

Five challenges to humanity: Learning from pattern/repeat failures in past disasters?

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Abstract

Human civilisation faces a series of existential threats from the combination of five global and human-engineered challenges, namely climate change, resource depletion, environmental degradation, overpopulation and rising social inequality. These challenges are arguably being manifested in both an increased likelihood and magnified impact of catastrophes like forest fires, prolonged droughts, pandemics and social dislocation/upheaval. This article argues that in understanding and addressing these challenges, important lessons can be drawn from what has repeatedly caused organisational failures. It applies the ‘Ten Pathways to Disaster’ model to a series of disasters/catastrophic events and then argues this model is salient to understanding inadequate responses to the five threats to civilisation. The article argues that because these challenges interact in mutually reinforcing ways, it is critical to address them simultaneously not in isolation.

JEL Codes: H12, I14, I31, J11, Q01

Keywords

Climate change, crisis, disaster management, environmental degradation, inequality, latent system failure, pandemics, population, resource depletion, social dislocation

Introduction

Global climate change poses a significant threat to civilisation but it is not alone. There are four other significant challenges that cannot be ignored if only because they mutually reinforce the threat. This article attempts to provide insights into those challenges and how they can and should be understood in terms of failings in human organisation. The

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first section briefly examines the five challenges and gives some examples of their interaction. The second section then considers what might be learned from smaller scale disasters. It asks whether 10 latent failures repeatedly associated with workplace disasters apply to other catastrophic events including epidemics, earthquakes, financial crises, severe storms and forest fires. Examining 18 events, it finds that the vast majority of pattern causes were present in each, indicating their occurrence could either have been prevented or at least significantly mitigated. The third section then applies these 10 latent failures to the 5 challenges, finding all are present in relation to each of these challenges. It is argued better understanding why/how human organisation fails, provides scope for more informed and effective responses. The conclusion draws these points together, arguing it is important to address all five challenges and there are positive synergies in doing so.

Five global challenges

Human civilisation is confronting challenges that in coming decades may give an unpredicted answer to physicist Enrico Fermi's paradox that, notwithstanding the improbability that life is confined to earth, there is no evidence of other civilisations in the universe's long history (now estimated at 13.8 billion years). Far from the enthralling technodoomsday scenarios like runaway artificial intelligence, these challenges are more prosaic but nonetheless potentially lethal and all are human-engineered – namely climate change, overpopulation, environmental degradation, resource depletion and socially dislocating economic inequality.

The global population is now 7.66 billion and projected to reach 9.3 billion in 2050, three and a half times what it was in 1950 and 5.8 times what it was in 1900 when population growth significantly accelerated. While population growth has slowed in some regions, it continues in Africa, the Middle-East and South Asia and the slowing has been partly offset by an unprecedented global wave of internal and external migration including refugees (an estimated 740 million internal migrants in 2009 and 244 million external migrants in 2015, (United Nations International Organisation for Migration, 2017: 2)) much concentrating in already crowded cities and regions. While the subject of discussion among environmental-sustainability researchers (Cafaro and Christ, 2012; Pimentel, 2012), overpopulation barely figures on the public policy radar. In 2009, in a speech to environmental groups and politicians, Britain's Chief Scientist Sir John Beddington warned that the world's population would require 50% more food and energy and 30% more water by 2030, targets unlikely to be met especially if droughts and other affects were factored in. Beddington predicted food and water shortages, in particular, would fuel widespread social dislocation/unrest, mass migration and political conflicts (*The Guardian*, 19 March 2009). Several years prior to Beddington's speech government agency reports and research were referring to increasing global competition for water and a water crisis, 1.1 billion people lacking access to clean water and killing almost 2 million children each year (Jury and Vaux, 2007; Watkins, 2006). Overpopulation has contributed to past disasters like the Black Death in 14th-century Europe as well as the collapse of civilisations – the Mayans and Angkor Wat being two examples (Fagan, 2008: 152–153, 211). One aspect of burgeoning population attracting

action by countries like China is food (both by storage and buying land/farms from Africa to Tasmania) and water security. A related question is lower rainfall impacts on currently favoured higher yielding grain varieties along with the shift to increasing meat production (far less efficient as a food source than plants) to meet growing demands far beyond what is optimal for a human diet (Meng et al., 2016). Concentrated populations, intense meat production methods and poor hygiene infrastructure have contributed to the widespread over-use/misuse of antibiotics, new drug development now rapidly being exhausted, increasing the risk of communicable diseases even in healthcare facilities (Nadimpalli et al., 2018).

As Fagan (2008) demonstrated, for a previous period of non-human induced climate warming (800–1200AD) civilisations collapsed – including those with multi-year water storage – because large regions of the planet experienced prolonged periods of below-average rainfall and droughts lasting decades, while others experienced rainfall increases. Drinking water was not so much the issue as insufficient water to grow food-crops (limiting the remedial effectiveness of dams or desalination plants). Prolonged droughts in some heavily populated tropical regions, like south-east Asia or those responsible for significant grain-growing on already marginal rainfall (like parts of China, see Fagan, 2008), would cause famine or mass relocations on an almost unimaginable scale, dwarfing current refugee movements. Research has been tracking the impact of long-term rainfall declines in regions like North Africa (see, for example, Thomas and Nigam, 2018). Rapid glacial shrinking in the Himalayas and elsewhere feeding into river systems critical to humanity is another vector already unfolding (Milner et al., 2017). While initial projections of rising sea-levels suggested the real threat was sometime away, recent research on the rate of melting of the Greenland ice-sheet suggests calibrations will need to adjust – this melting is also associated with methane release and changes to nutrients in surrounding oceans (Andrews, 2019). Considerable populations live barely above or even below sea-level, with some cities sinking under the weight of their ever growing built-environment footprint, like Jakarta, where relocation of the capital is in prospect (Cohen, 2019; Goodell, 2017). As scientific evidence mounts and governments and global agencies fail to act decisively, it is critical to recognise the powerful interest groups stymying action. Wright and Nyberg (2015) point to the role of corporations and the style of capitalism they promote in creating pathways to self-destruction to which could be added empire-building political regimes.

Resource depletion and the capacity to meet future basic needs – especially, fresh water and food – represent major challenges, exacerbated by climate change and environmental degradation, as the loss/damage to forest and farming land in recent Californian and Australian fires amply demonstrates. Water pollution has inhibited food production, affected biodiversity and urban water supply and is also a leading cause of global death (Jury and Vaux, 2007). The production of waste products like plastic – travelling large distances and accumulating in water systems and oceans – is also occurring at an unsustainable rate (Ryberg et al., 2019). Rapid industrialisation in countries like China and India has had severe impacts on water and air pollution, mirroring experiences of older industrial countries a century earlier. Forest fires linked to climate change, as well as clearing by burning, are adding a new dimension to air quality in countries/cities that, like Sydney, have spent decades cleaning their air and water

from their industrial past. Resource depletion including deforestation compounds climate change and species extinction. Apart from being a reservoir for developing new drugs, rainforest loss affects oxygen production, carbon storage, microbial communities, soil nutrients, predator species, rainfall and air pollution from smoke and ash associated with clearing extending well beyond the forest (see, for example, Aleixandre-Benavent et al., 2018; Poor et al., 2019). Ancient aquifers and other sources of fresh water, notably lakes and rivers, are also being depleted by irrigation, stock-raising and population growth (and exacerbated by privatisation as in Delhi), accentuating both pollution and salination problems with flow on effects to vegetation, as well as erosion and land subsidence like that around the Dead Sea (Bierkens and Wada, 2019; Kumar et al., 2019; Misra, 2010; Robertson, 2019). Competition for resources has also accelerated environmental degradation including that by Chinese businesses in Africa and elsewhere, as well as Australian and US mining operations in Africa (see, for example, Shandra et al., 2019).

Last but not least, the world is now experiencing a rising tide of global economic inequality, long predating but now being exacerbated by the COVID-19 Pandemic. Growing inequality is not confined to rich countries but includes poor and middle-income countries (Hickel, 2017). Indicators of this include the Gini-coefficient, the decline in labour's share of national income, wage stagnation and more basic but equally indicative measures like the ratio of CEO to average worker salaries which grew in the US from 1:20 in 1950 to 1:271 in 2016 – it is 1:68 in Australia (De Vries, 2018; Facundo et al., 2017; Milanovic, 2016). Socio-economic inequality has substantial health effects (Commission on Social Determinants of Health, 2008) including increased disease, morbidity, mortality, drug use (like opioids) and possibly suicide ideation. Furthermore, growing inequality is associated with other threats including the rise of authoritarian regimes, extreme ethnocentric politics and a corrosion of democracy in countries where it exists, measured by disenchantment in the choice between two or more neoliberal parties and electorate confidence. In Australia, the trust in democracy index fell from 78% in 1996 to 40.56% in 2018 (Stoker et al., 2018). In the European Union (EU), the growing dominance of neoliberal policies and their interconnections with EU expansion into Eastern Europe have jeopardised the regulated capitalism that formed its base (Gabrisch, 2020). Growing mistrust in established politics, insecurity and immiseration have fed right-wing nationalism, ethnocentrism/racism and religious extremism in Europe, the US and India, and social control measures by totalitarian regimes like Muslim concentration camps in China (Greitens et al., 2019). An economic ideology has been driving rising inequality across the planet, with policy prescriptions that wind back social-democratic institutions like unions/collectivist industrial relations regimes, the welfare state, public ownership/control of key instrumentalities like water, power, healthcare and transportation. Rising gaps between the rich and poor are a recipe for social dislocation. Economic and political conditions afford striking parallels with the 1920s and 1930s. There are differences – the 1920s/1930s did not have to deal with overpopulation, resource depletion, environmental degradation, climate change and a nuclear weaponised world – but these differences are not reassuring.

Can knowledge of past disasters inform future global challenges?

The challenges briefly described all result from human agency, arguably the result of forms of organisation. The hypothesis explored in this article is whether something can be learned about the origins and capacity to address these challenges from what is known about smaller scale (but still costly) disasters/catastrophic events. There are several reasons this approach might be useful. First, while the scale is different, these disasters/catastrophes result from failure in human/social organisation that may contain lessons, especially if there are repeated underlying causes that apply to a wide range of events, from fires to pandemics. Second, as noted in a recent United Nations Office for Disaster Risk Reduction report (2019; see also Coetzee and Van Niekerk, 2018), challenges like climate change and increased inequality contribute to the greater likelihood and vulnerability to disasters/catastrophic events like forest fires, prolonged droughts and financial meltdowns. This article asks whether learning from disaster can inform understanding of the five major challenges. In order to do so, the next section examines whether repeat/pattern causes of workplace disasters apply to disasters more generally.

Disasters rarely result from a single cause but rather multiple factors interacting; in this context, the notion of latent failures is valuable. James Reason (2008) developed the concept of latent failures to explain the origins of disaster lay not in a single failure but multiple failures that were already present but activated by an alignment and precipitative incident (often seemingly innocuous and unpredictable) that pierced multiple defence layers designed to prevent such events. The notion of latent failures has informed efforts to render workplaces immune to high-impact incidents (like explosions or fires) and has wider application. A critical question is whether some types of failure are more common or typically associated with catastrophic incidents and, if so, what are these repeat or pattern-failures? If such failures exist, this knowledge would enable more effective prevention measures by targeting these failure-points, building more resilient and sustainable organisations. This knowledge could also be used as a template for investigating disasters that occur. Other causes need to be explored, but each of these pattern-failures should be examined to ensure the findings are comprehensive and robust. This article argues there are pattern-failures repeatedly associated with disasters. In particular, it focuses on 10 pattern-failures identified in a study of workplace death and disaster (Quinlan, 2014):

- Design, engineering and maintenance flaws;
- Failure to heed clear warning signals;
- Flaws in risk assessment;
- Flaws in management systems and changes to work organisation;
- Flaws in system auditing;
- Economic/production and rewards pressures compromising safety;
- Failures in regulatory oversight;
- Expressed concerns prior to the incident;
- Poor communication/trust between those in control and those at risk;
- Flaws in emergency/rescue procedures and resources.

The following section examines their applicability to a wider array of human disasters.

Ten pattern causes – Pathways to disaster

Table 1 applies the 10 pathways framework to 18 disasters/catastrophes affecting single or multiple countries between 1970 and 2020, each resulting in multiple fatalities ranging from 29 to over 400,000 (at the time of writing), apart from 2 financial crises where associated death tolls are unreported. Previous research examined pattern causation in over 40 workplace disasters (Gregson and Humphrys, 2020; Quinlan, 2014) and several are included as illustrative examples. However, discussion here focuses on other types of disasters, drawing on a mixture of government investigations/reports, academic research and media reports. The 2019–2020 Australian bushfire disaster and COVID-19 pandemic have yet to be subject to detailed investigation, but were included because available evidence suggests most of the pathways were present, and including them has probative value in terms of highlighting the predictive value of the pathways model. Only 18 in total are included, although the examination places them in a wider context. One obvious question is why would a model designed to explain workplace disasters have value understanding other types of disaster? The answer is that the model focuses on organisational/societal failures and it is reasonable to hypothesise that failures in human organisation that apply at work also apply to other organisations or other consequences be that environmental degradation or financial/economic effects.

Leaving the foregoing to one side, the most apparent finding is that at least 8 pattern-failures were present in all these incidents and over half had 9 or 10 present (Table 1). Leaving a space blank or with question-marks rather than as a ‘no’ is deliberate. Investigations into disaster vary greatly in terms of comprehensiveness/quality, so it cannot be assumed the absence of evidence indicates the failure was not there. The particularly thorough Pike River Royal Commission found all 10 pathways. In other cases, especially regarding economic pressures, a question-mark has been used because there was some evidence of cost/safety offsets but insufficient to label it a significant contributing factor. This is not surprising as admitting disasters resulted from cost-saving/profit is highly charged and not simply in relation to disasters. In the trucking industry, a pay/safety connection is continually denied notwithstanding extensive evidence of the link – a link found in other industries especially those using piecework/subcontracting (see, for example, Kudo and Belzer, 2019). While their relative importance differed between incidents (this and combined effects warrant further research), all were significant to the outcomes. The following discussion illustrates these failures in relation to a number of incidents. Many involved multiple failures within the same category or more extensive evidence pertaining to them than is possible to reproduce here. For reasons of brevity, this discussion is illustrative not exhaustive.

Design, engineering and maintenance flaws

Design, engineering or maintenance flaws that should have been detected and rectified are a recurrent factor in disasters and present in every Table 1 incident. Most involved

Table 1. Some human disasters and 10 pathways.

Disaster	Design, engineering maintenance flaws	Warning signals ignored	Risk assessment flaws	Management system flaws	System auditing flaws	Economic/production pressure compromises	Regulatory failure	Supervisor and so on prior concerns	Poor communication and trust	Emergency and rescue procedure flaws
Westgate bridge collapse 1970	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Valujet crash 1996	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No
Indonesian forest fires 1997–1998	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Hurricane Katrina New Orleans 2005	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Global financial crisis 2007	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Sichuan earthquake 2008	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Deepwater Horizon explosion/fire 2010	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Pike River coalmine explosion 2010	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Fukushima Daiichi Nuclear Plant tsunami 2011	Yes	Yes	Yes	Yes	Yes	Yes	Yes	?	Yes	Yes
Rana Plaza building collapse 2013	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Maxima supermarket Riga collapse 2013	Yes	Yes	Yes	Yes	?	Yes	Yes	Yes	Yes	Yes
West Africa 2014 Ebola outbreak	Yes	?	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Tianjin Port fire 2015	Yes	?	Yes	Yes	Yes	?	Yes	Yes	Yes	Yes
Grenfell tower fire London 2017	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Australian banking crisis Royal Commission 2019	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Vale tailings dam failure Brazil 2019	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Australian bushfires 2019–2020	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Mainly no
COVID-19 pandemic	Yes	Yes	Yes	?	Yes	Yes	Yes	Yes	Yes	Yes

multiple failures but some relevant examples can be cited. Critical to deadly flooding associated with Hurricane Katrina were the failure of levy banks protecting New Orleans (1200 total deaths), later shown by a series of investigations to be flawed in design/construction and unable to cope with the scouring action associated with the storm (Rogers et al., 2015). At Fukushima, the seawall and other flood protection proved completely inadequate to protect the nuclear plant. The Great Financial Crash in 2007 was precipitated in part by poorly designed financial products (notably, collateralised debt obligations or CDOs), incentivised sales of inappropriate products, unsustainable lending practices (like home-loans to people unable to service them), and opaque corporate financial interdependencies – findings echoed in the 2019 Australian Banking Royal Commission (Hayne, 2019; Howe, 2019; Mobley, 2016).

Warning signals that were ignored

Surprising as it may seem, almost all disasters were preceded – sometimes months but more often years – by incidents/events (near-misses or smaller events that could have had more catastrophic consequences), evidence of hazards/risks directly relevant to the actual event. Warning signals are not ‘wondrous hindsight’ but something a prudent management/regulator/government/society should have considered and taken appropriate remedial measures. For all but one incident in Table 1, there were clear warning signals. For a year prior to Hurricane Katrina, homeowners near one of the failed levies reporting consistent seepage was not thoroughly investigated. The risk of fire in high-rise buildings is well-known, and there had been cladding fires prior to the 2017 Grenfell Tower blaze in countries like China and Australia but most governments only acted after Grenfell (Ahrens, 2016; Peng et al., 2013). Furthermore, the Grenfell Inquiry (Moore-Bick, 2019: 10) noted a 2009 fire at the 14-storey Lakanel House in Southwark in 2009 (6 died) indicated emergency response shortcomings still evident at Grenfell. For years prior to the 2019–2020 Australian bushfire disaster, senior fire-fighters had been warning that fire seasons were getting longer (well-known to their US counterparts too) and periods/conditions for hazard-reduction burning were shortening and that fires were also becoming more intense and damaging even for eucalypt fire-adapted forests. In April 2019, well before the fires began, former emergency chiefs wrote an open letter to the Prime Minister expressing ‘alarm at the lack of national action on climate change and pleaded for an end to the cycle of funding cuts for services’ – neoliberalism in action (Megalogenis, 2020). The prime minister rebuffed their request for a meeting and later calls in October that additional aircraft were needed because Australia faced a catastrophic fire season (as eventuated).

Failures in risk assessment

Risk assessment to manage serious hazards is central to minimising/managing disasters and the field has grown enormously over the past 40 years in terms of research/teaching, practice and regulation. Well before the 2014 West Africa Ebola and 2019 COVID-19 outbreaks, a significant body of scientific research pointed to a growing risk of pandemics and more specific risks posed by human interactions with particular wild animals like

bats consumed as food (Reperant and Osterhaus, 2017). While some countries improved epidemic preparedness, there was limited risk assessment focusing on preventing such outbreaks in source countries. The investigation into the 2017 Grenfell Tower inferno (Moore-Bick, 2019) identified failings in risk assessment of fire emergency responses including building layout information. If any assessment was done regarding the flammability and other hazards of cladding prior to Grenfell, it was either manifestly inadequate or ignored by regulators/government.

Failures in safety management systems

Like risk assessment, there has been an enormous growth of ‘systems’ approaches to safety (work, environment, etc.) over the past four decades. Many governments and large organisations have safety systems in place with regulatory requirements and global standards to back this up. The 2011 Fukushima disaster demonstrated the safety systems for managing the nuclear plant were inadequate and the belated emergency response exacerbated adverse effects (Aoki and Rothwell, 2012; Suzuki, 2014). The 2017 Grenfell Tower inferno investigation (Moore-Bick, 2019) identified a series of systems governing the Tower, with overlapping coverage as well as a number of management system flaws including that relating to emergency response. Cutting off gas supply to the building and surrounding area rapidly to avoid a greater conflagration was only accomplished because an engineer of the gas company arrived unprompted, stayed 24 hours and facilitated these actions (Moore-Bick, 2019: 167–170). This highlights the importance of examining what aspects of systems only worked serendipitously and therefore might not be repeated. The Tenant Management Organisation had an emergency plan but Moore-Bick (2019: 16) found it was not activated and 15 years out of date in any case. As the foregoing implies, implementation is as critical as system design.

Failures in system auditing

Even carefully planned systems can have flaws and corrode over time. Episodic independent auditing and internal monitoring are used to identify and guard against failures but they too can have flaws or their findings simply ignored. The 2011 Fukushima incident revealed Tokyo Electric Power Company Holdings (TEPCO) had failed to adequately audit plant safety systems for a tsunami of the magnitude that occurred – planning for known hazardous scenarios and testing is widely used in major hazard facilities like chemical plants and oil-refineries. Effective audits should have identified critical weaknesses including the vulnerability of emergency power supply to units whose failure magnified the impact (Suzuki, 2014).

Economic or production pressures compromising health and safety

The capacity of cost/financial and production pressures, including hazardous reward and bonus regimes, to undermine safety and encourage dangerous/hazardous corner-cutting practices has long been known and linked to incidents like the 1987 *Herald of Free Enterprise* ferry disaster (Hopkins and Maslen, 2015; Quinlan, 2014; Reason, 2008). The

1997–1998 Indonesian forest fires which burnt 8 million hectares, killed 240 people and caused widespread health-damaging pollution affecting surrounding countries originated from a combination of an El-Nino event, illegal logging and fires deliberately lit for land-clearing purposes, principally to grow palm oil. This was mirrored in subsequent fires in Indonesia, Brazil, Peru and elsewhere, where powerful economic interests undermined regulatory responses, suppressed native peoples, disempowered small landholders and encouraged land-use practices that increased the risk of uncontained fires and long-term environmental degradation/species diversity loss (Harrison et al., 2009; Purnomo et al., 2019; Vilanova et al., 2020). In the 2008 Sichuan earthquake, large numbers of school buildings collapsed (official death toll almost 5000 students and injuring 3 times as many) with subsequent investigation revealing widespread corruption and shoddy construction (design, engineering and materials) were responsible for many failures (Miyamoto et al., 2008; Yamamura, 2013). Finally, but not least, public health researchers have already pointed to how neoliberal policies both increased the likelihood and magnified the impact of the COVID-19 pandemic including undermining key international agencies (LaDou, 2020; Navarro, 2020).

Regulatory failure

While sometimes questioned, laws protecting community health and safety, and their effective implementation, represent an essential bulwark against death and disaster, limiting the discretion of powerful interest groups. Centuries of experience and detailed research indicate that where regulation enacted to safeguard the community fails, people die and sometimes in large numbers (Quinlan, 2014). Almost without exception, these laws were the product of public outrage/campaigns following disastrous incidents and even when introduced these interest groups often seek to undermine them (Quinlan, 2014). Failure is more commonly the outcome of interest-compromised oversight rather than outright corruption.

The 2019–2020 Australian bushfire disaster demonstrated several regulatory failures including the absence of a national coordinating authority attuned to the risks associated with climate change, government inaction in mandating more precautionary measures by energy suppliers (power cables had caused previous disastrous fires and power outages also exacerbated their impact), limits to new design rules for buildings in at risk locations and cutbacks to funding of fire-fighting as well as a failure to address long-standing issues about the role of voluntary fire-fighters and their remuneration/compensation. Evidence arising from the global financial crisis (GFC) of 2007 and the 2019 Australian Banking Royal Commission (Hayne, 2019; Quiggin, 2010) identified serious regulatory failings including the ineffectiveness of ‘light-touch’ or economic incentive driven regulation, and the complete failure of governance within large financial institutions, both essentially neoliberal policies. Regulatory failures contributing to the GFC mirrored those that had contributed to previous financial disasters (Buckley and Arner, 2011; Quiggin, 2010) demonstrating that powerful vested interests trumped long-term learning. While there was some regulatory reform following the GFC, there has been push-back since (Goodhart and Tsomocos, 2019).

Supervisor's or others' concerns ignored

Signs of impending disaster are commonly observed by consultants, experts, researchers/scientists, supervisors, workers, citizens or others who express these concerns to authorities but their concerns are either not treated seriously, ignored or worse. Following the 1997–1998 Indonesian forest fires researchers pointed to the increased risk of more intense fires and the link between this and both El-Nino events and logging (Siegert et al., 2001). Their concerns, and that of experienced fire-fighters (in the US and Australia), were largely ignored in countries experiencing these fires, including Brazil. In December 2019, Chinese doctor Li Wenliang sent a message of a severe acute respiratory syndrome (SARS)-like virus to fellow medicos, he was subject to police harassment and told to stop making false statements and spreading rumours. His subsequent death from COVID-19 caused anger and demands of free-speech, highlighting the importance of freedom of speech and independent science to safeguarding human society (BBC News online, 7 February 2020). Totalitarian regimes are especially threatened by anything smacking of dissent, although it is not uncommon for whistle-blowers to be treated badly within democracies.

Poor communication/trust between those in control and those at risk

Effective systems require trust, effective communication and feedback loops to raise concerns. Systems within hierarchical organisations are typically better at transmitting instructions than receiving feedback. In totalitarian regimes like China, there is neither a free press nor independent unions and social media which could promote accountability and preventive measures is heavily censored. Following the 2008 Sichuan earthquake, family protests were suppressed (see, for example, Branigan, 2008), and following the 2015 Tianjin port fire social media was heavily censored within China to suppress mentions/discussion of the disaster and the government investigations were never made public. Poor/circumspect inquiries are also typical of many poor countries following disasters. More informed scrutiny of Rana Plaza came from outside Bangladesh than from the Bangladeshi government, keen to maintain global supply chain clothing factories (Sinkovics et al., 2016).

Emergency or rescue procedure flaws

Disaster management needs to address circumstances where prevention fails to mitigate adverse consequences. Although fires in ports and major hazard facilities were well-known, after the initial Tianjin port explosion/fire, large numbers of fire-fighters, many young and relatively poorly trained, were rushed to the incident with little knowledge of the types of chemicals they were dealing with (risks exacerbated because some storage flouted regulation) and constituted a significant number of the 160 plus fatalities (Zhao, 2016). Better emergency infrastructure in rich countries is an important factor in minimising the death toll from storms, earthquakes and the like when compared to poor/middle-income countries where these are absent or less developed/resourced. Even so, outmoded or inappropriate advice may kill – well evidenced by incidents like the 1988

Piper Alpha oil-rig disaster where workers disobeying management's emergency procedures had better survival chances those following them (Whyte, 2006).

Discussion

Although even one or two of the failures identified could lead to disaster, the high number found in the incidents examined (Table 1) suggests the more present the greater likelihood. There may also be synergistic interactions between different latent failures, especially as some types of failure are closely associated. For example, inadequate risk assessment suggests flaws in safety system management as do auditing flaws. More importantly perhaps, cost-cutting/production pressures can undermine other safety-critical system components like engineering/maintenance not merely decision-making. The discussion suggests two failure pathways may be pivotal namely economic/production pressures and regulatory failure. Nonetheless, it is important to identify all 10 elements because they represent targets for intervention/learning and the combinations/interactions vary in strength. The strength/importance of particular failure points in particular incidents and across a range of incidents warrants further research. Leaving this point to one side, we can still gain much from what is already known. Some disasters still demonstrate learning with regard to particular elements (see above).

Can we draw wider lessons?

Even if the five challenges identified previously are typified as contributing to disasters rather than representing disasters in their own right it is still worth applying the 10 pathways framework to them to see if they are subject to the pattern latent failures that contribute to organisational, even societal, failure. Doing so, the following observations can be made.

Design, engineering and maintenance flaws. It is arguable that some aspects of human organisation, and global trends in relation to them, represent 'design-flaws' because they hinder the capacity to address four challenges (climate change, resource depletion, environmental degradation and overpopulation) and in one case (inequality) propagate the challenge. While human societies are divided along multiple lines (like religion, race and nationalism/geopolitical ambitions), it is neoliberalism which pervades global economic policy discourse, underpinning a pronounced widening of inequality since the mid 1970s. Neoliberalism has privileged markets over government (though governments and international agencies like the International Monetary Fund (IMF) and Organisation for Economic Co-operation and Development (OECD) have actively facilitated its growth) and the communities they are meant to serve/protect. It has been associated with a concentration of wealth within a tiny group (the fraction of 1%) in countries and globally, and with that has come a concentration of power including the rise of authoritarian states and corrosion of democracy referred to in the introduction along with examples of how neoliberal policies adversely affect societies like water supply in Delhi or urban development (to which could be added the rise of Mega cities whose vulnerability may eventually validate Perrow's (2007) warning about over-centralisation). Neoliberalism's mantra of

limitless economic growth (and with it, consumption of relatively disposable products) is not consistent with notions of resource-stewardship, environmental protection or sustainability (in population or climate management). Any effort to redistribute income globally in a way that would raise overall living standards and education levels which would slow population growth and prevent an escalating refugee crisis would require the abandonment of neoliberalism for an economic system based on greater equality and reciprocity. A recent United Nations Department of Social and Economic Affairs (2020) report highlighted the challenges rising inequality posed for sustainable development, especially in the context of mega-trends like climate change, urbanisation and migration, but its proffered solutions did not question neoliberalism.

Failure to heed clear warning signals. Regarding climate change, the evidence has been clear and compelling for over a decade (arguably longer) with accumulating evidence tending to err towards the worst case scenario spectrum. What should be alarming is the limited traction evidence from the world's leading scientists is having on political leaders and the widespread flows of misinformation (nature has no time for personal opinions). In other areas, evidence is there but more locked into silos or inadequately appreciated. Inequality has wide-ranging effects including profound and wide-ranging health effects well-summarised by World Health Organization's 2005–2008 Commission for the Social Determinants of Health, while more specific research points to the adverse health effects of under-employment, precarious and informal work which has grown under neoliberalism as well as the corrosion of unions and regulations aiming to give workers voice (Quinlan, 2015). Research indicating more equitable societies were more efficient has also been ignored (Wilkinson and Pickett, 2009).

Flaws in risk assessment. Consistent with the last section, risk assessment has been carried out with regard to climate change and overlapping areas like water shortages and food security are attracting attention. A number of studies point to the complexities and interconnectedness of risk-assessing and addressing specific problems. Hanjra and Qureshi's (2010) study of food security noted that efforts to eradicating poverty and hunger were being undermined by climate change, water scarcity, energy costs and the GFC. Hanjra and Qureshi (2010) argued accessing water for food required action on multiple fronts including,

tackling climate change, preserving land and conserving water, reducing the energy footprint in food systems, developing and adopting climate resilient varieties, modernising irrigation infrastructure, shoring up domestic food supplies, reforming international food trade, and responding to other global challenges. (p. 365)

Research dealing with population issues is guarded (for an exception, see Jury and Vaux, 2007) possibly in part because of the (premature?) debunking of Thomas Malthus' dire predictions, unpalatable historical connections with Eugenics or because we cannot conceive there would ever be simply too many of us. Rising economic inequality has been 'risk-assessed'. There is a wealth of research on the health effects of neoliberal practices like downsizing/precarious work and the health effects of inequality more generally,

copiously detailed along with concrete remedial measures by the Commission on Social Determinants of Health (2008). The evidence has had little effect on governments/policy-makers. Inequality gets mentioned in meetings like the World Economic Forum in Davos but one on a bucket-list of risks and certainly with no clear interventions in mind given that rectifying it would cut directly across that group's agenda or those of international agencies like the IMF, World Trade Organisation (WTO), OECD or World Bank who largely portray economic growth and market liberalisation as the answer (Quiggin, 2010). As noted earlier, the five challenges all interact and while research increasingly points to this, a more overarching assessment of the risks they entail is needed to inform responses/interventions.

Flaws in hazard/risk mitigation systems. Essentially, there are no global hazard/risk mitigation systems to address these challenges with the partial exception of agreements on climate, which some key countries have begged off. As already noted, neoliberalism does not just hinder action, it foments problems. Elements of this include prioritising markets in policy formulation that is inconsistent with long-term planning (markets do not plan unless governments/regulation force them to), promoting a unsustainable economic model of growth, cutting government infrastructure spending, privatisation (especially of energy and water utilities but also transport) makes policy reformulation/transitioning more difficult and empowering the influence of large corporations, while growing income disparities also affect the capacity of ordinary people to adapt to some of the changes that will be required. The United Nations Global Compact with 10 principles including human rights, labour standards, environmental-sustainability and anti-corruption appears at first glance to address some of the challenges but it is founded on a voluntarist corporate social responsibility (CSR) approach, that consistent with neoliberal ideology does not mandate minimum standards for all business but seeks to promote better practices among those who 'sign-on'. In short, like other applications of CSR, it lacks universal coverage and this approach has also been strongly criticised in terms of implementation and outcomes (see, for example, Jastram and Klingenberg, 2018; Woolfson and Beck, 2019).

There is no considered policy designed to deal with over-population (or associated issues like migration) and work towards sustainability globally nor at national level – a policy vacuum being filled by extremist/exclusionist/racist ideologies that 'progressive' political parties (including those with an avowedly environmental friendly agenda like the Greens) posture against but offer no reasoned alternative. Planning for population sustainability should include economic transfers to impoverished countries, urban and regional planning including jobs (especially in revitalised local manufacturing to reduce food-miles/value add and exploit new technologies) to encourage movements to more sustainable locations and away from a mega city focus and more sustainable food/diets (Candy et al., 2019). It will also entail some reformulation of immigration policies, though not knee-jerk exclusion of refugees or right-wing ethnocentrism which in the absence of other measures will prove ineffective in the longer term. Measures that contribute to population management can also benefit climate change pressures including educating women in poor countries and enhancing their income security/economic base (see, for example, Bongaarts and O'Neill, 2018). It would entail dealing with inequality

at the source in countries subject to a refugee crisis which would actually help far more people, more effectively and reduce impetus for movement. This is not an argument for discontinuing humanitarian help for refugees. It will make the numbers more manageable as global society transitions, while the alternative is escalating refugee numbers from climate change and associated problems of inequality, including rising political instability that no combination of countries will be able to manage within 20 years (probably 10 times the current number).

With the partial exception of climate change, there are no global safety systems in place for the five challenges. Attempts to establish multi-country/regional agreements are fraught to say the least with dam construction by China, for example, affecting downstream water users (the same problem occurs within countries) and similar issues in the Middle-east and elsewhere. Food, population and inequality remain largely nation-state level concerns but ones that will generate tensions when countries compete for food or where one country has purchased food-producing land in another. But the take away point is by and large there is no system to fail let alone succeed.

Flaws in system auditing. There are a number of relevant global auditing regimes in place, almost all operated by non government organisations (NGOs; some receive government agency funding) like Transparency International's corruption index – seen as valuable though subject to a number of criticisms (see, for example, Baumann, 2017; Madlovics and Magyar, 2019). Auditing regimes are confined to particular spheres but in practice they interact as in cases where corruption affects environmental impact assessments (Williams and Dupuy, 2016). The International Organisation for Standardisation (ISO) has developed an array of standards including food safety, environmental and energy management for businesses. Though not without benefits, like CSR, this is a voluntary not mandated regime leaving considerable coverage gaps (paperwork auditing and non-expert auditors has also been criticised, du Plessis et al., 2018; Schwartz and Tilling, 2009).

Economic/production and rewards pressures compromising health and safety. The dominant economic policy discourse, neoliberalism and its crony-capitalism equivalents in totalitarian regimes like China, have resulted in growing levels of inequality and this together with particular policies (unregulated 'free' trade, privatisation, outsourcing/supply chains, competitive tendering, reducing the welfare state, market-driven models of urban planning, reducing protective regulation and regulating to advantage the rich) has had wide-ranging adverse effects on population health, demonstrated by a compelling body of research and indeed now orthodox knowledge among many health researchers (see, for example, Commission on Social Determinants of Health, 2008 and its subsidiary reports; Schrecker, 2016). A regime that appropriates health is hardly likely to be one that will be compatible with preventing disaster. Market-driven solutions have already demonstrated their incapacity to deal with climate change. In debates over climate change arguments about its economic 'costs' in terms of jobs, economic growth and particular industries have been continuously raised. What these arguments overlook is the far higher economic costs of not doing enough, already foreshadowed by disasters like Deepwater Horizon, Hurricane Katrina or the Australian 2019–2020 bushfires (or those

in Brazil too for that matter). Similar arguments can be made with regard to resource depletion, environmental degradation and population growth. Far from spreading wealth, income and opportunity (to all but a minority) and solving problems at the source, rising inequality is driving political unrest and large scale migration/refugee movements. Neo-liberalism is also wedded to never-ending economic growth – however illusory – which is also incompatible with a sustainable future.

Failures in regulatory oversight. A patchwork of national legislation and global treaties/framework agreements (most notably on climate change) address only some of the challenges, but only in part and some global agreements and agencies (like the IMF and WTO) do not operate in ways that reduce inequality (Delgado, 2019; Hickel, 2017). Research suggests the Kyoto and Paris climate reduction targets have reduced carbon emissions, though the complicated criteria offer some ‘wriggle-room’ and some countries have threatened if not actually reneged on commitments (Shishlov et al., 2016; Gupta and van Asselt, 2019). Without effective auditing, interest groups will defeat standards and compliance weaknesses will have cascading effects on confidence in them.

Expressed concerns. As already indicated, there is already considerable scientific evidence on the severe risks posed by the five challenges (though mostly only considering the overlaps between two or three at most) and scientists have become increasingly vocal publicly, particularly with regard to climate change, environmental degradation/diversity loss and resource depletion (especially water). More research examining synergies between all five would be more persuasive but also likely to be labelled as political interference, especially if the issue of inequality is included (though some science papers certainly make the connection). High-profile individuals (like Al Gore, Greta Thunberg and Sir David Attenborough) have also spoken out, especially on climate change and a number of challenges have been picked up by global protests like the Occupy Movement over inequality/democracy (2011) and Extinction Rebellion over climate change (since 2018). Island-states have spoken out about the lack of action on sea-level rises threatening their very existence and country-specific protests against a mixture of inequality/corruption and lack of democratic accountabilities occurred in Chile, Iran, Iraq, Lebanon and elsewhere in 2019. In sum, expressed concerns are to be found but as yet they have had limited traction.

Poor communication/trust between those in control and those at risk. Communication failures are relevant to understanding the propensity for disaster, though not as often commonly portrayed in the risk literature which takes insufficient account of why information is held back or misinformation spread (for an exception see Button, 2016). When undertaking investigations into fatal mine incidents at Beaconsfield in 2006 and Pike River in 2010 – the former in an official capacity – I was somewhat surprised to find that public-relations firms were rapidly engaged. They implemented protocols to manage information flows/media-reporting, including who from management was interviewed, developing a narrative that emphasised rescue – which conveyed hope and optimism – and avoiding discussion of why/how the incident had occurred – which might foster interrogation and anger among the affected families. The narrative just described is

common to other disastrous events, often reinforced by media reporting that while not ignoring causation or critical investigative observations (especially when scientists/experts as distinct from other journalists are interviewed) largely focuses on individual human-interest stories of those affected or who witnessed the event. Typical is extensive media coverage of the miraculous rescue of a child following an earthquake or a Koala during the 2019/2020 Australia bushfires (ultimately it had to be euthanised), with politicians visiting the scene to express empathy with victims (carefully stage-managed in many instances) and expressing views – whether it be a terrorist incident, epidemic, fire or environmental disaster – that the community would be resilient and overcome the tragedy.

However soothing to the community (not for those directly affected), the rescue/resilience narrative does not address uncertainties about causation or remedies. Nor does it encourage the sort of community engagement and criticism that is needed. Writing on the Australian fires for the *New York Times* author Richard Flanagan (2020) pointedly stated what the country needed was not resilience but resistance to government policies failing to prevent the impending disasters accompanying climate change. In some instances, an official inquiry is announced, in some democracies this will become a public document subject to media reporting, including implementation of recommendations, although how effectively is seldom followed up. As evident for the 2008 earthquake and 2019/2020 COVID-19 outbreak, in totalitarian regimes like China a similar rescue/resilience narrative is promoted by state-media (echoed but with some critical observations by global media), choreographed political appearances along with censoring social media networks when they criticise government and the sacrificial lopping of some lower government officials who may have been complicit and an official inquiry (seldom made public) to appease anger/uncertainty. Two other aspects of communication warrant mentioning. First, while scientists might be accused about insufficiently publicising concerning evidence (in areas like resource depletion, environmental degradation and more especially overpopulation and inequality) but even where they have done so (particularly regarding climate) this has come under sustained attacks from right-wing politicians and media, helping to legitimate disparaging such evidence and conspiracy theories. Second, the rise of social media, while sometimes providing additional information and community, has also become an instrument subject to manipulation and disinformation. The interconnections all warrant more research, the points made principally to indicate failings in communication and mistrust between those in control and those at risk.

Flaws in emergency/rescue procedures and resources. There are no global plans in place to deal with the outcomes of these challenges as they play out beyond the emergency practices geared to smaller disasters and some national/regional programmes on adjusting to climate change. Some research suggests access to the latter favours those better-endowed to protect themselves, leaving the vulnerable even more precariously placed (Thomas and Warner, 2019). The uber wealthy may seek safe-havens (like the South Island, New Zealand) at the extreme north and south of the globe but, at best, these are too small to accommodate more than a minority. Ultimately, these challenges are likely to prove well beyond the realms of resilience. The COVID-19 pandemic provides an indication of just how disruptive and costly a single catastrophe can be and the cumulative effect

of a succession of disasters needs to be recognised. Even with smaller scale disasters, emergency/rescue procedures were the last-stand option of mitigating harm rather than preventing it. Adjustment measures will almost certainly prove unavoidable but hopefully as part of a transition to more fundamental solutions not the principle response.

In sum, the 10 pathways or latent failures most typically associated with disaster are present with regard to the 5 challenges facing human civilisation. This article has only been able to point to the connections and identify important theoretical and policy questions requiring further examination. This includes the question of scalability when examining organisational and society failure, although 10 pathways does seem to offer both a template for investigating and remedying them. Furthermore, the need to give more credence to Charles Perrow's (2007) warning on the vulnerability to catastrophe of societies where power/energy, population and the like was highly concentrated, has been graphically illustrated by the unfolding COVID-19 pandemic.

Conclusion

The five human-engineered challenges represent an impending existential crisis for human civilisation that interact in multiple and mutually reinforcing ways. Some remedial steps are clear, including reducing carbon-dioxide levels, protecting forests, promoting healthier/more sustainable food options and beginning to reverse neoliberal policies (like privatisation of utilities and removing profit/developer influence from urban planning). It will be hard to address climate change more effectively in the long term without also dealing with population pressures and addressing global economic inequality and the economic policies that promote it. Furthermore, effective action requires dealing with most if not all the latent failures identified not just some. On a more positive note, since the challenges interrelate addressing a number simultaneously will also be reinforcing. For example, slowing population growth will reduce pressure on resources, environmental degradation and assist those aimed at curbing climate change.

Barring nuclear war (always a possibility given competition for resources and the political instability wrought by rising inequality and authoritarianism) global disaster is not likely to eventuate as a single catastrophic event but rather a growing series of more intense weather events (sequential events caused the collapse of several civilisations, Fagan, 2008), pandemics, famines, social upheavals and the like that progressively undermine societies' capacity to respond. Some will collapse faster than others (failed states already exist) but the burden will spread and cascade onto others (e.g. mass-migrations beggaring present movements as a result of prolonged droughts/famine). Effective action requires a major shift in the way humans organise themselves towards sustainability, reciprocity and equality involving both internal and global shifts in resources/wealth (including trade based on raising labour and living standards not a race to the bottom as now practised by the WTO) – anathema to the dominant economic discourse of neoliberalism and the rich ruling elites it serves. Efforts to move the agenda will face concerted calls that it is too costly, although the cascading costs of repeated disasters – both single incident and slow-burn ones like growing disease, poverty and hunger – will eventually demonstrate that the cost of doing little or nothing was far greater. Furthermore, there is only a narrow window for action, measured at several decades at best on climate change

alone before a tipping point is reached – hopefully, we have not already passed it. If significant action is not taken soon humanity will provide an unpalatable answer to Fermi’s paradox becoming the first (known?) advanced terrestrial civilisation to engineer/organise its own demise.

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