

REVIEW

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Hazards and disasters in the Anthropocene: some critical reflections for the future

Dale Dominey-Howes* 

Abstract

The arrival of the Anthropocene presents many challenges—both theoretical and practical. Scholars in different disciplines, practitioners, the public and others, are all considering the meaning of the Anthropocene and how its arrival affects their ways of knowing and doing. Given that a dominant narrative of the Anthropocene is one of a coming crisis, hazard, and disaster experts from different disciplines have much to contribute. Here, I briefly summarize the trajectory of hazards' and disasters' research through to the present to provide the context to ask a series of critical questions that experts in hazard and disaster might address to make theoretical and practical contributions to making the Anthropocene as good as it might be. The questions considered are: how useful is the contemporary crisis narrative of the Anthropocene for understanding the planetary history of hazards and disasters, and coupled to this; is the modern language of disaster risk reduction useful for understanding past disasters; how do we give voice to the more-than-human experiences of Anthropocene disasters; is it possible to mitigate the impacts of future hazards and disasters within the Anthropocene without addressing the root causes of vulnerability; how do we make space for slow emergencies and what do slow emergencies mean for understanding hazard and disaster in the Anthropocene; and finally, does the scholarship of hazard and disaster provide evidence useful for informing the debate about an early or late-start for the Anthropocene?

Keywords: Hazards, Disasters, Emergencies, Anthropocene, Disciplinary contributions, Critical questions, Future

“The bright sun was extinguish'd..... And men were gathered around their blazing homes.... Of the volcanoes, and their mountain-torch; a fearful hope was all the world contain'd..... Famine had written Fiend..... Darkness had no need of aid..... She was the Universe”
(*Darkness*, Lord Byron, 1816)

Introduction

Much is being written about the arrival of the Anthropocene, a concept that if accepted, means we have entered a new epoch in Earth history (Ellis et al. 2016; Veland and Lynch 2016). This epoch is one in which for the first time in geological history, a single species—*Homo sapiens*—has emerged as a planetary scale force, shaping both the

surface morphology of the planet and the functioning of the Earth system itself. In relation with the Anthropocene, key debates revolve around whether we have in fact, entered this new epoch, if we have, can we delineate a particular moment when it commenced (an early or late-start), what evidence can or might be used to delineate the boundary between the Holocene and the Anthropocene, will the Anthropocene be 'good' or 'bad' (in particular, for humanity), how might we limit the negative effects of human interference on the Earth system and humanity and how does the arrival of the Anthropocene challenge us as individuals, communities, and as a species? It is not my intention to repeat here the various debates, issues, and arguments related to them as a rapidly growing literature tackles these and other relevant questions. However, Fig. 1 presents these as a framework against which the questions asked here, intersect.

*Correspondence: dale.dominey-howes@sydney.edu.au
Asia-Pacific Natural Hazards and Disaster Risk Research Group, School of Geosciences, The University of Sydney, Sydney, NSW 2006, Australia

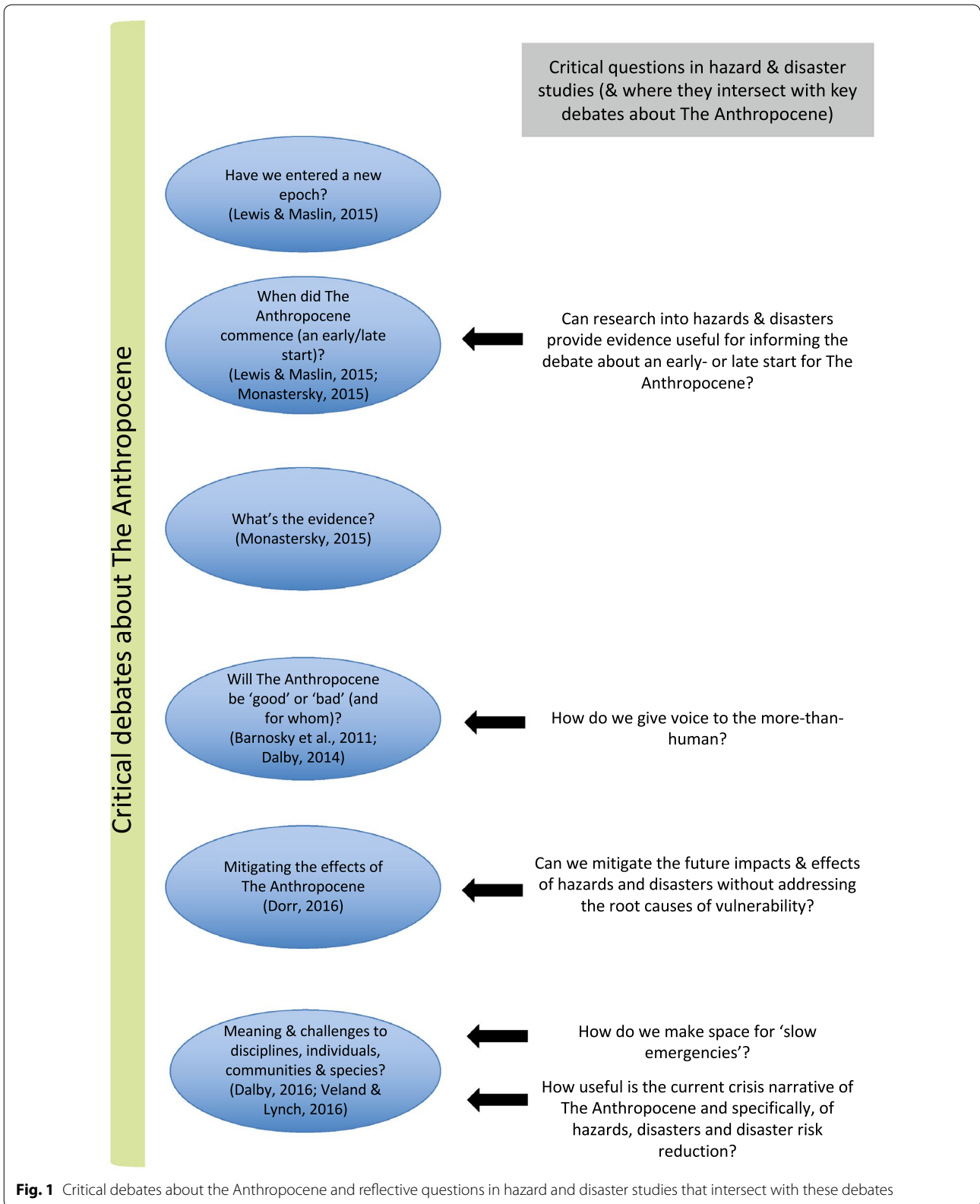


Fig. 1 Critical debates about the Anthropocene and reflective questions in hazard and disaster studies that intersect with these debates

Commentators suggest that the arrival of the Anthropocene challenges established academic disciplines to reimagine their thinking and knowledge and to ask deep and critically reflective questions (Dalby 2016). Furthermore, experts within different disciplines can make unique contributions to understanding the meaning and significance of the Anthropocene, including critically, the social sciences (Ellis et al. 2016), despite recent claims to the contrary (Hamilton 2016). I specialize in hazard and disaster studies having trained in ‘earth hazard geosciences’ and ‘disaster risk reduction.’ Earth hazard geosciences span the interface of the earth and human and social sciences. The former is generally concerned with an analysis of potentially hazardous events and processes such as earthquakes, tsunamis, droughts, bushfires, and so on, seeking to understand their causes, processes, distributions, frequencies, magnitudes, intensities, past histories, likely future occurrence, impacts, and effects (Arora and Malik 2017; Hyndman and Hyndman 2014; Nott 2016; Somerville 2014). Experts are interested in observing, measuring, monitoring, modelling, and forecasting these potentially hazardous events. This work intersects with, and helps to inform the disciplinary work of land use and urban planners together with engineers who seek to develop and build resilient places and structures. The latter is more concerned with understanding the underlying social, political, economic, cultural, religious contexts, and other structures, processes, and conditions that operate in relational scales from the local to the global that result in potentially hazardous events becoming actual disasters (Wisner et al. 2004). Such human and social work goes further in that it also seeks to understand how we might create and enable more resilient communities, empower people to reduce their own vulnerability, and live with and tolerate risk, thus also contributing to the work of disaster risk reduction (Nunn 2014; Satake 2014). Clearly, to address such a wide range of issues and topics, hazard and disaster studies necessarily draws upon experts, knowledge, theories, philosophies, methods, tools, and approaches from a variety of established and emerging academic disciplines (Fig. 2). Although Fig. 2 presents these as distinctive disciplines, in truth, the boundaries between them are blurred with experts often crossing between them, deploying theories, approaches, tools, and methods from closely related fields.

This paper is a response to the challenge of asking what can scholarship—in this case, in *hazard and disaster studies*, contribute to our understanding of the Anthropocene? This is important, because the most negative of the dominant Anthropocene discourses is one of crisis, disaster, insecurity, and a rapidly destabilizing planet (Clark 2014). Such a paper could take many forms and

directions. However, here, five critical review questions that can help make sense of the Anthropocene and explore its meaning for the professional work of hazard and disaster theorists and practitioners are presented. The purpose of articulating these questions and presenting a response is to provoke thinking and robust discussion and to encourage other experts of hazard and disaster across the disciplines to expand upon them and to identify others not examined here.

The first question considered is how useful is the contemporary ‘crisis narrative’ of the Anthropocene for understanding the planetary history of hazards and disasters, and is the modern language of disaster risk reduction useful for understanding past disasters? Second, how do we give voice to the more-than-human¹ experiences of disaster in the Anthropocene? Third, can we avoid or prevent the worst impacts of future hazards and disasters within the Anthropocene without addressing the root causes of vulnerability? Fourth, with all the noise and media flare of the ‘rapid and sudden onset disaster’, how do we make room for recognizing, understanding, and addressing ‘slow emergencies’ and what do slow emergencies mean for understanding hazard and disaster in the Anthropocene? Finally, can experts of hazard and disaster contribute to the debate about the early or late-start date for the Anthropocene?

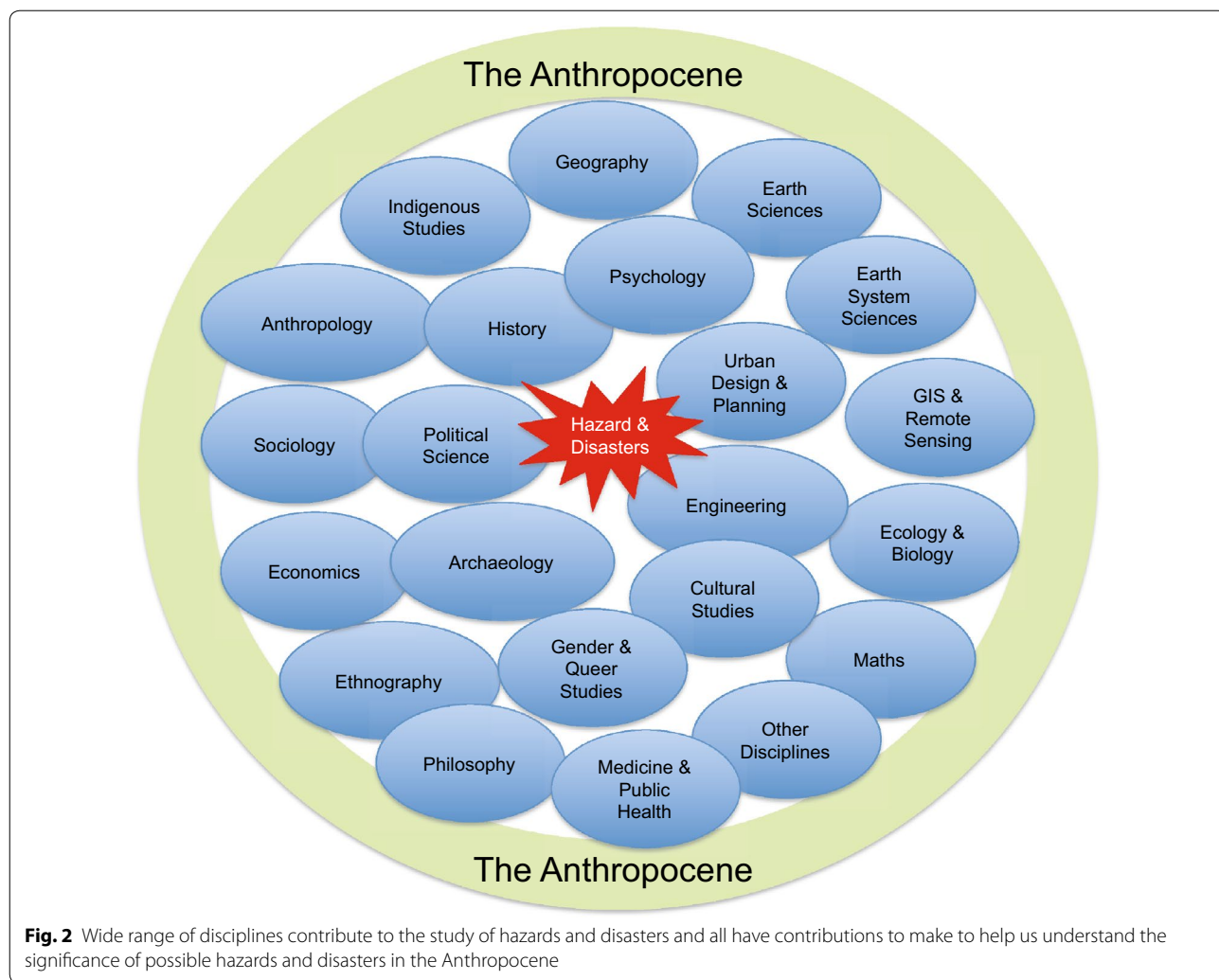
Before addressing these questions, I provide a short review of the fields of hazards, disasters, and disaster risk reduction to elucidate the research trajectory that has brought us to where we are today, and how the contemporary fields of hazard and disaster are built upon the expertise of numerous disciplines. This establishes the foundations that bring me to ask the five critical review questions posed.

Brief review of the research trajectory of the fields of hazards, disasters, and disaster risk reduction

Questions about and research into hazards and disasters is not new. Throughout history, individuals have explored and written about hazard events and disasters. Ideas about hazards and disasters may be broadly grouped into the ‘pre-enlightenment’ and ‘post-enlightenment’ periods.

Early pre-enlightenment work, at least in the west, focused on the ideas of pre-Socratic philosophers such as Homer who argued hazards and disasters were caused by the Gods as punishment for our wrong doing and who placed demands on the mortal. Our responses to these

¹ In this paper, I refer to the ‘more-than-human’ as including two elements. First, is all other non-human species—that is plants and animals. Second, at a broader level and consistent with social science thinking, I refer to whole ecological and physical environments as ‘more-than-human’.



determined our positions in the afterlife. These works did not explore the possibility of earth system processes as the cause of hazards and disasters. This thinking shifted with later Classical Philosophers such as Plato, and Strabo, who speculated about natural world processes’ causing hazards and disasters. Strabo in his work *Geographica* explored the physical and political geography of his world. Within *Geographica* are references to various natural hazards. Strabo considered that earth processes might be responsible for some of the extreme events experienced by communities that he visited and learnt about.

Western thinking shifted abruptly following the Lisbon earthquake and tsunami of 1755. As the enlightenment unfolded, philosophers such as Voltaire asked deeply reflective and critical questions about the nature of hazard and disaster, proposing the causes as a hybrid between processes occurring in the natural world coupled with concepts of faith and religion (Dynes 1999). These ideas were hotly contested. Interestingly, a

combination of Voltaire’s thinking and the consequences of the 1755 Lisbon disaster resulted in the development of the discipline we now call ‘seismology’.

From the 17th to early 20th centuries, there was a rapid development of the scientific method and thinking, and the field of geology emerged and contributed much to our understanding about hazards and disasters. Debates raged between religious (Christian) explanations for hazards and disasters attributing them to divine punishment and scientific explanations attributing them to earth system processes, the causes of which were speculated upon. Geological work resulted in the idea of ‘catastrophism’, later contested and abandoned and perhaps recently, re-found. Description of the natural world was followed by the development of theories, followed by exploration for evidence and measurement. With the arrival of the 21st century, fields such as geology have moved to numerical modelling and forecasting.

The 20th century began with a more-or-less exclusive scientific framing of hazards and disasters—consequences of the classification of the Earth into four systems (the atmosphere, the lithosphere, the hydrosphere, and the biosphere) (Smith and Petley 2009). However, two seminal works laid the modern foundations for the study of hazards and disasters—Prince (1920), White (1945).

In 1917, a military ship loaded with explosives moored in Halifax Harbour caught fire and exploded. The explosion was so large and it caused a major habourside fire and a tsunami. Over 2000 people were killed. Prince (1920) sought to understand this disaster and for the first time, he explored the role of human behaviour and decision-making in how the events unfolded. This socio-behavioural approach was the first of its kind and laid the foundations for understanding human contributions (the social dimension) of hazards and disasters. This work, however, focused on a technological disaster. This was followed by an enormously influential study by Gilbert White (White 1945). White, a Geographer based at the Chicago School, explored human dimensions and adjustments to floods in the United States and realized that disasters were really a sociological process, whereby underlying aspects of vulnerability due to political, planning, economic, and other socio-demographic processes amplified vulnerability to hazards—in the case of floods triggered within the earth system.

From the mid-20th century, the field of hazard and disaster research splintered into two major paradigms: the ‘hazards’ and the ‘alternative’. The hazards paradigm captured the physical and engineering sciences and the alternative hazards paradigm focused on (successively), behavioural, development, and complexity sciences (Smith and Petley 2009). The hazards paradigm places emphasis on the physical environment with earth scientists, physical geographers, physicists, mathematicians, and other closely related discipline experts driving forward research into the physical processes of hazards, their occurrence, mechanisms, frequencies, and behaviours. Here, vulnerability to hazards is viewed as a linear, negative outcome of exposure to a hazard, measured potential of impact and loss, and realized impacts of hazards. Geophysical agents are the focus. This led to the involvement of engineers, urban planners, and other experts exploring ways their fields might mitigate the risks associated with hazards prompting the development of highly technocratic solutions to risk and disaster management. Despite the best efforts of these physical and engineering fields, their efforts failed and people continued to die and losses increased across the planet.

This prompted the alternative paradigm combining political economy and political ecology with traditional

physical system approaches. Consequently, research focused on investigating hazard, risk, and vulnerability in a societal context. The main aims have been to understand the underlying political, behavioural, social, economic, religious, and other societal processes that influence vulnerability and reduce resilience to hazards and disasters. Experts from anthropology, sociology, geography, history, economics, and political sciences, amongst others, have made major contributions. From the 1970s onwards, a succession of theoretical models from behaviour to development to complexity has been advanced by researchers across a number of disciplines that collectively, greatly improve our understanding (Smith and Petley 2009). The evolutionary path and inter-relationships between these models are shown in Fig. 3. With time, these models have evolved in complexity and have become attentive to the interconnections between natural environments and human societies and the feedbacks between them, at a range of scales from the local to the global. These models and approaches have evolved into those referred to as coupled human–environment systems. The current dominant approaches include vulnerability science (Adger 2006; Calgaro 2010) and resilience (Alexander 2013) with a newly emerging field called ‘transformation’ (Pelling et al. 2015). These approaches are significant because to truly understand the complexity of hazards and disasters, teams of interdisciplinary experts come together from across the physical-engineering-human sciences domains. The current United Nations International Strategy for Disaster Risk Reduction calls for such interdisciplinary work.

Having briefly reviewed this evolutionary trajectory, it should be immediately clear that scholars of hazard and disaster have much to contribute to understanding the meaning of the Anthropocene—especially given the crisis narrative that pervades much of the discourse.

Five questions for scholars of hazard and disaster to consider in relation with the Anthropocene **How useful is the contemporary crisis narrative of the Anthropocene for understanding the planetary history of hazards and disasters and, is the modern language of disaster risk reduction useful for understanding past disasters?**

The narrative of the Anthropocene is one of a slowly, but increasingly rapid, unfolding process that in all probability will manifest as a catastrophe for the sustainability of the planet, its ecological systems, human and more-than-human inhabitants (Dalby 2014; Lewis and Maslin 2015; McKinnon 2017; Monastersky 2015; Rockstrom et al. 2009). The Anthropocene marks the arrival of a time characterized as not providing a ‘safe operating space for humanity’ (Rockstrom et al. 2009). The narrative

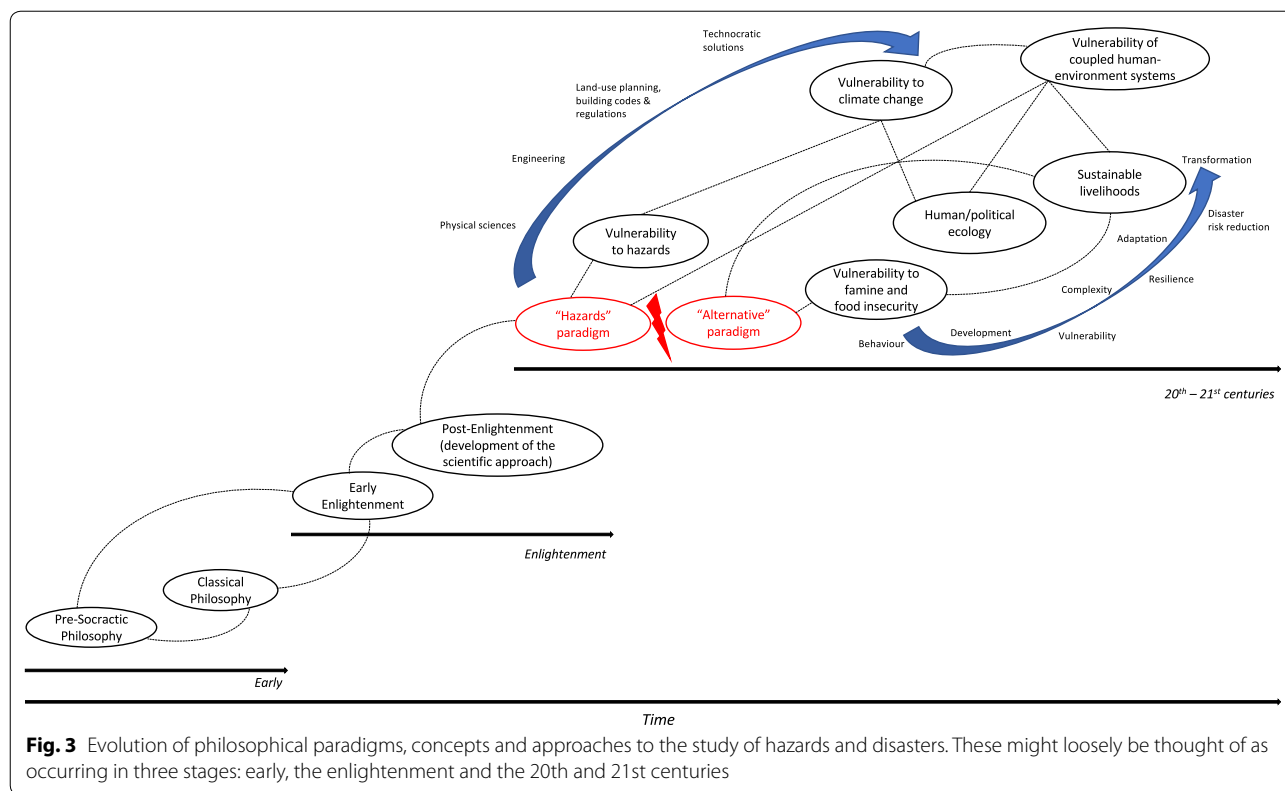


Fig. 3 Evolution of philosophical paradigms, concepts and approaches to the study of hazards and disasters. These might loosely be thought of as occurring in three stages: early, the enlightenment and the 20th and 21st centuries

presents the cataclysmic consequences of the Anthropocene as a contemporary and *novel* event in the history of the planet. The focus on the present and the future gives preference to these time periods and the framing of that trajectory as a specific ‘disaster’. It denies the deeper history of events that may be labelled as ‘disasters’ that have affected Earth, from which the planet *has* survived (Albritton 1989; Reimoldy and Jourdan 2012). Significant regional and planet-wide catastrophes have occurred destabilizing systems and terminating species. However, the Earth has recovered. Over and over, the Earth has returned to a succession of ‘safe operating spaces’. Importantly, some disasters in the planets history have actually heralded new evolutionary trajectories. For example, the age of dinosaurs ended as a consequence of a likely combination of extraordinary planetary volcanism coupled with major asteroid/comet impact that triggered planetary-wide (climate) change. The end of the dinosaurs and many other species at the Cretaceous–Tertiary boundary approximately 65 million years ago (Kaiho et al. 2016; Petersen et al. 2016), opened up a space that ultimately led to the evolution of mammals and of course, *Homo sapiens*. There have been other significant evolutionary jumps and radiations of species after global catastrophes that would not have been possible without the opportunity and space created by those disasters (Goswami

et al. 2016). As such, the contemporary crisis narrative of the Anthropocene that imagines the catastrophe of the Anthropocene as a unique event in the planet’s history is materially inaccurate and demeans the hazard and disaster experience of the past. Furthermore, it is possible to imagine that the narrative of future disaster should not be viewed entirely in the negative and the ‘disaster of the Anthropocene’ may in fact be an important moment in the future history of the planet—one from which new species and systems evolve in which *Homo sapiens* do not play a major role.

Coupled to the last point, the contemporary language associated with the study of hazards, disasters, and disaster risk reduction is unhelpful, in my view, for thinking about and acknowledging that deeper history of planetary disasters. The contemporary use of the nomenclature of disaster risk reduction again gives preference to the present and the future over the past, framing past events as ‘geological’ or ‘ecological’ events rather than as the disasters they actually were to the species that inhabited the planet at the time (Albritton 1989). To understand this point, it is necessary to critically reflect on the definitions of the key concepts at the heart of the field of hazard, disaster, and disaster risk reduction. Whilst it is true that these terms are fluid and contested, internationally, academics and practitioners have settled on

a collection of definitions that are broadly accepted and are provided by the UN through its office for Disaster Risk Reduction, the UNISDR (<http://www.unisdr.org>) in its official publication on disaster risk reduction terminology (available at: <https://www.unisdr.org/we/inform/terminology>). As the UNISDR says in the introduction to the global terminology

“The UNISDR Terminology aims to promote a common understanding and usage of disaster risk reduction concepts and to assist the disaster risk reduction efforts of authorities, practitioners and the public” (UNISDR 2017).

To illustrate this point examination of the concepts of *hazard*, *disaster* and *resilience* should assist. According to the UNISDR, these terms are defined as follows:

Hazard *“a process, phenomenon or human activity that may cause loss of life, injury or other health impacts, property damage, social and economic disruption or environmental degradation”*;

Disaster *“a serious disruption of the functioning of a community or a society at any scale due to hazardous events interacting with conditions of exposure, vulnerability and capacity, leading to one or more of the following: human, material, economic and environmental losses and impacts”*; and

Resilience *“the ability of a system, community or society exposed to hazards to resist, absorb, accommodate, adapt to, transform and recover from the effects of a hazard in a timely and efficient manner, including through the preservation and restoration of its essential basic structures and functions through risk management”*.

In respect of hazard, the focus is on the impacts and costs to humans and the things we directly value such as life, health, property, and economic activity. There is reference to the environment, but generally, this is in regard to environments and the goods and services they provide humans, rather than for the intrinsic value or right of environments and ecosystems for themselves. The point is the focus on us—*Homo sapiens*—to the exclusion of other, more-than-human entities. Hazards only seem to matter to humans—we are unconcerned with their impacts on the more-than-human, so the language has an almost entirely anthropocentric focus. Likewise, for the concept of disaster, the focus is on the negative disruption and effects to humans and the things we value and the associated inconvenience to us rather than upon the more-than-human and the wider collection of environments.

When critically reviewing the concept of resilience, whilst there is more explicit reference to the idea of environmental systems recovery as well as human system recovery [likely a consequence of the ecological systems origins of the concept (Alexander 2013)] the attention to ‘timely efficiency’ is again entirely anthropocentric in nature. *We* want things to recover quickly, so *we* can get back to normal as fast as possible. For humans with very short life spans, this is understandable. However, the planet has a longer life span and timely from the perspective of the planet and ecosystems (none of which are ever in a static state, because all systems are constantly changing), and the concept of recovery in a short, timely, and efficient manner is less meaningful. From a planetary perspective, recovery that takes a millennium or longer, such as the stabilization of the atmosphere after the cessation of human-induced carbon release, may take centuries to millennia (Rood 2014). But is that really a problem?

Disaster is a modern socially constructed concept (Wisner et al. 2014) placing the focus on people and the things we value and care about, and as such, it greatly diminishes the idea of disasters in deeper time. Hazardous events and the disasters they cause are not unique to the Anthropocene or of a uniquely anthropocentric nature, and the contemporary language negates that and reduces the significance of disaster impacts on natural ecosystems and environments of the planet through time and on the more-than-human. Denying the deeper experience of catastrophism that punctuates the story of the planet, denies the history of the planet, and robs us of lessons to be learned about the nature and consequences of hazards and disasters.

This leads us to the next question.

How do we give voice to the more-than-human experiences of Anthropocene disasters?

Explicit in the answer to the preceding question is that humans think about how the Anthropocene might do bad things to us via hazards and disasters. We give preference to ourselves, and our own needs. However, it is necessary we face the truth that we are in fact a serious hazard, or threat, or risk to other species and planetary ecosystems and our impact in the Anthropocene might mark a significant disaster in the history of the more-than-human. Some argue that the sixth great extinction event is now underway as a consequence of the actions of *Homo sapiens* across the planet (Barnosky et al. 2011). This sixth extinction will eventually be preserved within the geological record, meaning that humans will become synonymous with a significant ecological and ecosystem disaster within the planets history.

“what is clear is that extinction is part of the geological record; we are now..., in the sixth major episode in the planet’s history. But it is a unique one caused by the actions of one species, a geological innovation of profound importance” Dalby (2016:40)

Whilst experts—mostly from the fields of biology and ecology—have and are making contributions to this debate, scholars of hazard and disaster have been less attentive on the issue. Given the traditional focus by hazard and disaster scholars to concepts of equity, justice, and marginality underlying the vulnerability of humans to hazards and disasters, it seems appropriate that they bring their knowledge and skills to considering the idea that the more-than-human are experiencing injustice and a lack of equity in terms of the negative impacts of the Anthropocene on them. Malm and Hornborg (2014) argue that intra-species inequalities are unfortunately a part of the ecological crisis represented by the Anthropocene. However, do they need to be? Humanity—some of it anyway—is currently making decisions about which species to try and conserve and save from extinction whilst allowing others to disappear. Humans are actively ‘marginalizing’ some species over others. For example, iconic species such as polar or panda bears are easy to sympathize with. However, less attention is given to other species not so cuddly and cute. For example, no protests are held to protect the rights of, and to save bacteria, we cannot see or perhaps think are less worthy. Why do we try to give voice to some of the more-than-human but not others (Gibson-Graham 2011; Whitehouse 2015)? Why do we champion the needs and rights of some species but silence others? The decisions made now by some individuals with power and decision-making authority will have significant consequences for the planet and the more-than-human (Dalby 2016).

Is it possible to mitigate the impacts of future hazards and disasters within the Anthropocene without addressing the root causes of vulnerability?

Put simply, no. The narrative of the Anthropocene that imagines human ingenuity and capability will develop technological solutions that will reduce the vulnerability of the world’s population to hazards and disasters verges on fantasy. This is because as noted by Dalby (2016:38, 40),

“The school of eco-pragmatism or ecomodernism equates affluent, technologically savvy Americans (privileged rich few in western countries) with humanity in general... and disregards the current condition and fate of the majority of humanity in the coming decades”, and, “The techno-utopian vision of the future simply ignores the calamitous trajectory

humanity is on, and, as such, is dangerously misleading”.

That is, detection, monitoring, observation, and early warning systems and technologies are not widely available to the most disadvantaged and vulnerable people. Therefore, losses from future disasters will not be mitigated, so again, only a few will benefit from this utopian vision of a good and opportunistic Anthropocene. Second and connected to this, rich, white, powerful interests in the west do not want the existing system driven by the wealth of a carbon economy to change. Malm and Hornborg (2014:64) observe:

“We would argue.... Uneven distribution is a condition for the very existence of modern fossil-fuel technology. The affluence of high-tech modernity cannot possibly be universalized—become an asset of the species—because it is predicated on a global division of labour that is geared precisely to abysmal price and wage differences between populations (and making vulnerable the many—my emphasis)”

Studies of *vulnerability* emerged from the areas of food security and livelihoods and risk and natural hazards (see Fig. 3). Hazard and disaster scholars have been at the forefront of this work and have much to contribute in relation with the Anthropocene. Calgaro (2010) observes food security and livelihoods research explores the social–political, economic, and institutional conditions that influence food security, human welfare, livelihoods, and social differentiation. Vulnerability exists because of a lack of access and entitlement to resources or capital and is seen as a contextualized and politicized *social* condition moderated by poverty, inequality, unequal terms of trade, modes of production, power relations, and marginalization occurring at various scales of space and time. Environmental processes are important, but are less emphasized. Conversely, hazards work places emphasis on the physical environment. Vulnerability was traditionally viewed as a linear, negative outcome of a population’s physical exposure to hazard, measured potential of impact and loss, and realized impacts of hazards (White 1973). As noted earlier, geophysical agents were the focus, prompting the development of technocratic solutions (Adger 2006; Calgaro 2010). The failure of technological solutions to reduce vulnerability triggered new research merging political economy and political ecology paradigms with the traditional physical sciences (Adger 2006; Burton et al. 1993). These approaches, epitomized by Wisner et al.’s (2004) Pressure and Release/Access to Resources Model, capture the physical conditions that

heighten exposure, and the contextualized socio-political causal factors that create these conditions. Here, the natural hazard is seen as an independent trigger event that challenges the strength of the social–ecological system (Calgaro 2010; Pelling 2003; Wisner 1993).

More recent research on climate change draws on both traditions and has led to two basic framings (O'Brien et al. 2007). A scientific framing sees vulnerability as an outcome (IPCC 2001), whereas a human security framing views vulnerability as a contextualized characteristic, influenced by multidimensional interactions between biophysical, socio-political, economic, institutional, and technological conditions (O'Brien et al. 2007; Calgaro 2010). Thus, hazard and disaster scholars working at the intersections of the disciplines shown in Fig. 2 have much to offer.

Understanding the factors that reduce resilience and increase vulnerability within the coupled human–environment system, and their manifestation in particular places, has led to the development of integrated social and biophysical approaches within the interdisciplinary fields of sustainability science (Clark and Dickson 2003) and global environmental change. Emphasis on the coupled human–environment system acknowledges that humans are not detached from the physical world (Schröter et al. 2004; Calgaro 2010).

Ensuring the societal relevance of global environmental change research is important if transitions towards sustainability and improvements in human security are to be made within the Anthropocene (Moser 2010). Calgaro (2010) observes that the need for relevance has prompted O'Brien (2006) to propose a rethink in the way that global environmental change research is framed. Is scientific certainty and measurement of hazard events and change most important in supporting sustainability, or should societies goals be more aligned with reducing vulnerability and human insecurities (O'Brien 2006)? O'Brien (2006), Moser (2010) argue for a greater focus on the latter—a human security framing—over preoccupations with the scientific identification, measurement, and prediction practiced in physical science-based approaches that have failed to engage society in creating the transformations needed for sustainability—all the more important as we arrive at the Anthropocene. This aligns more with the security framing of Dalby (2017) referred to later. There are two advantages to this people-centred approach. First, it enables meaningful exploration into the role place-specific differences and personal circumstances play in producing differential vulnerability and resilience (Alexander 1997; Rigg et al. 2008). Second, this aids individuals and communities to respond effectively to change by challenging the drivers of vulnerability (O'Brien 2006).

As elegantly articulated by Calgaro (2010), vulnerability is place- and system-specific, contextualized, highly scaled, dynamic, and differential and a households or population's characteristics, the multiple stressors they face, and their capacity to respond and adapt, changes spatially and temporally. Vulnerability is determined by exposure, sensitivity, and system adaptiveness. Here, being vulnerable to a hazard not only means that the exposure unit is both exposed and sensitive to the effects, but must also exhibit limited ability to respond and adapt (Polsky et al. 2007). Exposure, sensitivity, and system adaptiveness are determined by unequal power and resource distributions that limit opportunities (Birkmann 2006). The more resources an individual, household, or community have, the lower the vulnerability (Moser 1998).

Another important determinant of vulnerability levels within communities is the mode of production operating, which influences rates and histories of development, capital concentration and governmental regulation over capital, and labour rights (Watts and Bohle 1993; Wisner 1978). Fundamental to this conceptualization of vulnerability, however, are the contested actions and outcomes that link human agency and scaled structures of power spatially and temporally. Here, political economies focus on social structures and economic systems as the key determinants of inequality is coupled with insights from constructivism that emphasizes the role human agency and culture play in producing differential vulnerability among individuals and groups (Calgaro 2010). Constructivists stress that human actors are causal agents in history and have the capacity to create and realize multiple possibilities within the context of current cultural contingencies (Emirbayer and Mische 1998). Vulnerability is generated through continuous interaction between social structures and human agency (Jessop 2005; Calgaro 2010).

Since power and political will plays a central role in creating and perpetuating vulnerability, efforts to reduce vulnerability to hazards and disasters in the Anthropocene will require destruction of existing power structures and economic systems. However, such changes are unlikely to be tolerated by existing elites (Calgaro 2010). As Dalby (2016) contends, many commentators fail to deal with the fact that social relations of power are at the heart of vulnerability, and consequently, how the Anthropocene is being shaped and experienced by the masses. Hazard and disaster scholars can, and must, bring attention to these issues.

Whilst the discussion has been focused principally on people, questions about the vulnerability of ecosystems, buildings, and urban environments are all equally relevant. Without dealing with the root causes of poor urban

risk governance, inappropriate land use zoning, building code regulation and compliance, safety standards, post-construction operating regulations, and maintenance, our built environment will continue to remain sub-optimal, perpetuating the vulnerability of that built infrastructure and systems—and the people and the more-than-human species that occupy them (Acuto 2016; Birkmann et al. 2016). Consequently, hazard and disaster scholars with a focus on these areas have critical roles to play in changing the way we do business.

How do we make space for slow emergencies and what do slow emergencies mean for understanding hazard and disaster in the Anthropocene?

To date, hazard and disaster scholarship has been pre-occupied mostly with the flare and glamour of rapid, sudden onset events. This is not entirely unexpected or unreasonable given the dramatic impacts that in particular, large-scale events such as the 2014–2016 Ebola outbreak in West Africa, the 1971 Bay of Bengal tropical cyclone disaster, the 2004 Indian Ocean tsunami, and the 2011 Japan earthquake–tsunami–nuclear events have on people and places. Modern classifications and analyses of hazards and disasters focus on what Rickards and Kearnes (2016) refer to as “bounded events” that explode out of the assumed substrate of normal day-to-day life, triggering efforts to extinguish them as quickly as they appear’. This construct has in turn informed how some (many of us?) think about hazards and disasters in the Anthropocene, leading to a sense of what will the Anthropocene future hold in relation with the *sudden* occurrence of disaster? However, critical hazard and disaster scholarship should rupture this thinking. The “Anthropocene turn” demands that scholars consider the smooth background against which short-term fluctuations including emergencies, hazards, and disasters are manifest. We need to be attentive to the conditions that enable and facilitate apparent short-term, rapid onset events.

Critically, hazard and disaster scholars need to challenge the conceptual framings that define what we understand as emergencies and disasters, for those logics imply actions that either can, or cannot be. For Rickards and Kearnes (2016), there are two cultural logics of ‘the accident’ and ‘the disaster’. In the story of the ‘accident’, emergencies occur when systems fail and things go wrong. In these circumstances, accidents occur when environmental and human systems of various kinds fail. Mitigative actions can presumably be imagined and actioned. Conversely, in the story of ‘the disaster’, ironically, disaster occurs as a consequence of how things go right—they are a consequence of industrial modernity. For example, the industrial revolution is a revolution of the consumption

of fossil fuels, the consequence of which is anthropogenic climate change—attendant as it is with its extreme climate and weather events and disasters. Such alternative logics demand deep critical reflection for the Anthropocene, important as they are for the material living reality of the lives of the human and more-than-human masses. Furthermore, what do these cultural logics mean for the temporality of emergency and disaster now and in a future Anthropocene?

Whilst hazard and disaster scholars do think about and acknowledge slow onset disasters like drought and sea-level rise, the concept of the ‘slow emergency’ is something altogether more radical. Many processes might be reasonably imagined as *slow emergencies* including but not limited to climate change, the spread of antimicrobial resistance and desertification. The significances of the slow emergency are numerous. First, such processes and events lay the foundations from which rapid, sudden onset disasters emerge. For example, bushfires and floods are more common and intense in a world with a slowly changing climate and multi-drug-resistant epidemics and pandemics flare and kill in a world, where microbes have slowly become resistant to antimicrobial agents (Michael et al. 2014). Second, in being less attentive to slow emergencies, because they are traditionally not so visible and media worthy, we are tipping the risk scales towards larger rapid onset events that will erupt on spatial scales we find harder to respond too. Third, we will require different ways of monitoring and forecasting slow emergencies, and different conversations with societies about how to accommodate prepare for and respond to slow and fast onset disasters. These will also require compromises and discussions about what we value and what we are prepared to (not)accept now and for future generations, as well as, how to resolve issues of intergenerational justice and equity (Beck 1992). Fourth, when studying slow emergencies, we will require different types of data and knowledge. Traditional societies and knowledges may be more attentive than the currently privileged western sciences to recognizing the onset of slow emergencies, familiar as they are with subtle variations in seasonal, animal, and planet behaviours (Veland and Lynch 2016). Dalby (2016), Veland and Lynch (2016) passionately call for the voices, experiences, and knowledge of others, especially Aboriginal ones, to be heard. Last, and perhaps most importantly, the study of slow emergencies forces us to confront a simple truth which is that for the vast majority of human and more-than-human populations, the concept of ‘the future hazard and disaster of the Anthropocene’ is a fantasy. For them, they live their daily lives right now in a situation that may be characterized as *a slow- and continuing-emergency* (Rickards and Kearnes 2016; Veland et al. 2013).

Rickards and Kearnes (2016) correctly contend that for many, it seems that they are already living a never-ending succession of emergencies and crises. Malm and Hornborg (2014) go further and point out that the idea we all still exist in a “safe operating space” and that the Anthropocene is a future risk is nonsense for the growing proportion of the world’s humans and more-than-human for which it is already a living disaster. For these, the coming Anthropocene disaster is already a *contemporary reality!* Confounding this disaster temporality, neoliberal policies and plans such as the Australian National Strategy for Disaster Resilience (Commonwealth of Australia 2011) eloquently detail how each of us needs to be personally responsible for our own resilience and disaster preparedness, yet at the same time, so many of us are disempowered by governments enacting restrictive legislation that confines possible future trajectories as a response to actual or perceived day-to-day security threats (Reid 2012). There is an unachievable gulf between the neoliberal rhetoric of resilience and the actual capacity of the masses. For many, the future is already bleak (IDMC 2015).

The consequence is that a process of perpetual ‘emergency life’ for too many has been normalized. If this position is accepted, what does this mean for hazards and disasters in the Anthropocene? Does the normalization of emergency life ‘stretch the scales, meanings and timings of emergencies and disasters’ and what does that imply for our capacity to anticipate and react to future Anthropocene disasters?

Different peoples, the more-than-human and places have experienced over and over the costs and consequences of the manifestations of emergencies, hazards and disaster that are the signature of the Anthropocene and its underlying drivers of imperialism and capitalism (Rickards and Kearnes 2016; Malm and Hornborg 2014). The consequences are both complex and frightening:

“... the sense that the planetary environmental crisis is ‘over’ and nature is already ‘dead’ is resisted by many scholars and activists as unbearably nihilistic and open to abuse by the very techno-optimists who caused the problem in the first place. But other critical scholars argue for positioning the Anthropocene disaster in the past rather than future in an effort to counter the implicit reification of the status quo contained within the idea that “we are all increasingly at risk (but are fine just now)”, papering over the lived emergencies of many humans and more-than-humans that have long been politically sacrificed in the daily operations of industrial capitalism”(Rickards and Kearnes (2016):3)

Hazard and disaster scholars from a broad sweep of disciplines listed in Fig. 2 must engage with the concept of the slow emergency that characterizes life for many in the Anthropocene. They must radicalize our understanding of sustained coping with emergency so as to identify new ways of knowing about the relationships between humans, the more-than-human and our environments in the face of a good or bad Anthropocene. Importantly, they must identify ways of surviving the coming threats. Critical questions to which such scholars might contribute include ‘how can people be expected to be ‘resilient’ when so many are powerless?’ and ‘as citizens of disaster, do we effortlessly move (or are we violently thrown) between slow and fast emergencies and disasters operating at different scales of place and time?’ Such critical work will help us think through:

“The conceptual challenge is also not to see these ‘chronic stresses’ as separate to the ‘acute shocks’ that resilience experts tell us we need to address. Seeing the linkages between the past, present and future and the patterns of ongoing privilege are essential if resilience is to be about more than housekeeping in preparation for future challenges”(Rickards and Kearnes 2016:6)

Does the scholarship of hazard and disaster provide evidence useful for informing the debate about an early or late-start for the Anthropocene?

Hamilton (2016) contends that,

“the Anthropocene cannot be defined merely by the broadening impact of people on the environment and natural world, which just extends what we have done for centuries or millennia”.

Rather, the Anthropocene is synonymous with our impact on the whole Earth system. Consequently, he suggests work to identify the start date of the Anthropocene is an academic folly.

The concept of landscape-wide ecology or even of archaeology as a whole measuring and identifying landscape impacts as markers of the commencement of the Anthropocene is not enough for Hamilton (2016). Hamilton (2016) argues that the consequence of the Anthropocene and, therefore, its date of origin are squarely laid at the foot of the industrialized use of carbon (a position that is highly valid) and, therefore, is indicative of a late-start, there ending the discussion. Oddly, though he decides, 1945 marks an appropriate start date for the Anthropocene. He further argues that other disciplines beyond Earth System Sciences have no role to play in the debate and that a late-start date for the Anthropocene is a must and an inevitability of the consequence of the use

of carbon. However, contrasting strongly with Hamilton's perspective, Dalby (2016) observes:

"[many social and political scientists] are very concerned that the anthropocene discussion is being led by natural scientists and in the process the inequalities in human societies are occluded and politics replaced by an invocation of a universal singular humanity that has emerged from history by some 'natural' process" (Dalby 2016:46).

In responding to the views of Hamilton (2016), Dalby (2016), there are two inter-related, but subtly conflated, points here. One is about the meaning and impact of the Anthropocene and the other is on the evidence to mark the start date. Clearly, hazard and disaster scholars with their attention to vulnerability, marginalization, injustice, inequality, differential power relations, and so on offer much to the social science debates about the meaning, impact, and response to the Anthropocene and on discussions about global and societal tolerances for different Anthropocene trajectories.

This sociological approach also feeds into how Hamilton and Grinevald (2015) consider the issue of the timing of the Anthropocene in another way, whereby they worry that the ideas of an early start (and good Anthropocene) denigrates the importance of the concept of the Anthropocene altogether. In the first instance, rather than there being a sharp rupture between the Holocene past and the Anthropocene now, a 'gradualized' transition making the Holocene and Anthropocene co-existent and one in which humanities impacts on the environment are spread across time obscures the horrifying nature of the Anthropocene and the extraordinary measures required to respond to its challenges.

If these lines of reasoning are accepted, then the start date for the Anthropocene is indeed 'late'. Consequently, hazard and disaster scholars can add evidence to the argument for a late-start, given they can contribute significant knowledge about the occurrence, distribution, impacts, effects, and records of distinctly Anthropocene hazards and disasters—that is, *atmospheric and hydrospheric carbon generated extreme events*. We are skilled at identifying evidence for floods, storms, heat-waves, bushfires, and other hazards within the historical and geological records. We have contributed to Earth System Sciences' efforts to demonstrate statistical changes in climate extremes—the hazards that trigger disasters—the consequence of the Anthropocene (Perkins-Kirkpatrick et al. 2016; Sewell et al. 2016). Given that the Anthropocene's arrival is commensurate with a marked increase in carbon and a destabilizing atmosphere and hydrosphere and consequently, more hazards and disasters—then hazard and disaster scholars are

important experts in identifying traces of this evidence for Earth system change that point to a late-start.

In relation with the second subtle point embedded within the ideas advanced by Hamilton (2016), I respectfully disagree that discussion about the Anthropocene is the remit only of the Earth System Sciences in relation with the identification of evidence to pinpoint the start date of the Anthropocene and that discussion of earth surface impacts from other disciplines are irrelevant. In thinking about 'markers' to delineate the start of the Anthropocene, the footprints of human-induced hazards on the Earth surface are commensurate with humanities impact on the Earth system per se. Such markers provide an additional line of evidence that lends weight to an early start date. For example, the destabilization of hill slopes leading to landslides leading to river floods across dammed and managed lakes and rivers in many locations or soil degradation due to landscape and farm management leading to landscape failure and reorganization (Anthony et al. 2014; Turner and Sabloff 2012). This presents a patch-work of evidence from a hazards and disasters perspective that enrich the picture used to think about the start date of the Anthropocene. That said, Earth scientists with their sedimentological commissions and international congresses are the internationally recognised authorities to summarize, debate, and agree the relevant physical evidence within the geological record to formalise a final, definitive statement.

Summary and concluding remarks

In the traditional hazards and disaster work, disasters are a social construct that preference humans over the more-than-human species and systems. Whilst necessary for (anthropocentric) disaster risk reduction efforts, such framings are inadequate for responding to the wider challenges of the Anthropocene. Discussion about, and acceptance of the idea of the Anthropocene forces us to reflect critically on humanities relationship with hazards and the disasters they may cause, but also on the disaster of humanity for the planet and the more-than-human. Hazard and disaster scholars are well placed to do this work, but need to begin to pay attention to the more-than-human.

Will the future Anthropocene be bad and if so for who? Current trajectories indicate that the majority of the human population and most more-than-human species will be negatively impacted. Thus, issues of who gets to shape the future and policies and practices of human development and their impacts on the Earth System matter enormously, and in many ways, this will be shaped by a privileged few—mostly in the west (Calgaro 2010; Dalby 2016). Dialogue about a possible good Anthropocene and a technological future capable of saving us from

a bad Anthropocene must stop quickly, since such narratives deflect from the critical work needed that focuses on the structural disadvantage, marginalization and disempowerment and poverty of the world's masses (Klein 2014). Furthermore, since detection, monitoring, observation and early warning systems and technologies are not widely available to the peoples of the planet, losses from future disasters will not be mitigated, so again, only a few benefit from this utopian vision of a good and opportunistic Anthropocene.

Having considered all of these questions new work by Dalby (2017) on security is providing novel constructs around inter-coupled environmental–social insecurity that challenge ways of thinking about hazard and disaster in the Anthropocene. Dalby (2017) contends that humanity is remaking its environments generating new forms of insecurity, even though insecurity and disaster have journeyed with humanity throughout our history. Through a succession of theoretical debates from the 1960s onwards, discussion of climate insecurity has come to dominate ideas of environmental security and the provision of relatively safe conditions for routine human life. Dalby challenges us to recognize the interconnection between the Earth System and social formations, since these greatly affect environmental (in)security and by definition, hazards, and disasters. This is important, since it very much appears that feedback loops (in socio-ecological systems) are ‘trapping’ individuals, families, communities, and societies in repeating cycles of insecurity—products of inequitable processes.

In conclusion:

“what is clear from earth system science is that the geological conditions that humanity has known for all of recorded history are nearly over. What replaces them will be a world substantially remade by human actions. The consequent geopolitical question is whether contemporary civilization can quickly morph into something that simultaneously slows the rate of ecological change while effectively coping with the perturbations already set in motion”(Dalby 2017)

In light of this, hazard and disaster histories cannot and must not be used to forecast or assess future risks and insecurities of the Anthropocene and we need new tools, methods, models, and data to understand future landscapes of disaster risk. Hazard and disaster scholars are well placed to assist in this effort.

Authors' contributions

DDH conceived and wrote the manuscript. The author read and approved the final manuscript.

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