncertainty, we must discuss and defend our position of situating *the* polycrisis *in the* Anthropocene.

3. Polycrisis in the Anthropocene

The call for papers of this issue of *Global Sustainability* was framed as the 'polycrisis in the Anthropocene', the latter defined as how human societies have become 'the primary driver of change in the Earth's ecological and bio-physical systems'. In turn, the concept of polycrisis 'implies that the Anthropocene epoch features a new character of global crisis in which multiple problems compound and reshape one another, including climate change, ecosystem collapse, pandemics, violent conflict, economic stagnation, unaffordable costs of living, food and energy scarcity, weakened institutions, and systemic inequality'. (All citations are from the original call for papers found here: https://www.cambridge.org/core/journals/global-sustainability/announcements/call-for-papers/polycrisis-in-the-anthropocene <accessed 14 June 2024>)

The connection between the concepts of polycrisis and Anthropocene is often either implicit or missing in the debates over the former. The attempt by Lawrence et al. (2024a) to define a research program around polycrisis seems to imply a connection, but the full significance of the link is not discussed or reflected in the definition of the polycrisis concept. Adam Tooze is known for popularizing the concept, but it is too often seemingly forgotten that he linked it explicitly to the Anthropocene, framing the polycrisis 'in terms of two clusters of forces', one being the traditional focus on the state, geopolitics, and global capitalism, and the other being the shocks coming from the Anthropocene (like COVID-19 and climate change; see Tooze, 2021). Framing the polycrisis as *in the* Anthropocene seems critical because, at their core, Anthropocene discussions and discourses destabilize the familiar narratives about state, geopolitics, and capitalism (Dalby, 2022) and the traditional frames and mindsets of international relations, global/world politics, and global governance (Lövbrand & Mobjörk, 2021). The Anthropocene discourse is the acknowledgement that it is 'a *condition that we are in* rather than … an *external set of problems which we are confronted with*' (Chandler et al., 2021, p. 2; italics in original). As Dipesh Chakrabarty (2021) argues, climate change and related environmental transformations merge human history with geological time, producing a temporality that radically calls into question our political horizon, logic, and action. What are progress, security, peace, democracy, and development under Anthropocene conditions? What is crisis management, or what should it be about, under the conditions of the Anthropocene? The Anthropocene as a condition problematizes the modern binary of 'man *vs* nature', which imposes 'a renegotiation of assumptions about where and what we take political life to be' (Walker, 2016, p. 101).

Understanding the Anthropocene as a *condition* that we cannot escape has important implications for problem-solving, for governance, and for policymaking, notably for what comes under the rubric of climate change governance. Insofar as the Anthropocene is conceived as radically destabilizing the material foundations and philosophical underpinnings of all sectors of human activity, its emergence generates unprecedented levels of uncertainty. It is in this sense that *the* polycrisis becomes the (potential) conceptual tool of the 'insider' who recognizes the Anthropocene condition, paying attention to how Anthropocene forces impact specific practices and sites of crisis management and problem-solving while also rethinking assumptions about the possibilities of political life.

Conceptualized in this way, 'navigating the polycrisis' (Albert, 2024) means navigating the ocean of present and future uncertainties that the Anthropocene has in store for us. Moreover, as argued previously, this navigation will have to take place at the intersection of science and politics, where decisions will have to be based on an uncertain mix of scientific and political

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judgements. What do we know? What is incomprehensible or unknowable? What and how can we deal with a level of uncertainty that is arguably without historical precedent? Decision-making has always managed a certain level of uncertainty, generally through probabilistic risk analysis, but the combination of uncertainties linked to climate change, the Anthropocene, and to human activities has evolved into a serious problem for probabilistic approaches.

To conclude this section, two issues need to be stressed. First, some scholars might be critical of the claim that the current situation is unprecedented in human history. While claims to the unprecedented nature of things abound and are often clichés, even critics must recognize the unprecedented rates and speed at which the earth's systems are transforming. This is a core claim of the planetary boundaries framework and advocates of the Anthropocene as developed by Johan Rockström, Will Steffen, and their colleagues (see Rockström et al., 2009; Steffen & Morgan, 2021). We adhere to this position.

Second, to affirm the unprecedented nature of the polycrisis in the Anthropocene is not equivalent to saying that everyone will experience it in the same way. It is to recognize its political context and effects. It is to recognize and assess the radical possibilities of its politics in the sense that the Anthropocene is calling into question, and radically destabilizing, relations and structures of power that are not disconnected from the scientific production of claims aimed at understanding and navigating the polycrisis. The material, social, and ideological conditions of power are integral parts of the scientific endeavor as they shape the parameters and conditions of knowledge production – and science can shape our political imagination. This is what Sheila Jasanoff calls 'co-production', the intimate connections between science and politics or 'how knowledge-making is incorporated into practices of state-making, or of governance more broadly, and, in reverse, how practices of governance influence the making and use of knowledge' (Jasanoff, 2004, p. 3). The possibilities and limits of scientific judgement in the face of the colossal uncertainties of the Anthropocene will be trivialized if no link is made with the political space, but these same possibilities and limits may well shift or be transformed as we enter the uncharted territory of the Anthropocene. It is in this sense that the polycrisis research program must be explicit about how it will engage with the world(s) of politics and policy that seek to navigate us through the polycrisis.

4. The uncertainty possibility space

We propose to place at the heart of the polycrisis *in the Anthropocene* debate the struggle to grapple with uncertainty, the unknown, the ever changing, and the emerging, with the 'unprecedented existential and temporal uncertainty concerning the future of human subjectivity, and of the Earth itself' (Hamilton, 2019, p. 610). In order to manage this level of uncertainty and, therefore, an uncertain number of future possibilities, we believe that the integration of scientific and political challenges and methods is necessary. For those aiming to navigate the polycrisis, this means working at the intersection of scientific and political judgement, without assuming of the primacy of one over the other.

Having said that, the scientific world deals with uncertainty in different ways than the political world, largely assuming that it is a function of the present state of (cumulative) knowledge. Modern scientific truth claims are usually distinguished from other truth claims on the basis of the precepts of the scientific method. Through a scientific lens, uncertainty can be understood as a lack of information (ignorance) which can be resolved by acquiring more data, as too much information (complexity) which can be managed by developing theoretical approaches or complex models, or as a multiplicity or competing interpretations (ambiguity) through which, arguably, theories and models can be tested, and new discoveries be found. Scientific debates, and thus judgements about how to overcome uncertainty, can involve methodological disputes but also uncertainties about ontological, epistemological, and axiological perspectives (for a sample, see Janzwood, 2023; Katzenstein, 2022; Katzenstein & Seybert, 2018; Matejova & Shesterinina, 2024).

In the political world, uncertainty can be fabricated and weaponized (through propaganda or disinformation, for instance) or 'simply' integrated and managed as an inevitable condition of political life and practice. The possibility of collecting perfect data and reaching perfect knowledge is an ideal that cannot be achieved in practice. Even if it was achievable, knowledge of what was, what is, and what will be does not tell anyone what should be done next. Facts do not speak for themselves; or make decisions for you. The question is rather, as Katzenstein (2022, p. ix) put it to scholars of international relations: 'why do we prefer the resolvable, risk-inflicted world over the radical, uncertainty-marked one that we so often encounter?' For Katzenstein (2022, p. 308), it is 'the closed system assumption that makes the classical model of world politics gloss over uncertainty'. An element of answer is intimately tied to attempts at controlling uncertainty and at limiting its effects in order to preserve hegemonic political structures and relations, because the 'stabilization of an uncertain world … is a political act' (Katzenstein, 2022, p. 15). To acknowledge the inescapability of uncertainty is to acknowledge a range of political possibilities that is theoretically greater than what even science can discover. As Jervis (2017, p. 307) put it, 'uncertainties (of both scholars and actors) reflect not only lack of knowledge that in principle could be gained, but multiple possibilities that have yet to be realized'. Cioffi-Revilla (1998, pp. 3, 11) goes further arguing that the 'absence of strict determination in political life' means that 'our choice is between a rigorous understanding of politics, which must include uncertainty, or no understanding at all'.

While Katzenstein (2022) differentiates between operational uncertainty (the 'known unknowns') and radical uncertainty (the 'unknowable' or 'unknowable unknowns'), he remains firmly grounded into the realm of human affairs, seemingly underestimating how climate change and the Anthropocene multiply the significance of uncertainty and how such uncertainty can affect human affairs. As the field of science and technology studies has taught us, the line between the scientific and the political is not always certain, often blurred, not necessarily where it is supposed to be (Jasanoff, 2013; Wenger et al., 2021). This is precisely the point. In practice, the two worlds are deeply intertwined, be it through research funding flows and priorities, or the ideological conditions or 'worldviews' that frame who has the authority for making legitimate knowledge claims about the world. In the context of the polycrisis, it seems to be particularly pressing to address the uncertainties that are located at the science-policy nexus. Uncertainty is both a challenge to overcome and a possibility to create a future yet to be determined. The next section

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explores how one could build a project emphasizing the uncertainty possibility space.

5. The management of the uncertainty possibility space

In the last section of this article, we propose a potential solution. These are the beginnings of a project that seeks to navigate the polycrisis in the Anthropocene by focusing on the management of uncertainty at the intersection of science and politics. This intersection is conceived as a space of possibilities; literally a space where the future is indeterminate, and everything is theoretically possible and imaginable. Our inclusion in this space has the objective of producing knowledge and insights that are useful for the political navigation of *the* polycrisis. We propose this not in opposition to Lawrence et al. (2024a) but as a complement or an alternative.

We know that the climate is changing and warming and that global climate trends are increasingly well-understood (IPCC, 2023), but there are still several levels and sources of uncertainty surrounding its actual transformation and pertaining to the impacts and their distribution. The limitations of our physical models and of our understanding of the interaction between the Earth's systems, measurement errors, and uncertainties surrounding observational instruments, tipping points, natural variability, and climate sensitivity are scientific types of uncertainty that can theoretically be resolved through more research but never fully overcome (on the 'vast machine' of climate science, see Edwards, 2010). Furthermore, efforts at modeling climate change and its impacts or at mapping the polycrisis must also consider the value-laden and politically fraught context of decision-making processes and dynamics. As the debate around the concept of polycrisis demonstrates, any attempt at 'navigating' it involves contested framings, divergent worldviews, power relations and structures, and competing interests.

The level of uncertainty at play is also difficult to imagine. As Gregg Mann (2023) puts it, 'attempts to anticipate the impact of climate change, especially beyond the short-term, face an "immense cascading of huge uncertainties" of "truly stupendous" scale and scope'. More fundamentally for Hamilton (2019, p. 623), the collapse of the 'man-nature' binary is key as the 'Anthropocene integrates humanity and Nature into a system of incomprehensible complexity'. Yet, the scale and scope of the challenges must not prevent us from taking action. The aim is not to understand this complexity completely, but sufficiently to guide us through the polycrisis.

To improve policy outcomes, the polycrisis project must not only seek to reduce scientific uncertainty but contribute to its management. To do so, some methods are readily available. DMDU is a branch of decision science that aims at making such management possible, focused on making choices in situations where there is limited or uncertain information about the future, and where the consequences of those choices are also uncertain. DMDU is a generic term that 'consists of a set of concepts, methods, and approaches designed to inform and improve decisions that face such conditions' (Lempert et al., 2024). DMDU includes several types of approaches, ranging from dynamic adaptive planning, dynamic adaptive policy pathways, info-gap decision theory, engineering options analysis, and robust decision making (Marchau et al., 2019). Notwithstanding the different methods, a key element of DMDU is the development of a decision-making capability that does not depend on predicting the future or on risk assessments.

In DMDU parlance, uncertainty refers to the limits of our knowledge about the past, present, and future, but also involves the subjective judgement about the state of 'existing knowledge, which is colored by the underlying values and perspectives of the decisionmakers' (Marchau et al., 2019, p. 2). More importantly, DMDU methods tackle deep uncertainty head-on, because it recognizes that it can lead to decision paralysis, be ignored, or trap decision-makers into 'substituting assumptions for deep uncertainties [which] might simplify choices in the short term but may come at a much higher price in the longer term' (Marchau et al., 2019, p. 4). DMDU methods vary, but they all 'emphasize multi-scenario, multi-objective decision analyses, considering a wide range of plausible futures; seeking policies which are robust over these futures rather than optimal for any best estimate' (Lempert et al., 2024). They seek to address 'multiple rather than single policy objectives in order to reflect a diversity of values; and explicitly designing policies to adjust over time in response to new information' (Lempert et al., 2024). DMDU methods have achieved interesting results in complex and high-stakes domains such as environmental policy, infrastructure development, and public health (Kingsborough et al., 2017; Webber & Samaras, 2022; Workman et al., 2021).

The traditional decision-making method often assumes that the future can be reasonably predicted or imagined. It thus relies on a 'predict-then-act' approach using deterministic models, probabilistic assessments, and historical data. It evaluates solutions based on their performance in the predicted scenarios, and once a decision is finalized, the plan is usually rigid. In contrast, DMDU acknowledges the unpredictability of the future and does not lean heavily on precise predictions. It uses stochastic models, simulations, and scenario planning, but without any pretension in regard to predicting a precise future. The emphasis is on exploring conceivable and plausible possibilities. It can create an assortment of scenarios – a multiplicity or multiverse of possible futures – that requires an approach to decision-making that emphasizes preparation, continuous monitoring, flexibility, and adaptability. The simulations of this multiverse can be generated by computer or, for example, by tabletop exercises. The objective is to produce plausible future scenarios that will be used to identify the strategy that would be able to respond to the greatest number of scenarios. The data generated by the simulations are then studied to identify the circumstances or conditions that could defeat the strategy (Groves & Lempert, 2007; Lempert & Groves, 2010). In this way, DMDU methods recognize the uncertainty that arises from the limitations of the data and the judgement of experts and decision-makers.

Modeling a multiverse that includes the evolution of the earth's systems and the human context in which the research takes place requires immense resources, particularly computer resources. Climate models already exist, but their integration with human scenarios remains limited (Reed et al., 2022). However, the new era of artificial intelligence technologies is opening the door to solutions, as demonstrated several fields, from medicine to management, where they have had a major impact (Agarwal et al., 2024; Miller & Brown, 2018). At the moment, the main drawback is that these technologies are essentially black boxes. It is difficult, if not impossible, to understand how the AI machine arrives at its conclusions or predictions, because the causal links are not apparent. Nevertheless, they are proven invaluable for understanding and managing complex interactions and for diagnosing uncertainties. They have had great success in simplifying the calculations of hydrological models, cloud models, climate modeling, etc. (Rolnick et al., 2023).

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Combined with DMDU methods, AI technologies facilitate the production of the multiverse required for DMDU approaches. In theory, they allow an exponential increase in the number of simulations, scenarios, and assumptions that can be tested. They make it possible to explore the impact of a large number of different assumptions, decisions, variables, and feedback loops. For example, we could simulate different food security futures to test the impact of potential strategies, highlight vulnerabilities, assess uncertainties, challenge assumptions, and identify resilient strategies.

These technologies can be leveraged through DMDU methods for the purposes of producing polycrisis-relevant policy insights. DMDU methods promote two key principles. One is that 'science-based analysis should seek to facilitate human creativity, deliberation, and judgment in solving complex problems rather than aspire to proscribe the best decisions' (Lempert et al., 2024). The main objective of an AI-assisted polycrisis multiverse would not primarily be to identify causal mechanisms or predict outcomes, but to build a space of plausible and possible futures against which policy options are assessed according to predetermined policy objectives. As Marchau et al. (2019, p. 25) put it,

> models and data become vehicles for systematically exploring the consequences of assumptions; expanding the range of futures considered; crafting promising new responses to dangers and opportunities; and sifting through a multiplicity of scenarios, options, objectives, and problem framings to identify the most important tradeoffs confronting decisionmakers.

As such, DMDU methods recognize the uncertainty inherent to science, and thus the necessity of political judgement but also the need for flexibility in decision-making processes and mechanisms so that the strategy can adapt quickly to changing circumstances. The creation of an uncertainty possibility space – a multiverse – will create its own set of uncertainties that need to be carefully controlled, monitored, updated with more or new data or through simulations. Only in recognizing the uncertainty of the scientific endeavor can, to name the DMDU's second key idea, 'science help decision-makers manage deep uncertainty, not just reduce it' (Lempert et al., 2024).

Implementing an AI-assisted DMDU mechanism to navigate the uncertainty possibility space of the polycrisis presents us with two central challenges. One is technical. Modeling the polycrisis multiverse will still be a monumental task, although various models of global systems (climate, food, energy) now exist, and AI tools are now more accessible and powerful than ever (Kitsios et al., 2023; Wong, 2024). Moreover, depending on the policy objective, the precision of the polycrisis multiverse and its level of complexity might not need to be so high – not all possibilities need to be simulated. The framing of the analysis and the modeling should be custom-made to answer the identified policy problem, which allows to specify the system structure and its boundaries. Modeling the polycrisis multiverse is only the first step and it must be done in close collaboration with the stakeholder or policy partner.

A second set of challenges is human. To maximize their impact or usefulness, DMDU methods necessitate to be anchored in a particular context and respond to a specific problem. The definition of the problem to be solved is crucial. Navigating the polycrisis is too vague. You first need to identify the starting line and the policy or strategic objectives. A scientific team can develop a project in isolation and independently, but DMDU methods were designed for close collaboration between scientists and decision-makers. It is the organization (be it a government, a ministry, a city council, a non-profit organization, a private corporation) that must identify the problem to be solved and the strategic objective to achieve. The scientific team will help refine the problem and the objectives, while providing analyses and decision-making tools. This way of managing the uncertainty possibility space is agnostic because the political and ethical issues are raised a priori, in the choice and the parameters of the collaboration. Moreover, one of the advantages of AI-assisted DMDU methods is precisely that they constantly test the hypotheses, premises, and biases of the analysis, as allowed by the construction of a multiverse of plausible possibilities.

The other side of this coin, however, is that such methods can be labor and resource intensive and, perhaps more importantly, they undoubtedly require a change in organizational culture and in decision-making practices, mechanisms, and modes of governance, as DMDU methods are designed for strategic (long-term) planning and imply giving up the illusions of control and predictive possibility. Organizations often lack the capacity to think long-term or to integrate strategic perspectives with their daily and short-term practices. Hierarchical and control-focused organizations might struggle with the messiness and ambiguity of competing normative, scientific, and political value judgements, or with participatory or democratic approaches. While there are limits to our AI-assisted DMDU alternative, the key point is that to be useful and effective it must be adapted to the particular context of the science-policy intersection where it is deployed.

6. Conclusion

In this article, we have defended the idea that the polycrisis must be located in the Anthropocene and, consequently, that one of its main characteristics is the scale and scope of the uncertainties it generates. Based on this foundation, we argued that the key challenge is the management of deep uncertainties and that this challenge can only be faced at the intersection of science and politics, where different judgements clash, conflict, or merge. To navigate the polycrisis, we have proposed the construction of a multiverse of possibilities adapted for use by DMDU methods. Adopting DMDU methods is not a claim to having found a panacea, to produce a superior truth, or to escape politics. On the contrary, rather than ignoring or glossing over the uncertainty and political judgements that underlie any understanding of the polycrisis, DMDU methods integrate and insert them into a rigorous (albeit imperfect) process of strategic decision-making. Theoretically, there is no limit to the number of strategies that can be tested or the type of political project that can be supported. The limits of DMDU methods are to be found in the definition of the problem to be solved, and therefore in the choice of the political actor with which the research team may implicitly or explicitly decide to associate itself.

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References

Agarwal, N., Moehring, A., Rajpurkar, P., & Salz, T. (2024). *Combining human expertise with artificial intelligence: Experimental evidence from radiology*. National Bureau of Economic Research Working Paper Series.

Albert, M. (2024). *Navigating the polycrisis. Mapping the futures of capitalism and the earth*. MIT Press.

Chakrabarty, D. (2021). *The climate of history in a planetary age*. The University of Chicago Press.

Chandler, D., Müller, F., & Rothe, D. (Eds.). (2021). *International relations in the Anthropocene. New agendas, new agencies and new approaches*. Palgrave Macmillan.

Cioffi-Revilla, C. (1998). *Politics and uncertainty. Theory, models and applications*. Cambridge University Press.

Cox, R. (1981). Social forces, states and world orders: Beyond international relations theory. *Millennium*, *10*(2), 126–155. https://doi.org/10.1177/03058298810100020501

Dalby, S. (2022). *Anthropocene geopolitics: Globalization, security, sustainability*. University of Ottawa Press.

Davies, M., & Hobson, C. (2022). An embarrassment of changes: International relations and the COVID-19 pandemic. *Australian Journal of International Affairs*, *77*(2), 150–168. https://doi.org/10.1080/10357718.2022.2095614

Drezner, D. (2023). Are we headed toward a 'polycrisis'? The buzzword of the moment, explained. *Vox*. Retrieved: https://www.vox.com/23572710/polycrisis-davos-history-climate-russia-ukraine-inflation

Edwards, E. P. (2010). *A vast machine: Computer models, climate data, and the politics of global warming*. MIT Press.

Groves, D. G., & Lempert, R. J. (2007). A new analytic method for finding policy-relevant scenarios. *Global Environmental Change*, *17*(1), 73–85. https://doi.org/10.1016/j.gloenvcha.2006.11.006

Hames, R. (2022). Attention deficit hyperobject disorder. *Crudes Futures*. Retrieved: https://crudefutures.substack.com/p/attention-deficit-hyperobject-disorder

Hamilton, S. (2019). I am uncertain, but we are not: A new subjectivity of the Anthropocene. *Review of International Studies*, *45*(4), 607–626. https://doi.org/10.1017/S0260210519000135

IPCC. (2023). Sections. In H. Lee & J. Romero (Eds.), *Synthesis Report. Contribution of Working Groups I, II and III to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change* (pp. 35–115). Climate Change. https://doi.org/10.59327/IPCC/AR6-9789291691647

Janzwood, S. (2023). Confidence deficits and reducibility: Toward a coherent conceptualization of uncertainty level. *Society for Risk Analysis*, *43*(10), 2004–2016. https://doi.org/10.1111/risa.14008

Jasanoff, S. (2004). The idiom of co-production. In S. Jasanoff (Ed.), *States of knowledge. The co-production of science and social order* (pp. 1–12). Routledge.

Jasanoff, S. (2013). *Science and public reason*. Routledge.

Jervis, R. (2017). One world or many? *Critical Review*, *29*(2), 170–188. https://doi.org/10.1080/08913811.2017.1315920

Katzenstein, P. (Ed.). (2022). *Uncertainty and its discontents. Worldviews in world politics*. Cambridge University Press.

Katzenstein, P., & Seybert, L. A. (Eds.). (2018). *Protean power. Exploring the uncertain and unexpected in world politics*. Cambridge University Press.

Kingsborough, A., Jenkins, K., & Hall, J. W. (2017). Development and appraisal of long-term adaptation pathways for managing heat-risk in London. *Climate Risk Management*, *16*, 73–92. https://doi.org/10.1016/j.crm.2017.01.001

Kitsios, V., O'Kane, T. J., & Newth, D. (2023). A machine learning approach to rapidly project climate responses under a multitude of net-zero emission pathways. *Communications Earth & Environment*, *4*(1), 355. https://doi.org/10.1038/s43247-023-01011-0

Klein, N. (2007). *The shock doctrine: The rise of disaster capitalism*. Metropolitan Books/Henry Holt and Company.

Lähde, V. (2023). The polycrisis. *Aeon*. Retrieved: https://aeon.co/essays/the-case-for-polycrisis-as-a-keyword-of-our-interconnected-times

Lawrence, M., Homer-Dixon, T., Janzwood, S., Rockström, J., Renn, O., & Donges, J. (2024a). Global polycrisis: The causal mechanisms of crisis entanglement. *Global Sustainability*, *7*, e6. https://doi.org/10.1017/sus.2024.1

Lawrence, M., Shipman, M., Janzwood, S., Arnscheidt, C., Donges, J., Homer-Dixon, T., Otto, C., Schweizer, P. J., & Wunderling, N. (2024b). *Polycrisis research and action roadmap 2024: Gaps, opportunities, and priorities for polycrisis research and action*. Cascade Institute. https://cascadeinstitute.org/technical-paper/polycrisisroadmap

Lempert, R. J., & Groves, D. G. (2010). Identifying and evaluating robust adaptive policy responses to climate change for water management agencies in the American west. *Technological Forecasting and Social Change*, *77*(6), 960–974. https://doi.org/10.1016/j.techfore.2010.04.007

Lempert, R. J., Lawrence, J., Kopp, R. E., Haasnoot, M., Reisinger, A., Grubb, M., & Pasqualino, R. (2024). The use of decision making under deep uncertainty in the IPCC. *Frontiers in Climate*, *6*, 1–18. https://doi.org/10.3389/fclim.2024.1380054

Lövbrand, E., & Mobjörk, M. (Eds.). (2021). *Anthropocene (In)Securities. Reflections on collective survival 50 years after the Stockholm conference*. Oxford University Press.

Mackensie, K., & Sahay, T. (2022). 'An introduction to polycrisis'. The Polycrisis newsletter. Phenomenal World. https://www.phenomenalworld.org/analysis/an-introduction/

Mann, G. (2023). Treading thin air. *London Review of Books*, 45(17). Retrieved: https://www.lrb.co.uk/the-paper/v45/n17/geoff-mann/treading-thin-air

Marchau, V., Walker, W., Bloemen, P., & Popper, S. (2019). *Decision making under deep uncertainty from theory to practice: From theory to practice*. Springer eBooks. https://doi.org/10.1007/978-3-030-05252-2

Masco, J. (2017). The crisis in crisis. *Current Anthropology*, *58*(S15), S65–S76. https://doi.org/10.1086/688695

Matejova, M., & Shesterinina, A. (Eds.). (2024). *Uncertainty in global politics*. Routledge.

Miller, D. D., & Brown, E. W. (2018). Artificial intelligence in medical practice: The question to the answer? *The American Journal of Medicine*, *131*(2), 129–133. https://doi.org/10.1016/j.amjmed.2017.10.035

Reed, P. M., Hadjimichael, A., Moss, R. H., Brelsford, C., Burleyson, C. D., Cohen, S., Dyreson, A., Gold, D. F., Gupta, R. S., Keller, K., Konar, M., Monier, E., Morris, J., Srikrishnan, V., Voisin, N., & Yoon, J. (2022). Multisector dynamics: Advancing the science of complex adaptive human-earth systems. *Earth's Future*, *10*(3), e2021EF002621. https://doi.org/10.1029/2021EF002621

Reid, J. (2023). 'Idea of de-globalization is a "mirage", says historian Niall Ferguson'. https://www.cnbc.com/2023/01/17/idea-of-de-globalization-is-a-mirage-says-historian-niall-ferguson.html

Rockström, J., Steffen, W., Noone, K, Persson, Å., Chapin, F. S., Lambin, E. F., Lenton, T. M., Scheffer, M., Folke, C., Schellnhuber, H. J., Nykvist, B., De Wit, C. A., Hughes, T., Van Der Leeuw, S., Rodhe, H., Sörlin, S., Snyder, P. K., Costanza, R., Svedin, U., … Foley, J. A. (2009). A safe operating space for humanity. *Nature*, *461*, 472–475. https://doi.org/10.1038/461472a

Rolnick, D., Donti, P. L., Kaack, L. H., Kochanski, K., Lacoste, A., Sankaran, K., Ross, A. S., Milojevic-Dupont, N., Jaques, N., Waldman-Brown, A., Luccioni, A. S., Maharaj, T., Sherwin, E. D., Mukkavilli, S. K., Kording, K. P., Gomes, C. P., Ng, A. Y., Hassabis, D., Platt, J. C., … Bengio, Y. (2023). Tackling climate change with machine learning. *ACM Computing Surveys*, *55*(2), 1–96. https://doi.org/10.1145/3485128

Steffen, W., & Morgan, J. (2021). From the Paris agreement to the Anthropocene and planetary boundaries framework: An interview with Will Steffen. *Globalizations*, *18*(7), 1298–1310. https://doi.org/10.1080/14747731.2021.1940070

Tooze, A. (2021). Chartbook on shutdown #2: Writing in medias res. Retrieved: https://adamtooze.com/2021/09/04/chartbook-on-shutdown-2-writing-in-medias-res/

Tooze, A. (2022). Chartbook #165: Polycrisis – Thinking on the Tightrope. Retrieved: https://adamtooze.com/2022/10/29/chartbook-165-polycrisis-thinking-on-the-tightrope/

Tooze, A. (2023). Chartbook #192: On deglobalisation and polycrisis. Retrieved: https://adamtooze.substack.com/p/chartbook-192-on-deglobalisation

Walker, R. B. J. (2016). *Out of line. Essays on the politics of boundaries and the limits of modern politics*. Routledge.

Walker, R. B. J. (2018). Man, citizen, and political judgement. *International Political Sociology*, *12*(1), 88–107. https://doi.org/10.1093/ips/olx022

Webber, M. K., & Samaras, C. (2022). A review of decision making under deep uncertainty applications using green infrastructure for flood management. *Earth's Future*, *10*(7), e2021EF002322. https://doi.org/10.1029/2021EF002322

Wenger, A., Jasper, U., & Cavelty, M. D. (Eds.). (2020). *The politics of science of prevision. Governing and probing the future*. Routledge.

Wong, C. (2024). How AI is improving climate forecasts. *Nature*, *628*(8009), 710–712. https://doi.org/10.1038/d41586-024-00780-8

Workman, M., Darch, G., Dooley, K., Lomax, G., Maltby, J., & Pollitt, H. (2021). Climate policy decision making in contexts of deep uncertainty – from optimisation to robustness. *Environmental Science & Policy*, *120*, 127–137. https://doi.org/10.1016/j.envsci.2021.03.002

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