## 1AC

### Journalism---1AC

#### Advantage 1 is Journalism.

#### The journalism industry is collapsing because it’s reliant on online platforms to disseminate their product and generate revenue. That drains democracy and accountable governance.

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Courtney Radsch and Michael Karanicolas, “Introduction: Best of Frenemies,” Sustaining Journalism, Sustaining Democracy: A Policy Guide on Platforms and the Press, 04/2023, https://itlp.law.ucla.edu/wp-content/uploads/2023/04/UCLA\_ITLP\_PlatformsPress\_Final.pdf

After decades of shrinking revenues, and an increasing expectation among consumers that the news should be free, the global news media industry has reached a crisis point. The importance of the press to maintaining democracy means that, as the financial models which underlie the news media industry have come under increasing strain, both emerging and established democracies have seen a steady erosion of trust in institutions of knowledge and governance. Evidence of the problem can be seen in the proliferation of misinformation and conspiracy theories, which blur the line between fantasy and reality, from politics to public health. As the electorate loses faith in our political and governance structures, extremism and political violence become normalized. Even worse, as structures of public accountability degrade, autocrats and would-be autocrats have grown skilled at manipulating the online discourse to suit their pursuit of power.

While there is no single cause underlying journalism’s long-term decline, much of the blame points to shifting markets for information, and the increasing reliance of news outlets on online platforms to disseminate their product and to generate revenue. As the major platforms have grown to dominate our political and information ecosystem, the already tenuous funding models underlying news media have been stretched to a breaking point. The leading platforms not only claim a sizable share of both the publishing and advertising infrastructure, but also possess a formidable grip on audience access, content moderation, and data, allowing them to set the terms of their engagement with the news media industry, and to claim the lion’s share of revenue generated from news content. The demands of following a platform-specific logic for how news is generated and distributed has added technical complexity and instability to news media operations. News is constrained by the policies, conventions and fluctuating algorithms that determine visibility and viability. Content moderation systems are opaque in their rule-making and enforcement, and this in turn governs visibility, monetization, and outreach of the content published by journalistic organizations. In this environment, journalists must remain vigilant not only of the legal and ethical standards underlying their work, but also the community standards and engagement metrics that determine their audience and viability. When virality governs the news industry, the public interest suffers.

In less developed countries, or those with poor press freedom records, the situation is often even more dire. Although platforms can be a lifeline for media outlets in places where the airwaves are restricted, government intervention is prevalent, and journalistic independence is limited, news outlets have an even more difficult path pursuing sustainability and predictability in their engagement with platforms. This is due to the latter’s overwhelming focus on their english-language, and specifically American, operations.1 The experience of Ukraine’s largest independent media outlet, Ukrainska Pravda (UP), illustrates this challenge perfectly. The outlet’s 100 million monthly page views soared 900% in the first month of Russia’s attack on Ukraine, a global news event. However, erroneous content moderation decisions by the platforms meant that native ads on its website dropped to nearly zero over the same time period, while programmatic revenue dropped 90%.2

As democracies around the world have watched this problem unfold, and experienced the ancillary impacts of journalism’s decline, they have begun to implement a range of solutions aimed at supporting long term sustainability for news media. Among the most high profile interventions have been the European Union’s 2021 Digital Copyright Directive and Australia’s 2021 News Media and Digital Platforms Mandatory Bargaining Code, but similar initiatives have been pursued in many other countries, from Indonesia to India to Canada. In the United States, there have been a number of legislative proposals aimed at tackling the problem, most notably the Journalism Competition and Preservation Act.

These initiatives have faced a range of challenges and criticisms. In Australia, Facebook infamously shut down news in the country for four days in response to the new Code, though they reversed course on this after public outcry, and early results from that country appear promising.3 Subsidy or tax credit schemes create challenges related to determining who is or is not worthy of support, or the even more fraught question or who even qualifies as a “journalist”. There are concerns that whoever controls these levers of funding, whether it is a government or a company, may abuse this power to punish disfavored perspectives or to silence critical reporting. But if the threshold for qualifying is too low, it could result in channeling resources to the worst purveyors of misinformation and hate, further degrading the political discourse. Some journalists have also raised concerns that these programs, even if administered fairly, could further erode public confidence in their reporting, by creating a perception that they are beholden to their government or Big Tech paymasters.4

There is also a tension between calls to harness the resources of major platforms to support journalism and ongoing antitrust and competition inquiries that view the platforms’ market power as the heart of the problem.5 There are concerns that a licensing model that ties the future of journalism to the profitability of Big Tech will make it more difficult to break the companies up and further entrench the surveillance-heavy business model they are built around.

Every proposed solution involves trade-offs and challenges. However, given the foundational importance of the press to a functioning democracy, and the existential crisis facing newsrooms around the world, inaction is not an option.

This publication considers the range of policy changes that have been tried or recommended by global regulators, assessing their impacts on press freedom and news media sustainability, with consideration for the risk of capture, and other potential tradeoffs of these interventions. It examines four categories of interventions: related to taxes and direct subsidies; copyright and licensing; competition and antitrust regulation; and transparency. Each piece discusses the driving concept behind each intervention, its advantages to publishers, how these benefits are distributed and how decisions are made regarding them, potential government involvement in each one, and their ability to address key underlying challenges related to news media sustainability. Our research also emphasizes the interrelationships between these policies and their broader effect on the platformatization of journalism. However, given that these interventions are in their early stages, or in some cases are still theoretical, a dearth of data makes it difficult to conclusively assess their impacts on media sustainability, media freedom and access to news. Where data asymmetries exist related to these questions, they are noted as areas for further research and potential regulatory attention.

This publication was developed as part of an innovative new experiential learning class at the UCLA School of Law aimed at onboarding students into the tech policy space and developing their critical analytical capabilities by training them to answer emerging policy questions. Developed by the Institute for Technology, Law and Policy at UCLA, this new Information Policy Lab engaged a group of students to work through the implications of proposed interventions on media freedom and sustainability. They address the theory of change driving each intervention, the benefits that accrue to publishers, the definition of who benefits and how that decision is made going forward, and the potential for government intervention. They also address the adequacy of each approach for addressing core challenges to news media viability in the platform era. This analysis underscores the interdependency between them and their impact on platformatization, which policymakers may want to consider more explicitly.

Fact-based journalism is essential to populations in conflict and crisis, as well as to public health, development, and accountable governance. The increasing dominance of online platforms over our public sphere has led to an uneasy relationship between news organizations and large tech companies. While the latter have generated new opportunities to connect journalists with audiences, evade censorship, and engage in influential cross-border collaborations, they have also forced journalists to contend with shifting algorithmic priorities, warped incentive structures in the online economy, and an increasingly complex array of technology policies that shape the environment in which they work and the business models for sustainability. Perhaps most urgently, the platformization of journalism has contributed to a crisis in funding in which quality journalism, particularly locally-focused and investigative journalism, has struggled to figure out how to navigate sustainability in the information age.

Public interest news media are rarely viable economically, and it is no different in the platform economy. But platforms have undermined the entire market for fact-based, reliable information that is at the core of journalism as a public good that is fundamental to well-functioning democracies. Rebalancing market dynamics and seeking to address information asymmetries is critical to not only ensuring the future viability of the news media industry, but the future of democracy.

#### A free press is the bedrock of democracy. The plan reverse-causally solves.

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Sanjukta Paul, “A new law can help us keep the robust free press our democracy needs,” Los Angeles Times, 10-03-2022, https://www.latimes.com/opinion/story/2022-10-03/jcpa-journalism-media-news-antitrust-google-facebook

A free and robust press is a central ingredient of a flourishing and democratic society — and given the number of existential crises we now face, also critical to its survival. Yet today, the journalism sector is collapsing. The number of newsroom jobs has declined by more than 30,000 since 2008, while local news deserts continue to grow and spread.

A major factor in this decline is the rise of powerful internet platforms, like Google and Facebook, which currently control the bulk of digital advertising and have become the main source of news for many Americans. A huge number of search results on Google link to news stories, reproducing enough content for users to consume. But 65% of these users do not click through to the news publishers’ websites. This means that even when their work has delivered value to the public, the businesses actually investing in and doing the work of journalism can’t earn sufficient advertising revenue to cover their costs. Needless to say, this is not economically sustainable. Hence, the devastating decline in the entire sector.

It’s important to recognize what is driving the problem here: It isn’t the “free market” or even technological changes per se, but the specific market design, which the law helps to shape.

These dominant internet platforms have effectively collected market power within their own corporate boundaries, ultimately allowing them to dictate terms to other businesses whose content they use. Yet, the law prevents journalistic enterprises from coordinating among themselves to bargain with these giant platforms for the value of their product.

A straightforward solution to the problem is to allow the newspapers and media companies to band together for the purpose of negotiating with the internet platforms for payment for the content they create.

That is exactly what the bipartisan Journalism Competition and Preservation Act, currently in Congress, would do. It would authorize news outlets to create “joint negotiating entities” to bargain for compensation from internet platforms for the news stories they use; it would also require binding arbitration if there’s no agreement over a specified period of months. The largest national newspapers and television networks would be excluded and the legislation would sunset after eight years.

The bill also creates a carve-out from federal antitrust law, the statutory framework that regulates economic competition and coordination. Make no mistake, this legal framework — which most people think of as simply promoting competition — today already allocates economic coordination rights to large, powerful corporations such as Google and Facebook, to the detriment of smaller players.

Some critics oppose the JCPA because they say it would create a “news media cartel.” But this criticism misunderstands both antitrust law and how economies actually work. Despite its current tendency to delegate market management to powerful firms like the dominant internet platforms, antitrust law has also long authorized numerous forms of coordination between otherwise independent enterprises in circumstances very similar to the one proposed for news media companies.

The antitrust exemption for labor negotiations as well as longstanding exemptions for agricultural businesses and fisheries are all examples of authorized economic coordination in which smaller, less powerful players are allowed to band together to bargain with a more powerful and dominant actor, such as an employer or an agricultural processor, or in this case, an internet platform.

Not only are such exemptions, or “safe harbors,” from antitrust’s regulation of coordination already well-established in the legal architecture of our economy, it is hard to imagine the economy functioning well without them.

Productive economic activity and the systems of distribution and commerce built on top of it require both competition and coordination, and our law and institutions, including antitrust law, recognize this while channeling and shaping both.

Indeed, the powerful platforms with whom news publishers currently deal, and with whom they would collectively negotiate, are not tightly knit production units but are instead vast sprawling empires containing distinct but interconnected operations and investments. The bargaining power they have amassed within their corporate boundaries is vast. It’s reasonable to balance their substantial coordination abilities with the relatively modest coordination rights granted to journalistic enterprises under the proposed bill.

There is also recent precedent for authorizing exactly this type of news media coordination. Australia used its competition law to impose a similar rule last year, which has effectively required Facebook and Google to pay for the news content they distribute. That new system has already resulted in a significant shift in the distribution of revenues, resulting in more investment being channeled back into the work of journalism.

The JCPA falls squarely within the American antitrust tradition. The Sherman Act, the foundational federal antitrust law, was the ultimate outcome of the efforts of a farmer-labor political coalition, which aimed to foster cooperation among smaller players and to rein in monopoly directly. A careful examination of the legislative history, political and intellectual context and common law antecedents shows that Congress never intended to proscribe or even discourage such forms of economic coordination when it passed the Sherman Act.

The JCPA is good policy that effectively responds to an urgent need, and it is a good fit with the underlying purposes of antitrust law.

#### Democratic collapse triggers transition wars. DPT is true and necessary to prevent rogue tech.

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Haydn Belfield, “Collapse, Recovery, and Existential Risk,” How Worlds Collapse: What History, Systems, and Complexity Can Teach Us About Our Modern World and Fragile Future, pp. 74-76, 2023, https://doi.org/10.4324/9781003331384

A world dominated by totalitarian states would be more incompetent, more war-prone, less cooperative, and more inhibitive of progress than one dominated by democratic states. Our current world is not particularly competent, peaceful, cooperative, or progressive—a totalitarian-dominated world would be worse. It would increase the risk of another collapse and extinction and could shape the future toward less desirable trajectories (Beckstead, 2013).

Totalitarian states are incompetent. They are bad at forecasting and dealing with disasters (Caplan, 2008).16 This can be seen most clearly in the great famines of Communist China and the USSR, in which millions died (Applebaum, 2017; Becker, 1996; Dikotter, 2010; Snyder, 2010). In comparison, functioning multiparty democracies rarely, if ever, experience famines (Sen, 2010). “Established autocracies” (or “personal”/“sultanist”) are particularly bad, as there are few checks or restraints on arbitrary rule and the whims and ideology of the single individual, even from other elites (Svolik, 2012). From the inside, the “inner circle” around Mao, Stalin, and Hitler seems incredibly chaotic, with elites strongly incentivized to conceal information and encouraged by the autocrat to squabble and feud—so they are divided (Conquest, 1992; Kershaw, 2008; Zhang & Halliday, 2006). If totalitarian states are worse at addressing social, environmental, and technological problems, then a world dominated by them would likely be worse at responding to risks of collapse and extinction.

A world dominated by totalitarian states is more likely to have major wars. States with near-universal adult suffrage rarely (if ever) go to war with one another (Barnhart et al., 2020), so a world dominated by democracies has fewer wars. Miscalculation might be a particular problem for totalitarian states due to personalization and disincentives for accurate information, leading to well-known strategic disasters such as Hitler and Stalin’s blunders in World War II (Bialer, 1970; Noakes & Pridham, 2001), or at a smaller level, Saddam Hussein’s rejection of diplomacy (Atkinson, 1993). War makes collapse and extinction more likely, by raising the chance of weapons of mass destruction being used.

Linked to this, totalitarian states are less cooperative than democratic states. While cooperation is possible (Ginsburg, 2020), their internal norms are characterized by paranoia and treachery, and their lack of transparency limits their ability to credibly commit to agreements. This is bad for all risks that require cooperation such as pandemics or climate change (Tomasik, 2015).

Finally, continued social and scientific progress is likely to reduce risks of collapse and extinction. Social progress could reduce global inequality and other risk factors. Scientific progress could help address natural risks and climate change (Sandberg, 2018), differentially increase defensive rather than offensive power (Garfinkel & Dafoe, 2019), and solve safety challenges in AI or biotechnology (Russell, 2019). However, as we will now discuss totalitarian states would likely inhibit social progress.

A central question from a longtermist perspective is: Which values should shape the future? I would argue that we should prefer it to be shaped by liberal democratic values. This is not to say that the current democracy-dominated world is perfect—far from it. The fate of billions of factory-farmed animals or hundreds of millions of people in extreme poverty makes that abundantly clear. However, democracies have two advantages. First, democracies have space for cosmopolitan values such as human rights, plurality, freedom, and equality. These are better than those that characterize life under totalitarianism: Fear, terror, subjection, and secrecy. Second, they have within themselves the mechanism to allow progress. In the last 100 (or even 50) years, the lives of women, LGBT people, religious minorities, and non-white people have dramatically improved. Our “moral circle” has expanded, and could continue to expand (Singer, 1981). The arc of the moral universe is long, but given the right conditions, it might just bend toward justice (King, 1968). A global society dominated by these values, and with the possibility of improving more, has a better longterm potential. A totalitarian-dominated world, on the other hand, would reduce the space for resistance and progress—distorting the human trajectory.

We should be particularly concerned about “bottlenecks” at which values are particularly important—where there is a risk of “locking-in” some particular set of (possibly far from optimal) values. While they are currently far-off, future technologies such as artificial general intelligence, space settlement, life extension (of autocrats), or much better surveillance could enable lock-in (Caplan, 2008).17

Conditional on them avoiding new catastrophes, world orders dominated by totalitarians could be quite long-lasting (Caplan, 2008). Democracies can undermine authoritarian and totalitarian regimes through the following ways: Control, including conquest; contagion through proximity; and consent, promoting receptivity toward democratization (Whitehead, 2001). Democracies can actively undermine these regimes through war, sanctions, hosting rebellious exiles, or sponsoring internal movements. Passively, through contagion, they offer a demonstration that a better, more prosperous life is possible. For example, in the final years of the USSR, ordinary Soviet citizens were able to see that the West had a higher standard of living—more innovation, more choice, and more consumer goods. The elites were able to read books from the outside, and travel—Gorbachev’s contacts and friendships with European politicians may have made him more favorable to social democracy (Brown, 1996). Democracies can undermine the will and capacity of the coercive apparatus (Bellin, 2004). However, in a world not dominated by democracies, all these pressures would be far less.

A world in which, say, totalitarian regimes emerged as dominant after World War II (for example if the USA was defeated) could be self-reinforcing and long-lasting, like the self-reinforcing relationship of Oceania, Eurasia, and Eastasia (Orwell, 1949). Orwell’s fictional world is characterized by constant low-grade warfare to justify emergency powers and secure elites, and with shifting alliances of convenience as states bandwagon and balance, thereby preventing any resolution. A totalitarian-dominated world order could be rather robust, perhaps for decades or even centuries.

A long-lasting totalitarian-dominated world would extend the period of time humanity would spend with a heightened risk of collapse or extinction, as well as increased potential for distortion of the human trajectory and the possibility that a “lock-in” event may occur. This example illustrates the possibility of a “negative recovery,” resulting in a trajectory with less or no scientific and social progress and a less favorable geopolitical situation, which would threaten the destruction of humanity’s longterm potential.

#### And, the stronger U.S. authoritarianism is, the more it spreads globally. If unmitigated, that sparks a global polycrisis culminating in extinction.

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Thomas Homer-Dixon, Luke Kemp, Michael Lawrence, and Megan Shipman, “How Donald Trump’s Reelection Could Amplify Global Inter-systemic Risk,” Cascade Institute, 10-03-2024, https://cascadeinstitute.org/wp-content/uploads/2024/10/Impact-2024-How-Donald-Trumps-Reelection-Could-Amplify-Inter-systemic-Risk-2.pdf

Expanded authoritarian practices at home (FL2) would likely bolster authoritarian governance elsewhere (FL3). Foreign authoritarianism could then reinforce domestic US authoritarianism, as Mr. Trump points to other countries’ “strongmen” as exemplars. Greater authoritarianism globally would also contribute to an increase in failed states, mass violence, and humanitarian crises, while simultaneously promoting formation of competing geopolitical blocs, as nations of similar ideology and governance choose to cooperate with each other and sanction others.

America’s reduced participation in NATO, other international security arrangements, the UN, and other multilateral institutions would have perilous knock-on effects. The world could suffer governance failures on everything from macro-economic stability and pandemic preparedness to conflict management—contributing to virtually all components of the polycrisis.

Multilateral exodus and the spread of authoritarian governments might combine with trade wars to reinforce the emergence of intensely competing—and mutually hostile— geopolitical blocs. This outcome would in turn encourage arms races and substantially raise the risk of great-power war (F7 and F8). Any major American advances on military applications of AI would supercharge these spirals (FL8).

For clarity, Figure 14 does not show potential feedbacks from elements of the global polycrisis back to the factors that exacerbate those elements. But the crises on the figure’s right interact with the stresses and feedbacks on its left in many complex ways.

For instance, climate change would place additional strains on geopolitical arrangements. More frequent and severe weather events are already disrupting economies and worsening conflicts around the world. Impacts will intensify in the years ahead, especially if a second Trump administration manages to derail climate action. Geopolitical competition would further inhibit global climate cooperation in ways that could increase the likelihood that 3+°C warming becomes locked in. A rapidly warming world with decreasing cooperation and increasing geopolitical tensions would raise the risk of intrastate war and state failure while hampering international responses to new pandemics and financial crises. It would also raise the risk of war between great powers.

Finally, major external shocks, which we call “macro-triggers” (see Box 8) could dramatically exacerbate the processes identified in Figure 14. While the probability of any one of these specific triggers occurring may be relatively low, it is virtually guaranteed that the coming years will bring major and largely unexpected global shocks of one form or another.

3.3 Conclusion: Historical parallels and uncertain futures

There are striking parallels between the crises of the early 20 century and the pathways to an escalating polycrisis that we depict in Figure 14. The decades before World War II were marked by rising inequality and authoritarianism, the influenza pandemic of 1918, and the Great Depression of 1929-1932. These events culminated in a global battle between coalitions of authoritarian and liberal empires. The difference today is that the world’s hardening blocs have nuclear weapons and reside on a warming planet with rapidly degrading ecosystems. And despite their mutual antagonisms, they remain tightly linked by flows of capital, energy, food, manufactured goods, information, and technology.

flows of capital, energy, food, manufactured goods, information, and technology.

#### Independently, strong journalism is an impact filter. It’s necessary to respond to all existential risks.

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Gabi Mocatta, Shaneka Saville, Nicholas Payne, Lova Jansson, Jerry Lai, and Kristy Hess, “Are Journalists Reporting the ‘Global Polycrisis’?,” Deakin University, 08/2024, https://internews.org/wp-content/uploads/2024/08/are-journalists-reporting-the-global-polycrisis-report-210624-final-edit-high-res-compressed.pdf

To report the news in the current global moment is to observe a world in crisis. Multiple, cascading risks mark our times, intersecting with each other in ways that amplify their seriousness, and underscore planetary precarity. Climate change, (un)natural disasters, environmental harms – including deforestation, pollution and biodiversity loss – a global pandemic, wars, inflation shocks, democratic dysfunction and the rise of authoritarianism are just some of the interlinking crises that have marked the start of the 21st century. If societies are to confront these crises meaningfully and holistically, it is imperative that people and policymakers understand the interconnectedness of these threats and respond in a way that is commensurate. Journalists, as observers and public-facing analysts, are well placed to interpret and make sense of such phenomena for media audiences locally and globally.

To date, however, there has been little research into how, and indeed whether, journalists and the media they report for, cover intersectional crises. It has also not been established whether, when journalists do report on seemingly singular threats or disasters, they intentionally do so in such a way that makes the links between concurrent crises clear, so that audiences might grasp the interconnections, better understand causes and therefore the commensurate action needed. Further complicating this issue, there is no one agreed term to describe the spectrum of current, intersecting threats – though the expression ‘global polycrisis’ is one idiom that has emerged in some media and research publications to signify the concept.

To respond to these gaps in knowledge, this study examines journalists’ practices and perspectives on reporting the concept of ‘global polycrisis’. The study traces the origins of the concept and the current use of the term, in both media and in research publications and reports. Importantly, this research also goes directly to journalists themselves, asking them about their understanding of polycrisis, and how and indeed whether they report on intersecting crises. The work presented here is truly global in scope: journalists from 102 countries responded to the study’s multilingual survey, and the research team undertook in-depth interviews with 74 journalists in 31 countries. We present here findings from this first, detailed research into the attitudes of an international cohort of journalists about reporting on the world’s intersecting crises.

The study finds that, although the term ‘global polycrisis’ began to be used more regularly in online reports and in some media coverage from 2022 and in 2023, it is still a nascent term which is used more by NGOs than by media professionals. This study clearly establishes that the term ‘global polycrisis’ is not widely recognized or used by journalists. While only a minority of journalists who responded to our research said they used the specific term ‘global polycrisis’ in their reporting, most indicated that they were familiar with the concept it represents.

Journalists were largely motivated to present issues to their audiences in a way that underscored intersectionality, however, they experienced multiple barriers to doing so. These included time, resource and word constraints that curb in-depth reporting; newsroom/editorial interest and perceived audience concern; and the media’s economic imperative to provide ‘click-bait’ and ‘soundbite’ stories that sell. When covering intersecting crises and disasters, journalists were most likely to do so through the frame of climate change and environmental issues. While journalists felt they were mostly unable to convey the notion of ‘polycrisis’ in a single story, some said they could do so across a series of stories, over time. Importantly, some journalists railed against the term ‘polycrisis’ itself, considering it to be ‘jargon’ manufactured by NGOs, unintelligible to audiences, and unpalatable to editors. Significantly, the term ‘global polycrisis’ is overwhelmingly used in the English-speaking world: very few journalists working in languages other than English said they would translate the term into the languages they usually reported in.

Our study reveals an uneven global mediascape when it comes to covering the issues that constitute our contemporary confluence of crises. Broadly, journalists from wealthier countries and the English speaking world reported in interviews being slightly more familiar with the term ‘polycrisis’, and the concept it represents, than those in low- and middle-income country locations – precisely the places where people are currently most vulnerable to intersecting existential risks. However, journalists in higher income countries also had some of the strongest reactions against using the term itself. Likewise, many journalists working in low- and middle-income countries were familiar with the ‘polycrisis’ concept (if not the term) and reported using it in their work. This seemed to be especially the case if a journalist had worked with or had been funded by international donors or NGOs.

These results suggest that there are widespread opportunities for media support and donor organizations to fund journalistic work that highlights the interconnections between global and local interconnecting threats. However, as we detail below, seeking to encourage the adoption of the ‘polycrisis’ term may not be the most productive avenue for amplifying reportage on these issues. Engaging with journalists and their newsrooms to assist them in reporting the ‘polycrisis’ concept in whichever ways are most relevant for their specific audiences may be a more fruitful pathway for promoting public understanding and awareness.

BACKGROUND AND LITERATURE REVIEW

2.1 A landscape of multiple crises

Journalists, academics and commentators have long been alerting us to the complicated set of threats we currently face. These threats are economic, environmental, geo-political, societal and technological. They include ‘hot’ war in several global locations, and frozen – but still lethal – conflicts in others; environmental degradation and extreme weather disasters; societal and political polarization; economic shocks and a cost-of-living crisis, and diverse threats from artificial intelligence, including rampant mis- and dis-information (World Economic Forum, 2024). Overarching all of these is climate change, acting as a “threat multiplier” (UN News, 2019) and posing “systemic, existential risk” (Ripple, 2023). Economist Nouriel Roubini has written of this landscape as one of “megathreats” (Roubini, 2022): such threats are both broad in scope and ongoing. In 2022, as the world lurched from the COVID-19 crisis to war in Ukraine, Collins Dictionary named “permacrisis” the word of that year (Turnbull 2022).

#### And, journalism collapse dooms local economies and governments.

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Hal J. Singer, “Addressing the Power Imbalance: A Legislative Proposal for Effectuating Competitive Payments from Platforms to Newspapers,” Columbia Journal of Law & The Arts, 2023, https://heinonline.org/HOL/Page?handle=hein.journals/cjla46&div=26&g\_sent=1&casa\_token=&collection=journals

B. REMOVAL OF ECONOMIC STIMULUS TO LOCAL ECONOMIES

The negative employment trends among newspapers, exacerbated by underpayments from the dominant platforms,119 can have ripple effects throughout local economies. When reporters, correspondents, and broadcast news analysts along with the other supporting employees at a publishing firm lose their jobs, they lose incomes to spend at grocers, restaurants, and other local businesses. This reduction in spending can have a multiplier effect that ripples throughout a local economy and removes stimulus that was once there.120

Local newspapers also provide a valuable service to local businesses by creating a way to connect with community members and advertise their products and services.121 When underpayments intensify news publisher closure, local businesses no longer have access to this mode of communication and advertising. Furthermore, research has shown that there is a causal link between local newspaper closures and higher municipal borrowing costs, likely due to the reduction in independent oversight.122 This translates into an approximate cost increase of $650,000 per average municipal bond issuance.123 Higher borrowing costs are ultimately borne by local taxpayers, thereby reducing real disposable incomes and removing further stimulus from local economies.124

#### Strong localities prevent systemic disaster risks---extinction.

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Mami Mizutori, several dozen other authors, “Global Assessment Report on Disaster Risk Reduction,” United Nations Office for Disaster Risk Reduction, 2022, https://www.undrr.org/media/79595/download?startDownload=20250920

The central question for this Global Assessment Report on Disaster Risk Reduction 2022 (GAR2022) is how governance systems can evolve to better address the systemic risks of the future. In today’s crowded and interconnected world, disaster impacts increasingly cascade across geographies and sectors, as the coronavirus disease (COVID-19) pandemic and climate change are rapidly making clear. Despite progress, risk creation is outstripping risk reduction. Disasters, economic loss and the underlying vulnerabilities that drive risk, such as poverty and inequality, are increasing just as ecosystems and biospheres are at risk of collapse. Global systems are becoming more connected and therefore more vulnerable in an uncertain risk landscape. Such systems include ecologies, food systems, supply chains, economies and social services. COVID-19 spread quickly and relentlessly into every corner of the world, and global risks like climate change are having major impacts in every locality. Indirect, cascading impacts can also be significant. For example, many countries felt the negative economic impact of the COVID-19 pandemic months before ever registering a single case of the disease. Without increased action to build resilience to systemic risk, the United Nations Sustainable Development Goals cannot be achieved.

GAR2022 highlights that: ● The climate emergency and the systemic impacts of the COVID-19 pandemic point to a new reality. ● Understanding and reducing risk in a world of uncertainty is fundamental to achieving genuinely sustainable development. ● The best defence against future shocks is to transform systems now, to build resilience by addressing climate change and to reduce the vulnerability, exposure and inequality that drive disasters.

GAR2022 explores how, around the world, structures are evolving to better address systemic risks. In the face of accelerating climate change impacts, doing more of the same will not be enough. However, action is possible. This report shows how governance systems can evolve to reflect the interconnected value of people, the planet and prosperity. It outlines how actions such as changing what is measured to account for factors such as sustainability, the value of ecosystems and future climate change impacts can have a powerful effect, including unmasking dangerous imbalances in existing systems. Investment in understanding risk is the foundation for sustainable development. However, this needs to link to a reworking of financial and governance systems to account for the real costs of current actions. Without this, financial balance sheets and governance decision-making will remain fragmented, and will be rendered increasingly inaccurate and ineffective.

The report also explores how designing systems to work with, not against, the way human minds make decisions can support accelerated action. Innate biases and mental short cuts can make people’s thinking myopic, or prone to inertia, oversimplification or herding when making decisions around risk. This helps explain why people, and the institutions they work for, can resist making good decisions about risk, even in the face of clear scientific data. These biases are particularly likely to kick in when risks are newly felt, and therefore unfamiliar, as is the case with many systemic risks such as climate change or a pandemic.

Reframing risk information, policies and products to present expert risk understanding differently can help overcome this hurdle. Designing in consultation with affected populations, building on existing expertise and local knowledge, and leveraging technology to help support better communication and dialogue around risk can increase the effectiveness and acceptance of change.

Building on innovations in modelling systemic financial crises, GAR2022 outlines how similar methods are now being applied to better understand the cascading, cross-sectoral impacts of systemic risk on sustainable development. It shows how both developed and developing countries are innovating to improve analytics. Emerging methods better depict impacts in key systems like food, infrastructure and supply chains, which cascade across sectors and geographies. These further drive social impacts such as increased inequality, migration and conflict.

These technological advances are powerful tools in accelerating risk understanding. However, in a world of certain uncertainty, no model can accurately predict what is a fundamentally unpredictable future. Science can help identify positive pathways, test options and find weak points. But it cannot predict across the infinite variables of a complex world. GAR2022 therefore highlights examples where human experience and global models are coming together to apply data more effectively to support better decision-making around risk. Local food security projects in Kenya are using stateof-the-art climate information to discuss options for resilient agriculture with local partners. A “deep demonstration approach” is being applied in Viet Nam where innovators and governments are working together to co-design a green circular economy and better understand and address systemic risk. Examples given from around the world highlight how options exist to better leverage technology, enhance participation, and increase the use of local and indigenous knowledge to create the agile flexible systems necessary to build resilience in today’s complex world.

To accelerate essential risk reduction and resilience building, GAR2022 calls for action to: 1. Measure what we value. 2. Design systems to factor in how human minds make decisions about risk. 3. Reconfigure governance and financial systems to work across silos and design in consultation with affected people.

As climate change impacts gather pace, the baseline for how future generations will view inaction is clear. The time to act is now.

The GAR2022 call to action

1. Introduction: Rewiring systems for a resilient future

Disaster risk was increasing globally, even before the advent of the coronavirus disease (COVID-19) pandemic. More people were killed or affected by disasters in the last 5  years than in the previous 5  years. Intensive and extensive risks are growing at an unprecedented rate. Human action is creating greater and more dangerous risk. Disasters have increasing impacts on communities and whole systems as risk multiplies. Everyone is living downstream of something else. Global impacts become local, and vice versa. Impacts also cascade across sectors, creating new challenges.

Recent large-scale disasters – including the COVID-19 pandemic and major weather events that caused supply chain disruptions – have led many to conclude that something new is happening. Increasingly, people live in a world in which disaster risk manifests systemically, inflicting damage across the vital systems and infrastructure upon which human societies and economies depend. Despite commitments to build resilience, tackle climate change and create sustainable development pathways, current societal, political and economic choices are doing the reverse. Human actions continue to push the planet towards its existential and ecosystem limits. In the face of intensifying climate change impacts and increasing system threats, risk reduction efforts often seem too little and too late.

In the wake of the COVID-19 pandemic and the hottest decade on record, there is growing momentum to change how the global community manages risk, and a willingness to accelerate action on climate change. In the aftermath of disasters, psychologists note there is a moment when individuals are particularly open to change. The current phase of the COVID-19 crisis is perhaps such a moment that should not be wasted.

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To change course, new approaches are needed. It is possible to manage the risks of the future more effectively, but only if action is taken now to rework local, national and globalized systems to prevent and respond to systemic risk. This Global Assessment Report on Disaster Risk Reduction 2022 (GAR2022) focuses on how change is possible, and how governance systems can evolve to respond to an increasingly challenging planetary and socioeconomic environment. It highlights how tools and approaches already in place in the disaster risk reduction (DRR) community can be adjusted, enhanced and scaled up to help create a risk-resilient future. 1.1 Key concepts of this report Three key global agreements on DRR, climate change and sustainable development provide the foundation for multilateral action to manage risk and promote sustainable development towards 2030 (Box 1.1). Building on this foundation, addressing systemic risk requires working across systems and disciplines, but a common “risk language” or set of interoperable standards or definitions still remains elusive. This section therefore gives an introduction to key terms and concepts elaborated in GAR2022 from the perspective of DRR. 1 1.1.1 Disasters, hazards and vulnerability The United Nations Office for Disaster Risk Reduction (UNDRR) defines a disaster as 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” (UNDRR, n.d.). Disasters stem from a combination of hazards with vulnerability and exposure of people and assets. In this context, a hazard is 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” (UNDRR, n.d.). The origins of hazards can be natural or human-made, and span a wide range of environmental, technological and biological hazards, including meteorological, hydrological, extraterrestrial, geological, environmental, chemical, biological, technological and societal factors. UNDRR and the International Science Council recently convened a wide-reaching expert-driven exercise, the Hazard Definition and Classification Review, which outlined over 300 hazard types that can contribute to disasters (UNDRR, 2020a). They include common events such as storms and floods and also less-frequent events such as pandemics and chemical accidents. Vulnerability describes “the conditions determined by physical, social, economic and environmental factors or processes which increase the susceptibility of an individual, a community, assets or systems to the impacts of hazards” (UNDRR, n.d.). Exposure is the “situation of people, infrastructure, housing, production capacities and other tangible human assets located in hazardBox 1.1. Risk reduction in the global agreements The Sendai Framework on Disaster Risk Reduction 2015–2030 (Sendai Framework) focuses on the adoption of measures that address all dimensions of disaster risk – hazard, exposure, vulnerability and coping capacity – to prevent the creation of new risk, reduce existing risk and increase resilience. It incorporates a strong focus on inclusiveness “through the implementation of integrated and inclusive economic, structural, legal, social, health, cultural, educational, environmental, technological, political and institutional measures that prevent and reduce hazard exposure and vulnerability to disaster, increase preparedness for response and recovery, and thus strengthen resilience” (United Nations, 2015a). Transforming our World: the 2030 Agenda for Sustainable Development (2030 Agenda) sets out 17 Sustainable Development Goals (SDGs) and provides a comprehensive global policy framework towards ending all forms of poverty, hunger, inequalities among and within countries (based on gender and other socioeconomic status), and tackling environmental degradation and climate change, while ensuring “no one is left behind” (United Nations, 2015b). Its suite of planned worldwide positive changes will help reduce most elements of disaster risk. The SDGs incorporate multiple Sendai Framework targets as well as climate change and sustainability targets. The Paris Agreement steers action towards global climate change adaptation and the mitigation goal of limiting global warming to well below 2°C above pre-industrial levels, and preferably to 1.5°C. Article 7 outlines the global adaptation goal, which includes the need to incorporate sustainable development in adaptation planning (United Nations, 2015c). The Warsaw International Mechanism for Loss and Damage associated with Climate Change Impacts under the United Nations Framework Convention on Climate Change also recognizes the importance of averting, minimizing and addressing loss and damage due to climate change, including extreme weather and slow-onset hazards and changes (UNFCCC, 2013). Comprehensive risk assessment, risk insurance facilities and climate risk pooling are important tools that link climate action under the Paris Agreement with risk reduction under the Sendai Framework. 2 prone areas” (UNDRR, n.d.). When hazards combine with vulnerability and exposure, disasters are most likely to occur because exposure increases the impacts and vulnerability reduces coping capacity (UNDRR, n.d.). That vulnerability and exposure are core to causing disasters highlights the role of human decisions in creating disasters. Disasters are not “natural” events, but instead are a function of how humans interact with their environment. The root causes of disaster risk and disasters stem from structural conditions of a particular mode of development and growth. They are also shaped through social, economic, cultural and political processes, and conditions, practices, priorities, choices and values that unfold over time (Oliver-Smith et al., 2016, 2017). The drivers of disasters are in part defined in the context of limited access to power structures and resources, and attached to economic and political systems (Blaikie et al., 2004). Root or underlying causes are bound up with deep-rooted, fundamental or structural drivers relating to development ideologies, cultural factors, ingrained habits, social inequality and other processes that all have a role in the creation of risk and disasters. Disasters are traditionally divided into rapid-onset events (like typhoons, earthquakes or flash floods) or slow-onset events (like droughts, saltwater intrusion or desertification) where impacts manifest over months or years. While most hazards are natural, some, like air, pollution, are largely human made. Disasters are also usefully characterized as either extensive or intensive. Extensive disasters are high-frequency localized events that manifest over a dispersed area, causing recurrent smalland medium-scale impacts. Examples include small- or medium-sized seasonal storms, floods and droughts. Intensive disasters risk relates to large-scale events, typically affecting large cities or densely populated areas. They are caused by high-severity hazards such as major earthquakes or once-in-a-generation floods (UNISDR, 2015). 66,920 People affected Accounting for 93% of the Population 65 Confirmed fatalities 90-95% of Homes Damaged or Destroyed 1.3 billion in Damages and Losses All 53 health facilities sustained damage 90%+ of Crops Destroyed Accounting for 225% of 2016 GDP Water/Sanitation: 43 out of 44 water systems were not functioning Shelter: 90% of structures damaged; 62% of houses heavily damaged, o/w 15% were destroyed Power: 90% of population lacked access to electricity for over 4 months Roads/Bridges: 1-2m of floodwater; debris deposits of 1-4m in riverbeds, 6+ bridges severely damaged Emergency Services: 5 of 11 police stations & 4 of 8 fire and ambulance stations severely damaged Food: 24,000 people became severely or borderline food insecure, according to WFP Livestock: Country-wide losses included cattle (45% lost), pigs (65%), small ruminants (50%), broiler chickens (90%), layers (90%), rabbits (50%), and beehives (25%) Figure 1.1. Impact of Hurricane Maria on Dominica Source: Government of the Commonwealth of Dominica (2020) 3 As exemplified in Figure 1.1, the impacts of a single devastating storm can have major long-term impacts (Maskrey et al., 2022). Disaster impacts on national well-being can be particularly pronounced in small nations such as Dominica, where 90% of the island’s approximately 75,000 people live in coastal areas at high risk to storms and other disasters. Similar longterm impacts may be expected in other small island developing States (SIDS) such as Tonga, which are affected by hazards such as underwater volcanic eruptions, tsunamis and their cascading impacts. 1.1.2 Towards an understanding of systemic risk A key focus of this GAR2022 is how systemic risk is affecting sustainable development, and what can be done to better address and reduce losses from systemic impacts. The concept of systemic risk is based on the notion that the risk of an adverse outcome of a policy, action or hazard event can depend on how the elements of the affected systems interact with each other. This can either aggravate or reduce the overall effect of the constituent parts. Interactions occur through positive or negative feedback processes. Systemic risk creates the chance of system malfunction or even collapse (Sillmann et al., 2022). Even though the notion of “systemic risk” is at least a few decades old, the term is still used in different ways across disciplines (Faulhaber et al., 1990; Sillmann et al., 2022). Although systemic risk analysis is regularly applied in financial systems and in medicine, it is now increasingly being considered in Earth systems analysis, climate science and DRR. Triggered by the repercussions of the systemic global financial crisis of the late 2000s, the perception of systemic risk has often focused on global and catastrophic or even existential risks (Helbing, 2013; WEF, 2021a; Sillmann et al., 2022). However, systemic risk can occur at all spatial scales, from local to regional, national and global. Systemic risk can be endogenous to, or embedded in, a system that is not itself considered to be a risk and is therefore not generally tracked or managed. Systems can contain latent, or cumulative, risk potential to impede overall system performance when some characteristics of the system change (UNDRR, 2019). Systemic risk does not necessarily lead to a complete system failure. However, as outlined throughout this report, the design and evolution of modern human systems is creating new risks. Some of those risks, like climate change and biodiversity loss, are existential in nature. The impacts of systemic risk cascade across sectors, such as food– health–water–energy, and/or among communities, countries and continents. For example, in the pursuit of ever more efficient food systems, there is now far greater reliance on trade to fill or compensate for local or national production gaps or to absorb oversupply. This so-called “efficiency” of the system has led to reduced margins or buffers against unplanned interruptions such as local conflict, natural hazards or international crises that reduce trade. This increases the potential for cascading risk throughout and beyond food systems (see the Food systems and systemic risk case study after Chapter 12). In an increasingly connected world focused on efficiency, a central question for GAR2022 is how technical design, and socioeconomic and governance systems can be adjusted to reduce systemic risk and curtail potential systemic failures. Key characteristics of systemic risk can be broadly categorized under five themes: the scale of the system, the relationship of the elements within a system, the level of system understanding, the transboundary effects and the outcomes of systemic risk. Figure  1.2 builds on the work of several scholars (e.g. Schweizer and Renn, 2019; Renn et al., 2020) and a review of a wide range of definitions of systemic risk found across disciplines in scientific literature and reports (Sillmann et al., 2022). Recent publications such as the Global Assessment Report on Disaster Risk Reduction 2019 and the work of the International Risk Governance Council take a close look at the various drivers of systemic risk and future emergence of such risks (Centeno et al., 2015; IRGC, 2018; UNDRR, 2019; Sillmann et al., 2022). Global intergovernmental processes are also starting to recognize the importance of considering systemic risk. For example, the new research agenda of the Integrated Research on Disaster Risk 2021–2030 (ISC et al., 2021) focuses on complex impact and systemic risk from a multi-hazard and disaster risk 4 Scale Relationship • Unknown • Lack of knowledge • Unpredicted • Uncertainty • Ambiguity • Underestimated • Tipping points/events • Stochastic effects Outcomes System • Feedback loops understanding • Interactions • Interconnections • Interdependencies • Interlinkages • Intertwined • Global • National • Regional • Local • Breakdowns • Collapse • Critical services to society • Disruption of systems and essential services • Failure of economic, financial or social systems • Impacting/affecting an entire system • Serious negative consequences • Threats to system survival • Unbound damage • Cascading effects • Complexity (Complex causal structures) • Contagion • Indirect impacts • Knock-on effects • Nonlinearity (Nonlinear cause–effect relationships) • Ripple effects • Spillover effects • Wider effects Transboundary effects Figure 1.2. Terminology for key attributes of systemic risk Source: Based on Sillmann et al. (2022) perspective. Similarly, the Intergovernmental Panel on Climate Change (IPCC) is moving from what could be characterized as a static framing of risk as a function of hazard, exposure and vulnerability to a more dynamic framing where responses to the risks with potential side effects and interactions among risks are more strongly considered (Reisinger et al., 2020; Simpson et al., 2021). Figure 1.3 provides a snapshot of how an extended risk framework is important to addressing the systemic risk of climate change, and how factors such as transition decision and governance need to be taken into account (Zscheischler et al., 2018). A related “impact web” analysis of the COVID-19 crisis is included in the case study following this chapter. Figure  1.3 shows that multiple climatic drivers cause one or multiple hazards, leading to societal and environmental risk. The climate drivers (which may vary from local-scale weather to large-scale climate modes, represented by yellow circles) and/ or hazards may be mutually dependent. Non-climatic drivers related to vulnerability and exposure may also contribute to risk (Zscheischler et al., 2018). 1.1.3 Measuring and valuing the wrong things GAR2022 also explores pitfalls in economic and governance systems that hold back the essential resilience building needed to underpin stability and development that is truly sustainable. The first pitfall is the tendency to exclude key values, such as the value of human life and biodiversity, from economic balance sheets and governance decisionmaking. For example, most risk assessments in the private sector usually cover a 12 month period, and place value only on economic goods and services, not fundamental assets such as ecosystem health. The second pitfall is that they do not often take into 5 account potential medium- or longer-terms impacts of climate change. Public sector accounting, especially for areas such as infrastructure, is usually longer term but again focuses on measuring value in economic terms only. This narrow definition of value limits the facts on the table when decisions are made. The myopic approach to scope and time frame means there are insufficient incentives for investment in reducing the negative impacts of consumption and exploitation of natural resources and increasing socioeconomic inequality. Little attention is paid to recovering undervalued “assets” when their value is depleted. For governments, this means that so-called “cost–benefit analysis” often excludes the value of many assets and benefits that their populations prize most highly, such as health, clean air and water, and a safe future for their children. The third pitfall in measurement systems is myopia in being able to see how risks cross geographic or sectoral boundaries. Economic systems and governance structures are constrained by their alignment with political and geopolitical borders, but risks are not. The COVID-19 pandemic provides a stark reminder that neither a virus nor its impacts can be contained within a single country’s borders. In 2020, people in Fiji were already suffering reduced access to health care and massive economic damage, due to border closures and impacts on wider global systems, long before it recorded its first case of COVID-19 (UNDRR and UNU-EHS, 2022). Similarly, climate change impacts and factors such as ecosystem and biodiversity loss do not respect human territorial boundaries. 1.1.4 How human minds simplify complexity and what this means for disaster decision-making GAR2022 also looks at how a better understanding of the cognitive biases people bring to understanding and acting on risk information can help illuminate the gap between will and action in reducing risk and averting disasters. Cognitive scientists highlight that people order the world based on simple, ruleVulnerability Hazards RISK Exposure CLIMATIC DRIVERS NON-CLIMATIC DRIVERS EMISSIONS AND LAND-USE CHANGE IMPACTS NON-CLIMATIC DRIVERS CLIMATE SOCIOECONOMIC PROCESSES Governance Socioeconomic pathways Adaption and migration actions Natural variability Anthropogenic climate change Figure 1.3. Extended risk framework Source: Zscheischler et al. (2018), adapted from IPCC (2014a) 6 of-thumb decisions (heuristics) that reinforce their basic psychological motives and expectations, even though they are not aware this is happening. These individual decision-making processes interact with the social environment, and cultural and governance norms. Although humans often believe the decisions they make about how to manage risk are driven by reasoning and data, scientists now understand more about how human minds are configured to make decisions, and how this often distorts the use of risk information in decision-making. Human thinking can be divided into two main types: decisions that require “thinking slow” and those that rely on “thinking fast” (Kahneman, 2013). Thinking slow mode is the deliberate thinking that most people have in mind when speaking of human reasoning, and is focused on expectation maximization. This is the kind of decision-making associated with sound long-term development and well-reasoned personal choices and good governance. There is also another form of thinking that is equally important, although more often associated with the kinds of quick decisions needed in “fight or flight” situations. Human minds are configured to consider disasters as thinking fast events that require quick and binary decision-making. However, risk reduction and resilience building, as well as planned or anticipatory humanitarian action, also require deliberate or slow thinking at the individual and organizational levels. In addition to thinking fast and slow, human minds have developed other short cuts to cope with complexity, which may negatively affect their ability to make decisions on disaster risk. Under most conditions, people use heuristics, or mental short cuts, to help find solutions to the problems faced. These tend to simplify decision-making, rather than making a full and complete calculation of a best overall answer. People are almost never aware of their use of those mental short cuts, as they mostly originate in the part of the brain that processes automatic behaviours. One of the most commonly used short cuts is to simplify complexity by attempting to determine a linear cause and effect (Kahneman, 2013). However, as the discussion on systemic risk above outlines, this tendency to oversimplify may not be serving human societies well in coping with the complexity of global challenges. Issues such as addressing climate change or reducing the impacts of a global pandemic cannot be reduced to a simple linear decision-making process. There are other heuristics that may also be hindering people’s ability to make sound decisions when it comes to managing disaster risk, such as a tendency to focus only on what is in front of them (myopia) and the human belief that bad things will not happen to them (optimism). This understanding of human decision-making may point to how to rework systems to accelerate risk reduction. If incentives in the social environment can be aligned with these heuristics or biases, and governance systems are reconfigured to be conducive towards fostering risk-informed behaviour and decision-making, the possibility of significant behaviour change is real. For example, studies show decision makers are much more likely to undertake loss reduction measures if they are told there is more than a one in five chance of having at least one severe wildfire, flood or other disaster causing damage to their property over the next 25  years, rather than being told there is a 1 in 100 annual probability of such a disaster (Slovic et al., 1978). This suggests greater attention to the design of products, services and communications methods can increase the efficacy of risk reduction efforts. It also means governance systems need to improve consultative and “reality check” processes, to enable more considered and agile decision-making in the face of systemic risk. 1.1.5 Why risk communication is essential Failing to communicate effectively about risk – indeed, failing to communicate at all – can fuel rumour, erode trust, hamper solutions and increase risk. Communication strategies that reflect the systemic nature of risk and that are rooted in ongoing dialogue can improve understanding of exposure, vulnerability and hazards. Such processes can also acknowledge and respect local priorities, indigenous knowledge and world-views. They can spark innovation, work across generations, build trust 7 and increase transparency. This can boost people’s confidence and motivation to make informed decisions and to act, ultimately contributing to a shift in how societies relate to risk. Societies have more data about risk than ever before. However, it remains rare to have productive conversations about it with the right people, at the right times and at the right scale. If there is to be a shift in how people understand, deliberate and act on risk, radical advances are required in how this is done. This requires mutual communication and cross-boundary and cross-disciplinary collaborations that bring expertise, multiple perspectives, strategic vision and creativity. There is also a need for greater emphasis on recognizing the biases that lead key private and public sector decision makers, as well as the general public, to deny or ignore disasters and other extreme events. 1.1.6 Why data is essential for understanding systemic risk In the information age, experts can enable the development of tools and provide services, but the “last mile” is up to decision makers and local stakeholders. An entire ecosystem is required to generate risk understanding and engage communities at risk. Doing this means acknowledging and exploring the degree to which algorithms are a product of the perspectives, priorities and biases of their developers. It also requires considering the ethics and human rights implications of risk analytics and technologydriven solutions such as artificial intelligence. Without data, disaster decision-making is blind. Without the infrastructure to interpret the data and instrumentalize the decisions, risk governance is paralysed. Data-driven DRR systems can help to manage disaster risks and prevent unnecessary suffering, but only if risk management becomes part of a common DNA of stakeholders at different levels, and if policymakers understand there is a need to accept uncertainty. Otherwise, even the most advanced big data strategy cannot reduce risk. Exploiting the added value of data-driven risk management systems requires the development of a “hive mind”, where different disciplines and perspectives come together to better understand options and inform decisions. This requires fostering a risk culture based on mutual trust among generalists, specialists and communities at risk. Such an approach requires common terminologies or jargon, the collaborative identification of bottlenecks and a direct link to governance decision-making. Reducing, managing and avoiding creating risk require an in-depth understanding of spatially and temporally complex processes at different scales. The gaps between remote sensing, modelled, official data sources and what is happening on the ground are often too big for the data to be successfully used for local analysis or projects. However, participatory processes and crowdsourcing approaches can typically close this gap, particularly given advances in communications technologies. To help contextualize existing data and highlight critical data gaps, it is important to capture realistically how to minimize uncertainty within translated risk data, and how to break down the barriers of co-production by recognizing and embracing local needs and concerns. These same approaches are equally important in helping to understand potential future vulnerability and exposure through prospective disaster risk management (DRM) (IPCC, 2021a; Birkmann et al., 2015; Jurgilevich, 2021). 1.2 Transforming risk governance in the era of systemic risk Effective risk reduction requires awareness, the formation of an intent to act, the identification and selection of a plan of action, and the execution of that plan. Biases and influences can distort effective action at each stage. For example, a focus on achieving economic growth under current development models is creating unstable and unsustainable human systems, thus increasing systemic risk in the form of climate change and biodiversity loss. A myopic focus on growth as the main signal of well-being has led to a failure to invest a small percentage of global gross domestic product (GDP) in preventing the existential threat of climate change. This means that governments fail to invest in risk reduction measures or to recognize the exponential growth potential of crises (as witnessed during the COVID-19 pandemic). This leads to the 8 social vulnerabilities of individuals and groups being ignored, and failure in addressing structural inequalities that drive hazards to become disasters. Immediate actions that can help catalyse the required transformations necessary to address systemic risk include: 1. Measure what we value. 2. Design systems to factor in how human minds make decisions about risk. 3. Reconfigure governance and financial systems to work across silos and design in consultation with affected people. The challenges and potential solutions available to help better address systemic risk for a sustainable future are explored throughout this report. GAR2022 aims to take a fresh look at what can be done to get global risk reduction efforts back on track, to help governments and policymakers consider their options and to inspire action to accelerate risk reduction. These goals and concerns are also shared by stakeholders in all regions (Box 1.2). 1.3 Overview of the structure of this report Part  I lays out the challenge that the global community is not on track to reducing risk. The case study following this introductory chapter explores how the COVID-19 pandemic highlights the need to better understand and act in the face of systemic risk (COVID-19 and systemic risk case study). Chapter 2 documents how the combination of preexisting hazards and human actions are creating greater, more dangerous and more systemic risk, pushing societies and the planet towards their limits. Chapter  3 outlines how recurring disasters and the ecological consequences of climate change and other development choices undermine the SDGs and global targets for climate change and risk reduction. It also highlights where opportunities exist to leverage synergies between reducing risk and achieving sustainable development to accelerate results. Chapter  4 sets out how addressing the root causes of vulnerability and the drivers of risk can have positive impacts on avoiding and reducing risk and increasing sustainability if governance and knowledge systems are able to use transdisciplinary and collaborative approaches. Chapter  5 outlines how current systems are not collecting the right data, key assets are undervalued in decision-making and learning opportunities are missed. Chapter  6 then looks at how systemic thinking requires working across traditional sectors and disciplines and developing new ways of working that incorporate different world-views, including indigenous and traditional knowledges, to enhance decision-making. Part  II looks at why decision-making around risk reduction and addressing systemic risks is so suboptimal. Chapter  7 describes how a better understanding of human decision-making about risk can be used to accelerate effective action. It also identifies ways that systems can transform or adapt to better manage risk. Chapter 8 looks at how it is possible to reconfigure incentive systems and to market risk reduction products and services to work with, not against, the way human minds work. Chapter  9 highlights how changing communication around risk reduction is essential, especially how moving from top-down approaches to co-design and data-driven consultative decision-making can accelerate resilience building. Part  III focuses on what needs to happen to accelerate risk reduction. Chapters  10 and 11 explore recent advances in modelling and learning approaches that are improving how to understand systemic risk, and how they are helping people to learn faster and address risk in an uncertain world. Chapter  10 focuses on recent advances in modelling systemic risk. Chapter  11 looks deeper into how such tools are being applied around the world. Chapter  12 outlines how, in the face of global systemic risks, governance systems must quickly evolve and recognize that the challenges of economy, environment and equality can no longer be separated. Nowhere is the need for action more obvious than in food systems, which is explored as a final case study in the report (Food systems and systemic risk case study). The report’s Chapter 13 concludes with a call to action to accelerate risk reduction, to better address systemic risk and to build a safer and more resilient world for today and for future generations. 9 Box 1.2. Regional perspectives on risk governance challenges and opportunities Regional assessment reports, regional platforms, action plans and evolving DRR agendas in Africa, the Americas, the Arab States, Asia and the Pacific, and Europe and Central Asia, highlight the challenges and opportunities that shape regional, national and local implementation. All regional platforms met during November 2021, although the formal Asia-Pacific Ministerial Conference on Disaster Risk Reduction was deferred due to the pandemic. Risk as a social construct, and new risk governance approaches ● Applying a systems-based approach and inclusive, transdisciplinary and accountable disaster risk governance mechanisms is a means to overcome related underlying risk factors. ● The COVID-19 pandemic has exacerbated the systemic impacts of risk, including loss of lives and livelihoods, damage to infrastructure and displacement. Even before the pandemic, disasters had become a major cause of forced displacement, requiring concerted action to reduce risk at the local, national and regional levels. ● Strengthened transboundary collaborative mechanisms to understand risks, enhanced governance and reduction of existing, emerging and future risks are crucial to address the impacts. ● Ecosystem management and use of traditional wisdom and practices were highlighted in the Africa region and the Pacific region. ● Financial and social disclosure of climate risk and green and disaster-resilient economic recovery is crucial to enhance collective responsibility for leaving no one behind, a focus in all regions. Gender equality and women as key agents of change ● There is great emphasis in the regions on the key role of women as leaders and agents of change to build resilient development pathways, actively participating in the creation and implementation of DRR strategies, policies, plans and programmes. ● The negative impacts of the COVID-19 pandemic on social and economic development have created disproportionate vulnerability and exposure for women and girls, all of which undermine efforts to achieve the 2030 Agenda as well as regional agendas. The various regional forums have called for the adoption of a gender-based approach that accounts for the needs of women, the elderly, children, youth and persons with disabilities, as well as for a new social contract for inclusive all-of-society approaches to build resilience. New collaborations and partnerships ● All the regional gatherings identified collaboration and alliance building across critical sectors as vital to tackling complex and compounding risk. Opportunities for collaboration include strengthening data sharing at country and regional levels and increased provision of evidence-based scientific research and analysis for decision-making. ● Stronger partnerships among institutions responsible for DRR, environmental management, climate change action, planning and finance and other sectors can ensure a coherent, integrated and all-ofsociety approach to DRR and climate change adaptation at all levels. ● Indigenous, local knowledge systems and practices can foster the integration of age and cultural perspectives into the design and implementation of DRR and climate change adaptation strategies and plans, while recognizing the importance to protect cultural heritage from disaster risks. Sources: AfRPDRR (2021a, 2021b); Amach (2021); APP-DRR (2021); ARPDRR (2021a, 2021b); EFDRR (2021a, 2021b); PRP (2021); RPDRR-AC (2021a, 2021b); UNDRR (2021a, 2021b) 10 Case study COVID-19 and systemic risk The COVID-19 pandemic has affected all dimensions of human security, including economic, food, health, environmental, personal, community and political systems (Robles, 2022). Although a global pandemic was a known risk, the world was not prepared for its direct or wider systemic impacts. Diseases had previously spread from animals to humans, including acquired immune deficiency syndrome (AIDS), Ebola virus disease, Middle East respiratory syndrome (MERS), severe acute respiratory syndrome (SARS) and Zika virus disease. However, pandemic preparedness measures were myopic, focusing on health system responses, not on prevention, coordination and leadership, or the likely wider effects of a global pandemic (Independent Panel for Pandemic Preparedness and Response, 2021a). A combination of pre-existing vulnerabilities and exposure amplified risk and led to cascading, systemic impacts, as outlined in the conceptual model in the figure that illustrates a systemic impact web. Pre-existing vulnerabilities of COVID-19- related-at-risk groups and health systems Pre-existing vulnerabilities of the general population, sectors and systems Direct risks and impacts Interconnected, cascading risks and impacts, across systems, borders and scales Interventions COVID-19 Concurring hazards Exposure to the virus (and other hazards) Reinforcing vulnerabilities Reinforcing impacts Reinforcing vulnerabilities Globally networked risks Globally networked risks Social systems Education systems Economic systems ... Interconnectivity, feedbacks Health Health systems Feedbacks Tipping point Reduce Globally networked risks Global dependencies Triggers Adjustment of interventions Cascading adverse effects Reinforcing the pandemic (endogenous) Hazards Exposure Vulnerabilities Risks and impacts Interventions Effects Feedback Systems Reinforcing vulnerabilities Source: UNDRR and UNU-EHS (2022) Conceptual model of the systemic nature of COVID-19 risk and impacts 11 CASE STUDY: COVID-19 AND SYSTEMIC RISK INTRODUCTION – REWIRING SYSTEMS FOR A RESILIENT FUTURE: Myopic thinking meant that, despite warnings and data that a pandemic was overdue, preparedness was inadequate and governance systems across the world struggled to pivot to a new reality. 1 OUR WORLD AT RISK: Human choices and demographic trends increase the likelihood that hazards like COVID-19 can spread from animals to humans and impact all continents rapidly. Exposure to underlying risk factors, such as high levels of air pollution, unsafe housing or limited access to health services, were found to significantly affect fatality rates. 2 TRANSITIONS TO SYSTEMIC RISK GOVERNANCE: At the start of the COVID-19 pandemic, assessment of preparedness measures was focused on the capacity of health systems and not on coordination and leadership, yet these turned out to be crucial in effective response and management of a protracted crisis. 12 FROM BIG DATA TO BETTER DECISIONS: Basic data collection at national and local levels has faced challenges of missing information and errors, but the pandemic has also triggered innovations in the generation, function and use of dynamic disaggregated data. 11 EMERGING APPROACHES TO ASSESSING SYSTEMIC RISK: The pandemic has exposed weaknesses in the foundations of data and analytics to understand the connections between health systems and socioeconomic vulnerability, at national and international levels. 10 ADVANCING RISK COMMUNICATION Misinformationand antivaccination campaigns reduced trust in public health measures, but there were also many effective scientific communicators in the media and successful collaborations focusing on specific communities. 9 : 12 SYSTEMIC RISK AS A CHALLENGE TO SUSTAINABLE DEVELOPMENT: The systemic impacts of the pandemic have derailed SDG achievements across almost all indicators. For example, using the Lifeyears Index, the economic and social costs of the pandemic in 2020, measured in lifeyears lost, far outweighed the average annual costs of other disasters, and the summed cost of all epidemics from 2000 to 2019. 3 HOW HUMAN CHOICES DRIVE VULNERABILITY, EXPOSURE AND DISASTER RISK: Although the pandemic has affected all countries and regions, vaccine inequity has seen lower-income countries left behind. The cascading health and economic impacts have been worse for poorer and marginalized communities, women exposed to violence and small economies dependent on tourism. 4 HOW SYSTEMS UNDERVALUE KEY ASSETS AND OPPORTUNITIES FOR LEARNING: The pandemic has caused fierce debates over what governments and societies should value most (e.g. health or economic activity; restricted movement/mask wearing or “freedom”), and what are acceptable risks (e.g. social protection, mental health, food and income versus infection, illness and overwhelmed health systems). 5 SHIFTING PERCEPTIONS ON RISK: The pandemic has highlighted the need to recognize that planetary and human systems are interdependent, and that risk knowledge systems need to become more flexible and open to different world-views, including indigenous and traditional perspectives. 6 HOW HUMAN BIASES AND DECISION PROCESSES AFFECT RISK REDUCTION OUTCOMES: The pandemic saw initial optimism bias (“we will be OK”), impacts of experience/availability bias (“our hospitals are overflowing”), pessimism (“there is nothing we can do”), political polarization (“our group does not wear masks”) and ”protect my country” versus promoting the global public good of vaccine sharing. 7 ADDRESSING BIASES TO INCREASE INVESTMENT IN RISK REDUCTION: To encourage social distancing and vaccination, health authorities used regulation and enforcement, appeals to a sense of social coherence (“we are in this together”), fear of loss (“do it for your loved ones”) and rewards such as promising to open entertainment venues when a certain percentage vaccination rate was reached. 8 13 The challenge The COVID-19 pandemic has heightened existing vulnerabilities in health systems. Rapid development of vaccines has been accompanied by inequality of access, with distribution favouring wealthier countries (Global Dashboard for Vaccine Equity; UNDP (n.d.a)) despite international commitments such as the COVAX Facility (Gavi et al., n.d.) and the World Health Organization (WHO) global COVID-19 vaccination strategy (WHO, 2021a). As health systems were overwhelmed by COVID-19 patients, many people with chronic conditions had to delay treatment, thus affecting the quality of care and longer-term health outcomes (Independent Panel for Pandemic Preparedness and Response, 2021a). Mental health has deteriorated globally, and many countries are also reporting a “shadow pandemic” of gender-based violence (Sri et al., 2021). The pandemic has had wide-ranging impacts across systems. Using the Lifeyears Index, the economic and social costs of the pandemic in 2020, measured in Lifeyears lost, far outweighed the average annual costs of all other disasters and the summed cost of all epidemics from 2000 to 2019 (Doan and Noy, 2022). As of June 2021, the World Bank estimated the direct and indirect effects of COVID-19 had pushed 97 million more people into poverty (Mahler et al., 2021). Sectors that could not move online and small countries reliant on tourism were particularly affected by restricted movement and travel (e.g. in the Caribbean and the Pacific). A survey in six Latin American cities found the greatest reduction in well-being was associated with the loss of work or income, although social cohesion provided a significant level of protection, highlighting the role of social capital in resilience building (Castro et al., forthcoming). Global financial and budgeting systems were also not prepared to cope with a major systemic risk arising from outside their sector. The pandemic has exacerbated inequality. Unemployment rose in the United States of America during 2020, by 3.6% for men and 4.0% for women on average, with a greater increase for Black / African American women at 4.9% and the highest for Hispanic / Latina women, at 6.2%. This reflects a concentration of marginalized communities and women overall in lower-paid, less-secure work (WEF, 2021b). Surveys in urban and rural areas in three African countries (Burkina Faso, Ethiopia and Nigeria) identified serious consequences for SDG achievements, including in education, nutrition and food security (Hamer, 2021). Schooling became impossible for half of the Asia and the Pacific regions, where families already lacked access to the Internet, and the loss of household income made education unaffordable for many families, especially affecting girls’ education (Nguyen, 2021) (Chapter 4). A study of systemic impacts of the pandemic in the old city of Ahmedabad, India, showed this pattern in detail (Kanji et al., 2022a) (Chapter 12). Measuring what we value During the pandemic, basic data collection at national and local levels has faced challenges (Dean, 2021), but the crisis also triggered innovations in the generation, function and use of dynamic disaggregated data to understand vulnerability in systems and their cascading effects. After a slow start, the global response included rapid sharing and constant analysis of real-time data on COVID-19 symptoms and physiological impacts, successes or failures in experimental treatments, epidemiological data on where and how fast it spread, rates of death and acute illness, and also the research into, and trials of, vaccines (Ellenberg and Morris, 2021). Freely available human mobility data, collected by a Google platform and other opentechnology platforms and devices, has been used to evaluate community mitigation strategies aimed at restricting the movement of people. In some cases, it was possible to model the spread of the virus based on actual movements (Ilin et al., 2021). 14 Designing systems to factor in how human minds make decisions about risk The pandemic response illustrated positive and negative extremes in how people make decisions about risk, and what prompts governments and individuals to act. A multi-country study found that the best predictor of adherence to COVID-19 restrictions is a sense of “we are all in it together and we all need to come out of it together” (Jetten et al., 2020). A successful example in Viet Nam also saw the Government adopt a strategy that evoked patriotism and bravery for compliance (Independent Panel for Pandemic Preparedness and Response, 2021b). Public compliance with mask wearing and social distancing were initially a challenge in Italy, but personal experiences soon led to a perception that COVID-19 was a serious and relevant threat. Residents became more active in undertaking preventive actions compared with their European neighbours who had not yet experienced these impacts (Meier et al., 2020). Compliance with mask-wearing orders or other COVID-19 mitigation measures in the United Kingdom of Great Britain and Northern Ireland and in the United States quickly became polarized. For many, it was less a question of rational risk reduction than public display of political identities (Choma et al., 2021; Kahane, 2021). WHO referred to an “infodemic” of too much information overall and too much false or misleading information (WHO and PAHO, 2022). In some cases, the infodemic caused confusion, mistrust and risk-taking behaviours and an undermining of the public health response. In Myanmar, where Internet access had surged only recently, unreliable information about COVID-19 abounded online, with people sharing posts about how various common foods and beverages could cure the disease (BBC Media Action, 2020). To counter this, a national communication campaign, Let’s Beat COVID Together, included a popular Facebook page that facilitated two-way communication so people could ask questions and share experiences (Partnership for Healthy Cities, 2020). Reconfiguring governance and financial systems to work across silos and design in consultation with affected people Countries with prior experience of SARS, including China, the Republic of Korea and Thailand, responded more quickly and effectively than other countries to contain the spread of the disease. Their populations were sensitized to the threat of pandemics due to prior experience, and they had already reconfigured institutions that were better able to work across silos to address pandemic spread (Thompson, 2020). In an effort to extend the reach of “collaborative intelligence” in future pandemic response, WHO has also launched a global hub for pandemic and epidemic intelligence (WHO, 2021b). 15 Part I The challenge 2. Our world at risk At no other point in modern history has humankind faced such an array of familiar and unfamiliar risks and hazards, interacting in a hyperconnected and rapidly changing world. The increasing number of reported medium- and large-scale disasters reflects a complex interaction of factors. Population growth and expanded settlements put more people and infrastructure in the path of existing hazards, and there is an increase in frequency and intensity of climatic hazards due to climate change (Van Aalst, 2006; IPCC, 2012, 2014a, 2018a; Otto et al., 2018). Climate change exacerbates disaster risk in a variety of ways. It increases the likelihood, frequency and intensity of climatic hazard events, affecting vulnerability to all hazards due to longterm socioeconomic stresses and impacts such as displacement, and altering exposure patterns as climatic conditions change and hazards emerge in new localities. Disaster events reported per year have increased significantly in the last two decades. While there were relatively more disaster peak years in the decade 2000–2009 compared to 2010–2019, overall frequency remains at an all-time high. Between 1970 and 2000, reports of medium- and large-scale disasters averaged around 90–100 per year, but between 2001 and 2020, the reported number of such events increased to 350–500 per year. These included geophysical disasters such as earthquakes, tsunamis and volcanoes, climate- and weather-related disasters, and outbreaks of biological hazards including crop pests and epidemics (UNDRR analysis based on the International Disaster Database (EM-DAT; CRED, 2021). If current trends continue, the number of disasters per year globally may increase from around 400 in 2015 to 560 per year by 2030 – a projected increase of 40% during the lifetime of the Sendai Framework (Figure  2.1). For droughts, there is a large year-onyear variation, but current trends indicate a likely increase of more than 30% between 2001 and 2030 (from an average of 16 drought events per year during 2001–2010 to 21 per year by 2030) (Figure  2.2). The number of extreme temperature events per year is also increasing; based on current trends, it will almost triple between 2001 and 2030 (Figure 2.3). This is further substantiated by climate projections, including the scientific evidence provided by the IPCC Sixth Assessment Report that points to increases in heatwaves, more intense floods and droughts, and a 7% increase in extreme daily precipitation events to 2030 (IPCC, 2021a). Based on current trends, the world is set to exceed the Paris Agreement’s target of 1.5°C global average maximum temperature increase by the early 2030s, further accelerating the pace and severity of hazard events (IPCC, 2021a). Figures  2.1, 2.2 and 2.3 are underestimates in that data systems are still not sufficient to capture the large proportion of slow-onset hazards and subnational, localized or small-scale extensive disasters. A staggering 99.7% of all disaster events between 1990 and 2013 were smaller disasters involving fewer than 30 deaths or fewer than 5,000 houses destroyed (UNISDR, 2015). Thousands of these smaller-scale events are unreported every year because they do not generate high impacts at the national or international levels; however, they do bring a constant stream of local losses (UNDRR, 2021a). 2.1 Reality check – risk versus perceived risk 2.1.1 Risk perceptions The data is clear that risk is increasing. However, this is not reflected in surveys of individual risk perception. The prevailing perception of risk – in particular long-term threats – is one of optimism, underestimation and invincibility. For example, the findings of a 2020 World Risk Poll suggest that, while the risks from climate change are 17 generally understood and acknowledged, a significant proportion of people underestimate, remain sceptical or have no opinion on the issue (Lloyd’s Register Foundation, 2020a) (Figure 2.4). However, opinions may be changing, particularly in areas that have recently experienced significant disasters. For example, in the United States, there is evidence that, following a recent spate of wildfires, tornadoes, record heatwaves and hurricanes, over 75% of the public now feel climate change is happening (Leiserowitz et al., 2021). Figure 2.4. Perceptions of climate change globally, 2020 Source: Lloyd’s Register Foundation (2020a) The average “risk perception gap” between worrying about and having experienced hazards varies from 30% in Latin America and the Caribbean to 13% in Australia and New Zealand. This seems to indicate personal experience is only one of many factors that affect people’s risk perception (Lloyd’s Register Foundation, 2020b) (Figure  2.5). A range of cognitive, behavioural and sociocultural factors 0 300 1970 1980 1990 2000 2010 2020 2030 100 200 400 500 600 Number of total disaster events Future trend Data Overall trend Projected increase of disaster events of 40% by 2030 Figure 2.1. Number of disaster events 1970–2020 and projected increase 2021–2030 Source: UNDRR analysis based on EM-DAT (CRED, 2021) Future trend 0 15 1970 1980 1990 2000 2010 2020 2030 5 10 20 25 30 Number of drought events Data Overall trend Projected increase of drought events of over 30% by 2030 Figure 2.2. Number of drought events 1970–2020 and projected increase 2021–2030 Source: UNDRR analysis based on EM-DAT (CRED, 2021) 0 30 1970 1980 1990 2000 2010 2020 2030 10 20 40 50 60 Number of extreme temperature events Data Overall trend Future trend Extreme temperature events likely to almost triple by 2030 Figure 2.3. Number of extreme temperature events 1970–2020 and projected increase 2021–2030 Source: UNDRR analysis based on EM-DAT (CRED, 2021) How much of a threat is climate change? Very serious 41% threat Somewhat 28% serious Not a threat at all 13% 18% Don’t know 18 come into play when considering disaster risk, yet risk perception is a crucial factor in how people prepare, reduce and respond to hazards. 2.1.2 Disaster loss and poverty Poverty is a cause and a consequence of disaster risk, particularly extensive risk. Hazards like drought are the most closely associated with poverty, but all hazards that lead to disasters curtail sustainable development. The poorest and the most vulnerable people endure the worst of disaster losses. The poor are more likely to be exposed and therefore affected by hazards and are more likely to depend on fragile infrastructure and housing. They also lose a much greater proportion of their income and assets than non-poor people when disasters strike. 1 The latest year with official global poverty rates is 2017. The World Bank COVID-19 projections use June 2020 Global Economic Prospects growth forecasts for 2018–2021 and country-specific historical (2008–2018) annual growth rates thereafter (World Bank, 2017). Over the course of one generation, 1.2 billion people have moved out of extreme poverty. The share of the world’s population below the extreme poverty line of $1.90 per day has steadily declined over the past 20 years (World Bank, 2017) (Figure 2.6).1 However, even before the onset of COVID-19, progress towards poverty alleviation had decelerated and was not on track to end extreme poverty by 2030 (SDG 1 on zero poverty). The share of the world’s population living in extreme poverty declined from 15.7% to 10.0% between 2010 and 2015, but had decreased only by a further 1.8  percentage points to 8.2% in 2019 (World Bank, 2017). The most optimistic poverty headcount scenarios predict that, compared with 2020, an additional 37.6  million people will be living in conditions of 52 22 48 18 29 16 Latin America & Caribbean Southeastern Asia Southern Europe Eastern Europe Eastern Asia Southern Africa Northern Africa Central/Western Africa Southern Asia Central Asia Northern/ Western Europe Middle East Eastern Africa Northern America Australia & New Zealand Gap: ‘Very worried’ minus ‘Experienced’ Have experienced Very worried 44 15 35 8 33 7 58 32 42 18 47 24 43 20 29 7 34 13 41 21 45 30 34 20 +30 +13 +15 +20 +21 +22 +23 +23 +24 +26 +26 +27 +29 +30 +14 The Worry and Experience Index shown by region. The indices measure worry and experience across seven everyday hazards. (region index scores out of 100) Figure 2.5. Risk perception gap by region, 2020 Source: Lloyd’s Register Foundation (2020b) 19 Figure 2.6. Proportion of the world’s population living below the international extreme poverty line of $1.90 a day, 2002–2015 Source: UNDRR analysis based on Global Sustainable Development Goal Indicators Database, SDG indicator 1.1.1 (UN DESA, 2021) 2002 10 5 15 20 25 30 2005 2008 2010 2011 2012 2013 2015 Percentage 21 18 16 14 13 11 10 26 extreme poverty due to the impacts of climate change by 2030. Under the “worst-case” or no action scenario, climate change will push an additional 100.7  million into poverty by 2030 (Jafino et al., 2020) (Figure 2.7). The systemic impacts of the COVID-19 pandemic are bringing about the first rise in global poverty since 1998. By October  2020 the World Bank estimated that the pandemic had set back poverty eradication targets by 6–7  years, as poverty levels had already risen close to those seen in 2017 (World Bank, 2020a; Yonzan et al., 2020) (Figure  2.8). The pandemic led to 97  million more people living in poverty in 2020 – an historically unprecedented increase. Southern Asia and sub-Saharan Africa experienced the largest increases, with an additional 32 million and 26 million people, respectively, falling below the international poverty line due to the pandemic in 2020 (Jafino et al., 2020). According to the INFORM Natural Hazard Risk Index, most of the countries that face high disaster risk are also those with a high share of population living under the national poverty line. Among the top 20 countries with an average INFORM Natural Hazard Risk Index of 6.6 or above, 90% are middle- and lower-income countries with an average national poverty rate of 34% (European Commission, 2021) (Figure  2.9). This compares to less than 0.5% for the countries at the opposite end of the risk scale. For such high-risk and high-poverty countries – which generally fall into the low-income category – disaster impacts can lead to income and consumption shortfalls, negatively affect welfare and cause major setbacks in human and economic development, with long-term consequences. Within high-risk countries, a higher percentage of poor households are exposed to disasters compared with non-poor households (Figure  2.10). For example, after Cyclone Aila hit Bangladesh in 2009, 25% of poor households were exposed to its impacts, compared to only 14% of non-poor households (Akter and Mallick, 2013). In Viet Nam, the higher share of poor households exposed to floods is concentrated in urban areas, as land scarcity is pushing poor populations to settle in higher-risk areas (Nguyen and Winters, 2011; Nguyen et al., 2013). The lack of access to social 20 60 0 110 120 160 180 Additional people living in extreme poverty by 2030 due to disasters and climate change (millions) 20 40 80 140 100.7 37.6 Optimistic scenario Pessimistic scenario 9.2 3 6.7 7 2015 4 2 6 8 10 Percentage 2016 2017 2018 2019 2020 2021 2022 2023 2024 2025 2026 2027 2028 2029 2030 6.1 COVID-19 - DOWNSIDE PROJECTION COVID-19 - BASELINE PROJECTION PRE-COVID-19 PROJECTION 3% 2030 TARGET Figure 2.7. Number of additional people (in millions) being pushed into poverty due to climate change, 2020 projections through to 2030 Source: Jafino et al. (2020) Figure 2.8. Projected global extreme poverty by 2030: COVID-19 impacts on poverty alleviation Sources: Lakner et al. (2020); World Bank (2020a); Yonzan et al. (2020) 21 0 10 20 30 40 50 60 70 80 Philippines (8.4) Bangladesh (8.2) Myanmar (7.8) India (7.7) Indonesia (7.7) Pakistan (7.4) Viet Nam (7.4) Haiti (7) Somalia (6.9) Ecuador (6.9) Afghanistan (6.7) Iran (Islamic Republic of) (6.7) Guatemala (6.7) Dominican Republic (6.7) Papua New Guinea (6.7) El Salvador (6.6) Nicaragua (6.6) Honduras (6.5) Share of people living under the national poverty line (%) INFORM Natural Hazard Risk Index score Figure 2.9. Top countries with highest levels of the INFORM Natural Hazard Risk Index and their shares of population under the national poverty line, 2021 Source: UNDRR analysis based on INFORM Natural Hazard Risk Index (European Commission, 2021) and Global Sustainable Development Goal Indicators Database (UN DESA, 2021) protection measures and risk-sharing tools like insurance means people in poverty are often forced to use their already limited assets to buffer disaster losses, which drives them into further poverty. 2.1.3 Disaster loss and hunger Disasters and food security are linked in numerous ways. At the local level, disasters directly damage crops, livestock and livelihoods. Nationally or internationally, they have systemic impacts on supply chains and international trade. There is a positive correlation between years of high disaster loss and global peaks in the food price index (Figure 2.11). This is further illustrated by the impacts of COVID-19. The pandemic has escalated a previously rising trend of global food prices, making nutritious food unaffordable for millions of families already struggling to cope with income losses. Hunger and malnutrition are significantly worse in countries with agrifood systems highly sensitive to rainfall, temperature variability and severe drought, and where the livelihood of a high proportion of the population depends on agriculture. For example, in 2020, the average level of undernourishment in countries with high exposure to climate shocks was 3 percentage points higher than countries with low or no exposure (Figure 2.12). 22 Figure 2.10. Share of poor and non-poor households exposed to disasters (selected examples 1997–2014) COUNTRIES CITIES REGIONS KENYA 99% 95% MIDDLE EAST & NORTH AFRICA 46% 35% VIET NAM 38% 29% NEPAL 56% 50% Non-poor Poor GUYANA 40% 30% HAITI 75% 45% GUATEMALA 35% 29% SAN SALVADOR 9% 8% MUMBAI 41% 23% The boundaries and names shown and the designations used on this map do not imply official endorsement or acceptance by the United Nations TEGUCIGALPA 17% 11% BANGLADESH 25% 14% Note: Given the lack of international data on this issue, the region, country and city examples were selected based on a review of literature to identify where specific studies had been done and to use the data available from them. Each source has a different definition of “poor” and “non-poor” people. The definition of exposure differs based on the type of hazard and context in which it occurs. Source: UNDRR analysis, based on literature for: Bangladesh (Akter and Mallick, 2013); Guatemala (Tesliuc and Lindert, 2002); Guyana (Pelling, 1997); Haiti (Fuchs, 2014); Kenya (Opondo, 2013); Middle East and North Africa (World Bank, 2014); Mumbai (Baker et al., 2005; Ranger et al., 2011); Nepal (Gentle et al., 2014); San Salvador and Tegucigalpa (Fay, 2005); and Viet Nam (Nguyen et al., 2013) 23 50 100 150 200 300 350 400 250 1900 1992 1994 1996 1998 2000 2002 2004 2006 2008 2010 2012 2014 2016 2018 2020 Disaster loss (billion $) Food price index 364.10 b 67.1 118.8 27.09 b Figure 2.11. Risk and hunger: relationship between disaster impact and food price index, 1990–2020 Source: UNDRR analysis based on EM-DAT (CRED, 2021), Food Price Index (FAO, 2021a) and Sendai Framework Monitor (SFM) (UNDRR, 2021c) Countries with low exposure to climate extremes Countries with high exposure to climate extremes Number of undernourished Prevalence of undernourishment (2020) 83% 11% 7% 24% Figure 2.12. Number of undernourished people and prevalence of undernourishment in countries, 2020 Source: UNDRR analysis based on EM-DAT (CRED, 2021) and FAOSTAT (FAO, 2021a) 2.1.4 Disaster loss and gender inequality Reducing poverty positively increases disaster resilience and also has strong positive associations with removing gender-based inequalities. Women’s reduced access to economic resources and roles in work, family and public life translate into a gender difference in resilience to disasters and climate change. Women as a group are not innately more vulnerable than men, but gender inequalities contribute to their disproportionate risk (Neumayer and Plümper, 2007). While gender-disaggregated data reporting on disaster impacts remains insufficient, gender differences in access to the economic and financial means for recovery are telling. The gender pay gap remains a key global challenge. Women receive on average 15% lower pay than men, and thereby have fewer economic resources to build resilience and recover from shocks (UNDP, n.d.b; WEF, 2019). This is compounded by women’s reduced personal access to ready finances in emergencies, which is on average 10% lower than that of men (Figure 2.13). Although the gender gap in access to finance in emergencies is greater in middleand lower-income countries (Figure  2.13), the global average for high-income countries also shows a difference, with 72% of men and 66% of women having individual access to finance in emergencies (World Bank, 2021a). Gender-differentiated impacts of disasters and the social responses to them can exacerbate gender inequality, especially in access to economic resources, leading to greater impoverishment and less resilience to future disasters. A recent study in Bangladesh on the economic dimension of women’s vulnerability during cyclones identified seven common challenges or issues: increased unemployment, decreased livelihood options and increased 24 poverty; increased food insecurity; loss of property; girls dropping out of education; early marriage; migration; and long-term displacement (Sultana, 2022). Among these impacts, the first four are immediate, while the last three are indirect and long lasting. Other studies have found gender disparities in disaster recovery support in areas such as employment and livelihoods, where, for example, formal programmes may focus on jobs mainly done by men and fail to recognize women’s livelihoods in the informal sector or the uninsured losses they sustain from food gardens, fishing and farming (ILO, 2020). Increases in gender-based violence during emergencies, disaster displacement and slow-onset disasters is also a key concern. Multiple studies have highlighted this challenge at the global level, in regions such as Asia and the Pacific (Bhalla, 2018), as well as in various countries and disaster settings such as wildfires in Australia (Parkinson and Zara, 2011), cyclones in Bangladesh (Rezwana and Pain, 2020) and floods and hurricanes in the United States (Gearhart et al., 2018). Monitoring during the COVID-19 pandemic has highlighted the “shadow pandemic” of genderbased violence globally (UNFPA, 2020; Emandi et al., 2021; WHO, 2021c). For example, a recent study on the impact of COVID-19 lockdowns and associated economic losses on urban populations in four Latin American cities found a high correlation between these stresses and violence within the home, as well as depression and anxiety, affecting women and people of diverse sexual orientations and gender identities (in Coquimbo and Santiago in Chile, Lima in Peru and Santo Domingo in the Dominican Republic) (Castro et al., forthcoming). 0% 10% 20% 30% 40% 50% 70% 60% South Asia Middle East and North Africa Latin America and Caribbean East Asia and Pacific Europe and Central Asia Sub-Saharan Africa 60% 53% 64% 58% 50% 33% 53% 39% 54% 41% 49% 38% Male Female Excluding high income Figure 2.13. Gender-differentiated access to finance in emergencies (excluding high-income countries) Note: Percentages indicate the share of people (male and female) who report that in case of an emergency it is possible for them to come up with 1/20 of the gross national income per capita in local currency within the next month (e.g. through savings, supplementary income, access to loans and credit). Source: UNDRR analysis based on World Bank (2021a) 25 Using SDG data, it is also now possible to observe statistically significant correlations between genderbased violence and being affected by disasters. An analysis of SDG data (Figure  2.14) shows a strong relationship between the number of people affected by disaster and the number of female victims of intentional homicide (the SDG statistics are based on numbers of victims per 100,000 population). Building on the above research on increased genderbased violence in disasters, this suggests that the additional socioeconomic and psychological stresses of disasters on affected people exacerbate vulnerability through indirect social impacts. These further undermine coping capacity, social cohesion and well-being, which in this example has a disproportionate impact on women and girls. Figure 2.14. Relationship between disaster affectedness and intentional homicides of women, 2015–2022 Source: United Nations Department of Economic and Social Affairs (UN DESA) analysis based on Global Sustainable Development Goal Indicators Database (UN DESA, 2021) Human trafficking is another recognized secondary impact of disasters, which has a significant gender dimension. An analysis of available SDG data demonstrates a strong relationship between disaster affectedness and the number of detected female victims of human trafficking (Figure  2.15) in all regions except Northern Africa, Western Asia and Oceania. While data availability on this issue, particularly in data-scarce regions, remains a concern, it points to a need to better understand the cascading and systemic impacts of disasters on well-being (IOM, 2017). Figure 2.15. Relationship between disaster affectedness and trafficking of women and girls, 2015–2021 Source: UN DESA analysis based on Global Sustainable Development Goal Indicators Database (UN DESA, 2021) In summary, pre-existing gender inequalities and different gender roles in societies affect exposure, vulnerability, coping capacity and preparedness in relation to disasters (Figure 2.16). SDG indicator 16.2.2 Detected victims of human trafficking (number) SDG indicator 1.5.1 Number of people affected by disaster (number) SDG indicator 16.1.1 Detected victims of intentional homicide, by sex (women) SDG indicator 1.5.1 Number of people affected by disaster (number) 26 Figure 2.16. DRR and risk factors shaped by gender Research also shows women play a crucial role in scaling up disaster preparedness, bringing a wealth of knowledge, capacities and needs-based approaches to decision-making. However, there is a need for women’s participation in these roles to be institutionalized in DRM (Picard, 2021). 2.1.5 Risk and urbanization The relationship between poverty and risk is compounded by rapid urbanization globally. By 2017, over half of the world’s population (56%) was living in urban areas – increasingly in highly dense cities (United Nations Population Division, 2018; World Bank, 2022) (Figure 2.17). Figure 2.17. Urban population as a share of total global population, 1960–2017 Source: UNDRR analysis based on World Bank (2022) and United Nations Population Division (2018) Moreover, a quarter of the world’s urban population lives in informal settlements in conditions of poverty (Figure  2.18). About 1  billion people in developing countries are vulnerable to disasters because they live in congested, poorly built houses with high levels of exposure and without adequate emergency services or coping capacities (United Nations Population Division, 2018; World Bank, 2022). Figure 2.18. Share of urban population living in informal settlements, by region, 2018 Source: UNDRR analysis based on World Bank (2021b) Rapid urbanization is making people more vulnerable to the impacts of climate change, in part due to the concentration of large cities in coastal areas subject to the impacts of sea-level rise. Sea levels rose on average 1.3  mm per year between 1901 and 1971, but since 2006, that rate has increased to 3.7  mm per year (IPCC, 2021a). It is projected that by 2100, 200  million people in the world will be affected by sea-level rise, with most of those in Asia, in particular China (43 million), Bangladesh (32 million) and India (27 million) (Kulp and Strauss, 2019). DRR Society RISK FACTORS SHAPED BY GENDER DYNAMICS: Exposure Vulnerability Coping Capacity Preparedness Disasters Disaster impact Gender inequality 0 10 20 30 40 50 60 1960 1970 1980 1990 2000 2010 Percent 2020 55.71 33.61 World Sub-Saharan Africa South Asia Arab States Southeast Asia Northeast Asia Latin America and the Caribbean Europe and Central Asia Pacific 10% 20% 30% 40% 50% 60% 29% 55% 45% 44% 33% 31% 24% 14% 11% Share of urban population living in informal settlements 0% North America 0.01% 27 SUBSTANTIAL REDUCTIONS SUBSTANTIAL INCREASES PRIORITY 1 Understanding disaster risk PRIORITY 4 Enhancing disaster preparedness for effective response and to ‘Build Back Better’ in recovery, rehabilitation and reconstruction PRIORITY 2 Strengthening disaster risk governance to manage disaster risk PRIORITY 3 Investing in disaster risk reduction for resilience A. Global disaster mortality B. Number of affected people globally C. Direct economic loss D. Disaster damage and disruption E. Countries with national and local disaster risk reduction strategies F. International cooperation to developing countries G. Multi-hazard early warning systems risk information and assessment The Sendai Framework outlines seven global targets to be achieved: Figure 2.19. Sendai Framework targets and priorities 28 2.2 The Sendai Framework at the halfway point: Getting it right towards 2030 The Sendai Framework includes four priorities and seven targets intended to define and measure progress towards its overall goal to increase resilience by reducing risk (Figure  2.19). The year 2022 is the halfway point of the agreement’s 15 year life. Member States and their partners have made significant achievements in its implementation and monitoring since 2015. The Sendai Framework targets are the basis for States’ voluntary reporting to SFM (Box  2.1). The first four targets are to substantially reduce disaster impacts: mortality, people affected, economic loss, and damage to critical infrastructure and disruption of basic services (Targets  A–D). The other three targets are to substantially increase the adoption of national and local DRR strategies, international cooperation to developing countries and access to multi-hazard early wanting systems (Targets  E–G). There are now 155 countries reporting on at least one of the seven targets, and new trends are emerging across the various indicators.2 2 All data from SFM used throughout this chapter up to and including 2019 is from the 31 March 2021 reporting milestone; all data from SFM for 2020 is from the 31 October 2021 reporting milestone. United Nations resolution 69/283, adopting the Sendai Framework, also called on all stakeholders to make specific and time-bound voluntary commitments (United Nations, 2015a). By February 2022, UNDRR had published 100 such voluntary commitments involving almost 650 organizations working in partnership at local, national, regional and global levels on wide-ranging projects, for example, supporting small business resilience, building youth capacity and exploring frontier technologies to understand risk. 2.2.1 Fragile progress in reducing the human cost of disasters A large year-on-year variability exists in mortality trends (Figure  2.20), highlighting that largescale events and mega disasters can overwhelm countries’ capacities to prepare, respond and recover. While global disaster-related mortality, in the long term, has seen an overall increasing trend (Figure  2.20), there has been a perceptible decline from over 104,000 deaths per year in the 2000s to an average of 81,000 per year in the 2010s. Yet, significant challenges remain in reducing global disaster mortality by 2030 (Sendai Framework Target A), especially in light of the COVID-19 impact, which pushed up the overall mortality from 2020 onwards. Box 2.1. The Sendai Framework Monitor (SFM) Figure 2.20. Global disaster-related mortality, 1989–2020 The Sendai Framework is supported by 38 indicators to track progress in implementing the seven targets of the Sendai Framework, as well as related dimensions in SDGs  1, 11 and 13. The Open-ended Intergovernmental Expert Working Group recommended the indicators, and the United Nations General Assembly endorsed them. SFM is the online reporting tool where countries enter, track and submit official data under a reporting framework. It supports countries to develop DRR strategies, make risk-informed policy decisions and allocate resources to prevent new disaster risk. Source: UNDRR (2021c) 1990 1995 2000 2005 2010 2015 2020 50,000 100,000 150,000 200,000 250,000 Number of people 300,000 350,000 Note: The mortality rate for 2020 includes deaths related to COVID-19; however, due to incomplete reporting, this figure does not reflect the complete impact of COVID-19 in terms of mortality. Source: UNDRR analysis based on DesInventar (UNDRR, 2021d), EM-DAT (CRED, 2021) and SFM (UNDRR, 2021c) 29 Evidence points to the benefits of disaster preparedness actions by countries, such as the preparation of DRR strategies as a means of saving lives and alleviating disaster impacts. The number of countries with local governments that adopt tailored national DRR strategies is strongly and positively correlated with a reducing disaster mortality rate over time (SDG indicator  13.1.3 / Sendai Framework Target E and SDG indicator 1.5.1 / Sendai Framework Target  A) (Figure  2.21). While this does not establish direct causality between local strategies and reduced disaster mortality, the development of such strategies is the type of investment in local risk reduction that, among other things, results in reduced mortality. The overall number of people affected by disasters (Sendai Framework Target  B) is on a moderate downward trend (Figure  2.22). Over the past 20  years, the average number of people affected has decreased from 228 million in the 2000s to just under 200 million in the 2010s. This uses the Sendai Framework reporting definition of people affected by disasters as people ill or injured, with damaged or destroyed dwellings, or whose livelihoods were disrupted or destroyed by disasters. Figure 2.22. Number of people affected by disasters globally, 1989–2020 Source: UNDRR analysis based on DesInventar (UNDRR, 2021d), EM-DAT (CRED, 2021) and SFM (UNDRR, 2021c) 100,000 200,000 300,000 400,000 500,000 Number of people 600,000 700,000 1990 1995 2000 2005 2010 2015 2020 SDG indicator 13.1.3 Local governments that adopt and implement local DRR strategies in line with national strategies SDG indicator 1.5.1 Deaths due to disaster Number of people affected by disaster Number of local governments that adopt and implement local DRR strategies 20,000 in line with national strategies 40,000 60,000 80,000 100,000 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015 2016 2017 2018 2019 120,000 140,000 160,000 180,000 180,000 200,000 5,000 10,000 15,000 20,000 25,000 30,000 35,000 40,000 45,000 0 Figure 2.21. Relationship between disaster-related deaths and adoption of local DRR strategies, 2005–2019 Source: UNDRR analysis based on SFM (UNDRR, 2021c) 30 3 As with other hazards, under the Sendai Framework terminology for Target B, “people affected” by COVID-19 are those who have suffered injury, illness or other health effects, as well as people evacuated, displaced or relocated, or suffering direct damage to their livelihoods, economic, physical, social, cultural or environmental assets. The systemic impacts of the COVID-19 pandemic are increasingly putting achievement of the Sendai Framework goal at risk. Low-income countries were the hardest hit in 2020 by disasters including the pandemic and other hazards, with one in four people being directly affected (Figure  2.23).3 Ensuring post-pandemic recovery and building back and forward better will be essential to future resilience. Over the past decade, disasters have also forced over a quarter of a billion people into internal displacement, resulting in three times more internal displacements than those due to conflict and war each year on average (Figure 2.24). Number of people 5,000 10,000 15,000 20,000 25,000 30,000 2015 2016 2017 2018 2019 2020 High income Upper middle income Lower middle income Low income Source: UNDRR analysis based on DesInventar (UNDRR, 2021d) and SFM (UNDRR, 2021c) Figure 2.23. Number of people affected by disasters per 100,000 population by country income group (Sendai Framework Target B), 2015–2020 Number of people 5,000,000 10,000,000 15,000,000 20,000,000 25,000,000 30,000,000 35,000,000 40,000,000 45,000,000 2010 2011 2012 2013 2014 2015 2016 2017 2018 2019 2020 Conflict Disasters 30, 688,349 42,350,850 2,892,200 11,768,022 Figure 2.24. Number of displaced people due to conflict and disasters, 2010–2020 Source: UNDRR analysis based on Global Internal Displacement Database (IDMC, 2021) 31 Some regions were hit hard by climatic disasters during 2020, which caused large-scale displacement. In Central and South America, the 2020 Atlantic hurricane season was the most active on record, with 30 major storms forcing millions of people to leave their homes. In November  2020, Hurricanes Eta and Iota caused chaos and flooding in 12 Central American and Caribbean countries. Four  million people were internally displaced in Honduras alone. South and East Asia and the Pacific countries faced intense cyclone seasons. Cyclone Amphan triggered nearly 5  million evacuations across Bangladesh, Bhutan, India and Myanmar. Across the Middle East and sub-Saharan Africa, extended rainy seasons also uprooted millions of people (WMO, 2021). Many internally displaced people – including those fleeing from conflict and war – are also living in climate change “hotspots” subject to increased drought, extreme temperatures, floods and sea-level rise that exacerbate their vulnerability and exposure, adding systemic disaster risk for groups already in vulnerable situations. 2.2.2 Alarming trends – growing economic cost of disasters While disasters are claiming fewer lives annually, they are also costing more and increasing poverty. On a global level, the dollar value economic loss associated with all disasters –geophysical, climateand weather-related – has averaged approximately $170  billion per year over the past decade, with peaks in 2011 and 2017 when losses soared to over $300  billion (Figure  2.25). In 2011, the high losses were mainly due to the Tōhoku earthquake in Japan and floods in Thailand, both of which became complex and systemic disasters with cascading impacts across national, regional and international economies. In 2017, the losses were from intense hurricane/cyclone seasons in the North Atlantic and East Asia. Such economic loss figures are likely underestimated, given the gaps in data for many countries, and the medium- and long-term economic losses that are not tracked. For example, a recent study of the losses to the tourism sector due to the Sunda Strait tsunami and COVID-19 in Indonesia highlighted that only by calculating indirect losses can disaster impact be assessed comprehensively and ultimately managed (Sagala et al., 2022). Figure 2.25. Direct economic loss from disasters (billion $), 1989–2020 Source: UNDRR analysis based on EM-DAT (CRED, 2021) While the economic impact of geophysical disasters has remained stable over recent decades, annual economic loss from climate- and weather-related events has risen significantly since the 2000s, in line with their amplified intensity and frequency. This is presenting a new challenge for meeting Sendai Framework Target  C to reduce economic loss in relation to GDP. While dollar value losses are often greater in highincome countries, it is the poorest countries that sustain the highest relative loss. Low-income and lower middle-income countries lose on average 0.8–1% of their national GDP to disasters per year, compared to 0.1% and 0.3% in high-income and upper middle-income countries, respectively (Figure 2.26). At regional level, the highest share of economic loss is borne within Asia and the Pacific, where countries lose on average 1.6% of GDP to disasters. Africa is the second most affected region, with an average disaster-related economic loss of 0.6% of GDP (Figure 2.27). According to SwissRe’s Sigma Research, less than half of disaster-related losses at a global level in 2020 were insured (approximately $89  billion of an estimated $202  billion). This was above the previous 10  year annual average of $71  billion of insured loss (Swiss Re Institute, 2021) (Figure 2.28). Between 1980 and 2018, on average, about 40% of all disaster-related losses were insured (Munich Re, n.d.). However, insurance is overwhelmingly concentrated in richer countries. The insurance 50 100 150 200 350 400 250 300 Direct economic loss (billion $) 1990 1995 2000 2005 2010 2015 2020 32 Europe and Central Asia Americas and the Caribbean Arab States Africa Asia and the Pacific 0.2% 0.6% 0.8% 1.0% 1.2% 1.4% 1.6% High income Upper middle income Low income Lower middle income 0.2% 0.4% 0.6% 0.8% 1.0% 1.2% Figure 2.26. Average economic loss from disasters as share of GDP by country income group (Sendai Framework Target C), 2010–2020 Source: UNDRR analysis based on DesInventar (UNDRR, 2021d) and SFM (UNDRR, 2021c) Figure 2.27. Average economic loss from disasters as share of GDP by region (Sendai Framework Target C), 2005–2020 Source: UNDRR analysis based on DesInventar (UNDRR, 2021d) and SFM (UNDRR, 2021c) 1970 1975 1980 1985 1990 1995 2000 2005 2010 2015 2020 100 200 300 400 500 0 Insured losses Uninsured losses 10-year moving average insured losses 10-year moving average economic losses Economic losses = insured + uninsured losses Figure 2.28. Insured and uninsured losses ($ billion at 2020 prices), 1970–2020 Source: Swiss Re Institute (2021) 33 coverage rate in most developing and emerging economies is well below 10% and sometimes almost zero (Munich Re, n.d.). Private insurance products are often not available or affordable for people with low-value assets and low incomes. In the aftermath of a disaster, uninsured losses will typically be paid through the labour and personal financial reserves of affected people, government funds and international humanitarian assistance. This uncertainty and drain on State budgets poses an ongoing challenge for poorer countries to afford to compensate affected people and also undertake resilient reconstruction and rebuild social services. Economic loss of such proportions – especially when uninsured – can have serious future implications for poverty alleviation. It can undo years of progress, reverse development trajectories and divert State resources that might otherwise have gone to social protection, poverty reduction and hunger alleviation. 2.2.3 Beyond direct loss Direct disaster loss calculations do not capture the full human, social and economic implications of disasters. Another way to describe the extent of the indirect costs brought about by disasters is in terms of life years lost, a metric developed for the Global Assessment Report on Disaster Risk Reduction 2015 (UNISDR, 2015). Rather than using only the four dimensions of fatalities, injuries, dislocations and the financial damage that they wreak, life years lost is a way to describe the time required to produce economic development and social progress. It provides a way of measuring setbacks to social and economic development across countries and regions (Doan and Noy, 2022). This measure shows that the costs of the pandemic in terms of life years lost, measured for 2020, far outweigh the annual average costs associated with other disasters and/or the summed cost associated with all other epidemics combined in the past two 0 40 80 120 104.374 39.585 25.803 32.512 1.127 3.540 1.160 0.652 0.004 20.771 3.048 6.771 0.716 0.078 0.028 Asia Americas Europe Africa Oceania Total life years lost (millions) COVID-19 total in 2020 Disasters 2000–2019 annualized average All epidemics in 2000–2019 sum total Source: Adapted from Doan and Noy (2022) Figure 2.29. Total life years lost by region due to COVID-19 in 2020 in comparison to the annualized average life years lost for other disasters (2000–2019) and the sum total for all other epidemics (2000–2019) 34 decades, and that this is the case across all regions (Figure  2.29). The life years lost from COVID-19 in 2020 were more than three times the annual average from other disasters in Asia, and also much higher than the average in the Americas, Africa, Europe and Oceania, although in the Pacific, the numbers appear small due to smaller populations. The COVID-19 pandemic has had severe economic and health impacts in many small but highly exposed and vulnerable countries such as SIDS in the Pacific, Indian Ocean and Caribbean (Doan and Noy, 2022). 2.2.4 The Sendai Framework’s “substantially reduce” targets Early analysis of the data reported by Member States through SFM indicates the global community is off target to reach the goal of the Sendai Framework by 2030. None of the Sendai Framework’s “substantially reduce” targets are on track to be achieved by 2030: disaster-related morbidity (Target  A), affected persons (Target B), direct economic loss relative to GDP (Target C) and damage to critical infrastructure and disruption to basic services (Target  D). On the contrary, direct economic loss and damage to critical infrastructure have increased substantially over the past decade (Figure 2.30). The climate emergency, the far-reaching repercussions of the COVID-19 pandemic and multiple other risk drivers further threaten progress towards the achievement of global DRR commitments. Projection scenarios for reducing disaster-related mortality and people affected by disasters reveal just how much the Sendai Framework goal has been reversed by the pandemic. Before COVID-19, global disaster-related mortality was on track to decline, with 2030 levels likely to be around 94% of 2010 levels. In the scenario that 0.0% 0.2% 0.4% 0.6% 0.8% 1.0% 1.2% 1.4% 1.6% 1.8% 2.0% 0 1000 2000 3000 4000 5000 6000 7000 2010 2011 2012 2013 2014 2015 2016 2017 2018 2019 2020 C1 Direct economic loss attributed to disasters in A1 Number of people relation to GDP (%) B2 Hundreds of people D1 Index of critical infrastructure damaged = number of infrastructure units and facilities damaged/population × 100, 000 A1 Number of deaths and missing persons attributed to disasters, per 100,000 population B1 Hundreds of directly affected people attributed to disasters, per 100,000 population C1 Direct economic loss attributed to disasters in relation to GDP (%) D1 Damage to critical infrastructure attributed to disasters Figure 2.30. Progress to substantially reduce mortality, persons affected, economic loss, damage to infrastructure (Sendai Framework Targets A–D), 2010–2020 Source: UNDRR analysis based on DesInventar (UNDRR, 2021d) and SFM (UNDRR, 2021c) 35 considers the short-term effects of the COVID-19 pandemic, slow vaccination rates in the Global South and various indirect impacts on human health, the global mortality rate may increase by 2030 (Figure 2.31). In addition, as noted above, there is not yet sufficient data on smaller localized events in the national and international data. To have a complete picture of the risks considered in the Sendai Framework, there is a need to incorporate intensive and extensive risks, and address future hazard scenarios that include viruses, other biological hazards and the effects of climate change. The DesInventar tool and database has supported countries to monitor and analyse the impact of all hazard events. It is being scaled up and enhanced by UNDRR in collaboration with the United Nations Development Programme (UNDP) and other partners. 2.2.5 The Sendai Framework’s “substantially increase” targets In the first 6 years of implementation of the Sendai Framework, there was a 1.5-fold increase in the number of countries with national and/or local DRR strategies (Target E), to 120 countries in 2020 (Figure 2.32; Table 2.1). Furthermore, the national strategies adopted by countries show an increasing level of comprehensive alignment with the Sendai Framework according to country self-assessment against the criteria provided in SFM (Table  2.1). This means they include a stronger focus than previous strategies on preventing the creation and accumulation of new risk, reducing existing risk, building the resilience of sectors, recovery, building back better and promoting policy coherence with the 2030 Agenda and the Paris Agreement. The COVID-19 crisis further underscores the urgency to adopt multi-hazard DRR strategies that address all risks, including biological and health emergencies (Christel et al., 2020). Strengthening resilience, supporting ex ante risk prevention, restoring livelihoods, and rebuilding economic and social infrastructure requires substantial financial resources. The Sendai Framework aims to substantially enhance international cooperation to developing countries, recognizing that official development assistance (ODA) plays a key role, particularly for the poorest and most vulnerable countries (Target  F). Disasterrelated funding forms a relatively small portion of overall ODA. From a total of $1.17 trillion of overall ODA provided over the past decade (2010–2019), 11% ($133  billion) was disaster related. A smaller fraction still – $5.5 billion – was the share allocated Figure 2.31. Number of deaths and missing persons attributed to disasters, actual data 2010–2020 and outlook 2021–2030 (Sendai Framework Target A) Source: UNDRR analysis based on DesInventar (UNDRR, 2021d) and SFM (UNDRR, 2021c) 2010 500 1,000 1,500 2,000 2,500 0 2011 2012 2013 2014 2015 2016 2017 2018 2019 2020 2021 2022 2023 2024 2025 2026 2027 2028 2029 2030 Number of deaths and missing persons attributed to disasters per 100,000 population Projections with COVID-19 Projections without COVID-19 36 Table 2.1. Number of national strategies and alignment with Sendai Framework, 2015–2020 Year Total number of countries with national and/ or local DRR strategies Average score of Sendai Framework alignment (for national strategies) 2020 120 0.68 2019 103 0.66 2018 88 0.55 2017 75 0.47 2016 54 0.43 2015 48 0.41 Source: UNDRR analysis based on SFM (UNDRR, 2021c) Both Only local Only national 10 0 30 20 50 40 70 60 80 100 90 2015 2016 2017 2018 2019 2020 3 4 5 3 2 2 8 10 14 18 27 29 37 40 56 67 74 89 Source: UNDRR analysis based on SFM (UNDRR, 2021c) TOTAL ODA 2010–2019 $1.17 trillion DISASTER FINANCING $133 billion DISASTER PREVENTION AND PREPAREDNESS $5.5 billion 4.1% 5.8% RECONSTRUCTION, RELIEF AND REHABILITATION $7.7 billion EMERGENCY RESPONSE $119.8 billion 90.1% Figure 2.33. Disaster-related financing as share of total ODA Source: UNDRR analysis based on OECD.Stat (OECD, 2021a) Figure 2.32. Number of countries with national and/or local DRR strategies, 2015–2020 37 for disaster prevention and preparedness, compared to $119.8 billion earmarked for emergency/disaster response and $7.7  billion for reconstruction, relief and rehabilitation. Thus, of overall aid financing between 2010 and 2019, only 0.5% of the total amount was spent on risk reduction measures in advance of disaster (Figure 2.33). The Organisation for Economic Co-operation and Development DRR policy marker introduced in 2017 provides figures for DRR-related ODA (OECD, 2018a). Figure  2.33 is based on analysis of the humanitarian aid portion of ODA. While disaster-related financing has increased since 2010, most of the resources have supported activities to respond to and recover from disasters (Figure 2.34). Countries with the highest disaster-related mortality receive only a negligible share of funding for DRR per capita (Figure  2.35). Some of the countries with the highest Natural Hazard Risk Index do receive commensurate levels of prevention and preparedness funding, while most do not (Figure 2.36). ODA for prevention and preparedness does not adequately reflect the needs. The world is therefore not on track to deliver on its commitment of substantially increased international development assistance for DRR, disaster preparedness and prevention (Target F). The adoption of multi-hazard early warning systems is another critical element of DRR, as reflected under Sendai Framework Target G. However, efforts should be scaled up. In 2020, 36 countries reported Figure 2.34. Disaster-related financing: ODA for prevention and preparedness, funding for reconstruction relief and rehabilitation, and emergency response ($ million), 2010–2019 Source: UNDRR analysis based on OECD.Stat (OECD, 2021a) 4,000 6,000 8,000 12,000 14,000 16,000 18,000 20,000 10,000 2,000 2010 2011 2012 2013 2014 2015 2016 2017 2018 2019 Disaster prevention and preparedness Reconstruction relief and rehabilitation Emergency response 38 Figure 2.35. ODA for prevention and preparedness received by countries with the highest mortality levels, 2010–2019 average 0 5 10 15 20 25 30 35 Haiti (232) Bhutan (176.94) Micronesia (Federated States of) (46.97) Iraq (37.9) Somalia (17.5) Dominica (15.28) Bahamas (12.24) Armenia (11.46) Democratic Republic of the Congo… Kiribati (8.2) Liberia (8.09) Malawi (7.67) Libya (7.6) Mongolia (6.99) Egypt (5.83) Turks and Caicos Islands (5.18) Nepal (5.15) Samoa (4.89) Djibouti (4.48) Sierra Leone (4.01) Saint Martin (French Part) (3.28) Cameroon (3.11) British Virgin Islands (3.04) Burkina Faso (2.69) United Republic of Tanzania (2.67) Togo (2.61) Mauritius (2.6) Gambia (2.53) Antigua and Barbuda (1.99) Guinea (1.98) Japan (1.91) Niger (1.82) Saint Lucia (1.7) Guatemala (1.53) Angola (1.51) Curaçao (1.5) Kyrgyzstan (1.45) ODA in $ per capita (2010–2019 average) Countries by rank of mortality in deaths/missing persons per 100,000 population Source: UNDRR analysis based on OECD.Stat (OECD, 2021a) and SFM (UNDRR, 2021c) 39 0 0.5 1 1.5 2 2.5 Philippines (8.4) Bangladesh (8.2) Myanmar (7.8) India (7.7) Indonesia (7.7) China (7.5) Pakistan (7.4) Viet Nam (7.4) Peru (7.1) Haiti (7) Somalia (6.9) Ecuador (6.9) Afghanistan (6.7) Mexico (6.7) Colombia (6.7) Iran (Islamic Republic of) (6.7) Guatemala (6.7) Dominican Republic (6.7) Papua New Guinea (6.7) El Salvador (6.6) Nicaragua (6.6) Honduras (6.5) Albania (6.3) Venezuela (Bolivarian Republic of) (6.2) Madagascar (6.2) Rank of INFORM Natural Hazard Risk Index (average 2013–2019) ODA in $ per capita (2010–2019 average) Figure 2.36. ODA for prevention and preparedness received by countries with the highest level of Natural Hazard Risk Index, 2010–2019 average Source: UNDRR analysis based on INFORM Natural Hazard Risk Index (European Commission, 2021) and OECD.Stat (OECD, 2021a) 40 having a multi-hazard early warning system in place. According to countries’ self-scoring against the SFM reporting criteria, around 30% of the reported early warning systems have moderate to low coverage and effectiveness. Some 50% have moderate and substantial levels of coverage and effectiveness, and 20% are considered as fully effective (Figure 2.37). 2.3 Ways forward Member States and their partners have made significant achievements in risk reduction since the adoption of the Sendai Framework in 2015. However, despite discernible progress, the world is off track to reach the goal of the Sendai Framework by 2030. This is further complicated by the significant gap between reported risk, perceived risk and action to reduce risk, as evidenced by perception surveys, policy prioritization and funding. Risk aggravates and is aggravated by multiple socioeconomic factors such as poverty, economic inequality, gender inequality, urbanization, conflict and fragility, and human development choices that are pushing planetary boundaries further. Ecosystem degradation is a major driver of disaster risk and a key component of vulnerability to disasters. Information on the trends and costs of disasters do not reveal the full picture of how disasters affect people’s lives, livelihoods and well-being, although it is useful for stocktaking and future planning. One dollar in losses does not mean the same thing to a rich person as to a poor person, and the severity of a $170 billion loss depends on who experiences it and in which country. The same loss affects people below the poverty line far more because they rely on fewer assets, their consumption is at subsistence level, they cannot rely on savings to smooth the impacts, their health and education are at greater risk, and they may need more time and resources to recover and rebuild. They are also less likely to be adequately covered by social assistance or insurance programmes that can reimburse at least part of their losses. The climate emergency, the COVID-19 pandemic and other systemic risks further threaten global progress towards achievement of the key global commitments to 2030. Transformative action is therefore required to accelerate investment in risk reduction and sustainable development. 0 2 4 6 8 10 12 14 Comprehensive achievement (up to 1) Substantial achievement (up to 0.75) Moderate achievement (up to 0.50) Limited achievement (up to 0.25) No hazard information available (0) 7 13 5 6 5 Number of countries Figure 2.37. Countries with available multi-hazard early warning systems, by score Source: UNDRR analysis based on DesInventar (UNDRR, 2021d) and SFM (UNDRR, 2021c) 41 3. Systemic risk as a challenge to sustainable development Disasters, climate change and their systemic impacts can undermine all three pillars of sustainable development: social, environmental and economic. As evidenced by the COVID-19 pandemic, this is occurring more rapidly and more unpredictably than anticipated, across multiple sectors, dimensions and scales. With only 8  years left to achieve the 2030 Agenda and the Sendai Framework targets, progress is not occurring at the pace and scale required. Progress to achieve the Paris Agreement goal to limit global warming to well below 2°C, and preferably to 1.5°C above preindustrial levels, is also not on track. A failure to meet the Paris Agreement goal will lead to further increases in the intensity and frequency of climatic hazard events, and the compounding and cascading disasters they cause. Managing risk in all its dimensions – hazard, exposure and vulnerability – and strengthening resilience to shocks and systemic crises is an end in itself and also a critical means of achieving sustainable development. This chapter highlights how investing in risk reduction can accelerate progress towards achieving global climate and sustainable development targets, and also how unsustainable development pathways lead to greater systemic risk. Development is not merely set back by disasters, it is also an essential factor in the creation of risk. Development that is not sustainable exacerbates existing risk and creates conditions for the emergence of new risk. This includes overexploitation of the environment and the building of cities and critical infrastructure that are not resilient. It is estimated that $94  trillion will be invested in infrastructure globally in the next 25  years to sustain economic growth (Global Infrastructure Hub, 2021). This enormous collective effort to improve human development outcomes must be risk informed, as must wider development efforts. Newly developed physical and social infrastructure that is unsafe or risk blind may be exposed to natural hazards, shocks and stresses that cause severe consequences for people and economic activity. Likewise, degraded physical infrastructure, such as communications, electricity and train systems, can also create direct and systemic risk because these are essential networks. Disruptions to such infrastructure can lead to wider system failures and cascading impacts if they fail during a disaster. This chapter examines statistical data on the interactions among SDGs from the perspective of risk reduction. Many SDGs and their domains are mutually reinforcing, leading to synergies and complementarities in policy outcomes. Truly sustainable development occurs when a combination of systems come together to increase well-being across the domains of people, planet and prosperity. When this is not the case, systemic risk occurs, and the likelihood of disasters increases. Global progress towards the 2030 Agenda crucially depends on nations and the international 42 community’s ability to recognize key interlinkages, maximize the synergies and address tensions to avoid trade-offs across the systems that underpin sustainable development. 3.1 Risky business – the intersection of risk and sustainable development There are significant interactions among SDGs that have positive synergies. For example, targets related to DRR under SDG  1 can have mutually reinforcing effects on public health (SDG  3), infrastructure (SDG  9), sustainable communities (SDG 11) and climate action (SDG 13). Policymakers and development practitioners are increasingly taking action to create pathways to reinforce these synergies. For example, the emerging WHO Health Emergency and Disaster Risk Management Framework emphasizes interdisciplinary, cross-sectoral, comprehensive and systematic management of health-related disaster risks. It also highlights the synergy between development and risk reduction goals (Chan et al., 2022). A number of the figures below look at SDG data series and indicators to point to functional relations that underpin progress towards achievement of the SDGs. Interactions can be either positive, where progress in one area is associated with progress in another (classified as synergies) or negative, where progress in one goal is accompanied by deterioration in another (referred to as trade-offs). The analysis was performed using the official Global Sustainable Development Goal Indicators Database (UN DESA, 2021), which collates reported country data for the 2000–2020 period, and examines SDG interactions over multiple dimensions of disaggregation: gender, geography, country income group and others. Only statistically significant correlations are presented. The data set is not complete across all countries (as discussed in Chapter  4). The figures below are therefore presented as indicative correlations, suggesting the need for further discussion, but also for greater investment in data quality and accessibility to further refine results. 3.1.1 Disaster risk reduction as a means to sustainable development Risk reduction and disaster preparedness and planning can lead to positive outcomes for poverty reduction and vice versa. High levels of vulnerability and large numbers of persons directly affected by disasters may be causes and consequences of poverty. If disaster risk and poverty reduction strategies go hand in hand, positive outcomes can be accelerated on both fronts. Statistical analysis of SDG data shows a strong relationship between poverty (proportion of population below the international poverty line) and the number of people affected by disasters. This is illustrated most clearly when comparing a high-income and a low-income region. Figure 3.1 highlights the disparities between the region of Europe and North America and the subregion of sub-Saharan Africa in terms of the relationship between poverty and direct economic loss attributed to disasters. Figure 3.1. Relationship between persons affected by disasters and poverty, Europe and North America compared with sub-Saharan Africa, 2021 Source: UN DESA analysis based on Global Sustainable Development Goal Indicators Database (UN DESA, 2021) SDG indicator 1.5.1 Number of people affected by disaster (number) SDG indicator 1.1.1 Proportion of people below international poverty line (%) Region Europe and North America Sub-Saharan Africa 43 The data demonstrates that in sub-Saharan Africa higher rates of poverty are correlated with higher levels of economic loss from disasters; the converse is true in Europe and North America (although it has a weaker correlation).4 Statistical analysis of available SDG data also highlights a significant and positive statistical association between the number of countries that adopt local DRR strategies (SDG indicator  13.1.3 / Sendai Framework Target  E) and the share of people living below the international poverty line (SDG indicator  1.1.1). While not suggesting a direct causal relationship between the existence of the strategies and reduced poverty, adoption of DRR strategies may be considered a proxy for a country’s wider investment in risk reduction. In this sense, the correlation observed between success in these two policy objectives (Figure  3.2) highlights the likelihood that DRR and poverty alleviation are mutually reinforcing approaches. 4 Analysis of SDG data in this chapter uses data sourced from the Global Sustainable Development Goal Indicators Database (UN DESA, 2021); this data also includes data on the corresponding Sendai Framework Targets A–E, which are reported as indicators under SDGs 1, 11 and 13, as part of the common reporting framework between the 2030 Agenda and the Sendai Framework. It is not only economic wealth that is vulnerable to disasters, but the overall economic growth rate. Disasters cause direct losses but can also bring about major economic slowdowns. There is a statistically significant correlation between direct economic loss from disasters (SDG indicator 1.5.2 / Sendai Framework Target C) and the annual growth rate of real GDP per capita (SDG indicator  8.1.1) in least developed countries. As economic loss increases, GDP growth slows (Figure  3.3). In a context of growing disaster occurrence and impact, global economic growth is at risk. At the same time as people are lifted out of poverty and the global middle class grows, the volume of accumulated wealth that is at risk of being lost to disasters increases. Figure  3.4 shows this relationship based on global SDG data analysis. As poverty is reduced and more people have more to lose, the economic value of disaster losses increases, so economic development remains highly vulnerable to disaster risk (Figure 3.4). Number of local governments that adopt and implement local DRR strategies in line with national strategies Proportion of population below international poverty line (%) 0 10 20 30 40 50 60 70 2005 2007 2008 2009 2010 2011 2012 2013 2014 2015 2016 2017 2018 2019 2006 80 90 0 5 10 15 20 25 SDG indicator 13.1.3 Local governments that adopt and implement local DRR strategies in line with national strategies SDG indicator 1.1.1 Proportion of population below international poverty line (%) Figure 3.2. Relationship between poverty and adoption of local DRR strategies, 2005–2019 Source: UNDRR analysis based on Global Sustainable Development Goal Indicators Database (UN DESA, 2021) 44 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015 2016 2017 2018 2019 SDG indicator 1.5.2 Direct economic loss attributed to disasters (current $ in million) SDG indicator 8.1.1 Annual growth rate of real GDP per capita (%), least developed countries only Direct economic loss attributed to disasters (current $ in million) Annual growth rate of real GDP per capita (%), least developed countries only 0 10,000 20,000 30,000 40,000 50,000 60,000 70,000 80,000 90,000 100,000 0 1 2 3 4 5 6 7 8 9 10 Figure 3.3. Relationship between direct economic loss, and annual growth rate in least developed countries, 2005–2019 Source: UNDRR analysis based on Global Sustainable Development Goal Indicators Database (UN DESA, 2021) 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015 2016 2017 2018 2019 SDG indicator 1.5.2 Direct economic loss attributed to disasters (current $ in million) SDG indicator 1.1.1 Proportion of population below international poverty line (%) Direct economic loss attributed to disasters (current $ in million) Proportion of population below international poverty line (%) 0 10,000 20,000 30,000 40,000 50,000 60,000 70,000 80,000 90,000 100,000 0 5 10 15 20 25 Source: UNDRR analysis based on Global Sustainable Development Goal Indicators Database (UN DESA, 2021) Figure 3.4. Relationship between poverty and direct economic loss attributed to disasters at the global level, 2005–2019 45 Figure 3.4 captures the global trend from 2005 to 2019 in poverty decreasing, while economic loss from disasters is increasing. But this trend is not true for all countries. Figure 3.5 shows that if only global averages are used, enormous variation among countries can become invisible. It is therefore important to look at the global, regional and country levels to understand the relationship between economic losses from disasters and poverty in each context. Figure 3.5. Relationship between poverty and economic loss from disasters over time, 2000–2010 and 2011–2020 Note: Each point on the graph represents a data point for a single country. Blue points plot each country’s average direct economic losses attributable to disasters over the decade 2000–2010, plotted against the country’s average proportion of people living below the international poverty line in the same period. Orange points show the same data for each country from 2011 to 2020. The straight lines show the correlations between the global averages for the same two decades. These level out rather than reflect the enormous variation among countries. Source: UN DESA analysis based on Global Sustainable Development Goal Indicators Database (UN DESA, 2021) Economic growth can also have a negative impact on risk reduction and climate change adaptation efforts. Although there are synergies between development and risk reduction, tensions can arise from the unintended consequences or unevenly distributed impacts of a particular development pathway. Such tensions may impede long-term adaptation or lead to maladaptation, which refers to “action taken ostensibly to avoid or reduce vulnerability to climate change that impacts adversely on, or increases the vulnerability of other systems, sectors or social groups” (Barnett and O’Neill, 2010). Planned changes that do not address structural vulnerabilities may improve resilience in one area, but increase susceptibility in another, or produce results with uneven benefits (Lo, 2022). Poverty reduction has historically been associated with increasing demand for fossil fuel energy as economies developed around the world. It is now understood this created a negative feedback loop that led to global warming. A continued reliance on fossil fuels undermines achievement of the Paris Agreement and increases risk from climate change. Transforming energy consumption into reliance on renewable energy sources is central to the sustainability of future economic growth, development and ecosystem stabilization. A proxy for use of fossil fuel energy is the share of renewable energy as a proportion of all energy used (SDG indicator 7.2.1). Figure 3.6 shows that as countries consume more fossil fuels, the percentage of total energy consumption provided from renewable sources is also decreasing in many contexts. A rapid scale-up of targeted investment in smart solutions for energy supply is imperative to meet higher demands without environmental costs that put pressure on planetary boundaries. As some of the poorest parts of the world have some of the highest renewable energy potential, using this potential could also help reduce poverty, hence turning this tension into a synergy. 3.1.2 Reconciling poverty alleviation and sustainable consumption While poverty reduction is the aim of the first SDG and a fundamental principle of sustainable development, natural resources must be used and managed in a way that maintains economic productivity and production of goods and services. However, SDG data shows the progress made in lifting millions of people out of poverty through development has also come with increasing demands for consumption. Time period 2000–2010 2011–2020 SDG indicator 1.5.2 Direct economic loss attributed to disasters (current United States $) SDG indicator 1.1.1 Proportion of people below international poverty line (%) 46 For example, progress towards poverty eradication (SDG  1) has also seen those same development processes increase the global material consumption footprint per capita (Figure  3.7). The relationship between poverty alleviation and responsible consumption and production (SDG  12) is therefore an important one, especially on a global scale in relation to reducing inequalities within and among countries (SDG 10). The environmental consequences of developmentinduced change include the modification of the physio-chemical composition of the atmosphere (leading to climate change and climate variability), soil degradation, ecosystem decline, biodiversity loss, pollution and global dissemination of invasive species. These changes are exacerbating disaster risk and climate change and generating new risks for human societies and systems. For example, deforested slopes can reduce water retention in 15.6 2005 2010 2015 2019 SDG indicator 7.2.1 Renewable energy share in the total final energy consumption (%) SDG indicator 1.1.1 Proportion of population below international poverty line (%) 15.8 16.0 16.2 16.4 16.6 16.8 16.8 17.0 17.2 15.4 0 25 20 15 10 5 Renewable energy share in the total final energy consumption (%) Proportion of population below international poverty line (%) Figure 3.6. Relationship between poverty reduction and share of renewable energy at the global level, 2005–2019 Source: UNDRR analysis based on Global Sustainable Development Goal Indicators Database (UN DESA, 2021) Figure 3.7. Relationship between poverty and material footprint per capita at the global level, 2000–2017 Source: UNDRR analysis based on Global Sustainable Development Goal Indicators Database (UN DESA, 2021) 2000 2001 2002 2004 2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015 2016 2017 SDG indicator 8.4.1 Material footprint per capita, by type of raw material (tonnes) SDG indicator 1.1.1 Proportion of population below international poverty line (%) Material footprint per capita, by type of raw material (tonnes) Proportion of population below international poverty line (%) 0 2 4 6 8 10 12 14 0 5 10 15 20 25 30 47 catchments, and can cause more landslides, silting and flooding, while destruction or reclaiming of wetlands can worsen flooding. The degradation of ecosystems such as forests, wetlands, and coastal and marine systems, and drylands is also a specific driver of vulnerability to disasters. It can severely compromise the wellbeing, income and food security of the farmers, fishers, forest users and pastoralists whose livelihoods depend directly on these ecosystems. However, improved ecosystem management can prevent and reduce the impacts of disasters on vulnerable communities and countries. Ecosystem-based or nature-based solutions can reduce disaster risk and provide co-benefits from ecosystem services, which contribute to livelihoods and also build local resilience to disasters and climate change. For example, “sponge cities” in China aim to design urban development to allow for seasonal flooding of wetlands and to encourage nature-based flood reduction solutions (Wong, 2021). If developed and developing economies continue to grow based on unsustainable consumption patterns and non-renewable energy sources, increases in economic prosperity that support poverty alleviation will be in tension with other systems, including those for reducing disaster risk, halting global warming and staying within environmental and biodiversity planetary boundaries. 3.1.3 Disaster risk reduction and sustainable development within planetary boundaries Most SDGs and the Paris Agreement, in some way, return to questions of sustainable consumption (Figure 3.8). Yet, world consumption of material per capita is steadily increasing with industrialization and development. The human material and ecological footprint is accelerating the rate of change. A potential impact when systemic risks become cascading disasters is that systems are at risk of collapse. tonne 2 12 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015 2016 2017 1 8 10 6 4 0 Figure 3.8. Global consumption – material footprint per capita (tonnes), 2000–2017 Source: UNDRR analysis based on Global Sustainable Development Goal Indicators Database, SDG indicator 12.2.1 (UN DESA, 2021) 48 In addition to the direct human costs, disasters can also have environmental impacts on a massive scale. Biodiversity and ecosystems are highly vulnerable to the impacts of natural hazards, industrial pollution, failures in infrastructure such as dams and levees, introduced plants and animals, and climate change. Tropical storms can greatly upset the natural ecosystem, disrupting coastal fish, insect, bird and mammal habitats, particularly when water quality is affected when sewage facilities flood or debris enters reservoirs and waterways. Wildfires, floods and drought can completely defoliate forests and cause structural changes to ecosystems. Wildlife and endangered species can be killed by the force of hazards or affected indirectly through changes in habitat and food availability. Beaches move and change shape due to storm surges. River banks erode during flash-flood events. The list of potential impacts is long. The degradation of forest ecosystems due to overexploitation and deforestation, and their exposure to destructive forces such as wildfires and invasive species, are further exacerbating vulnerabilities around the world. This is particularly bad news for climate change. Deforestation accounts for nearly 20% of global carbon emissions through clearing, overuse or degradation of trees. However, healthy forests act as carbon sinks, absorbing and storing about 1/10 of the projected annual global carbon emissions into their biomass, soils and products. The combined absorption capacity of the world’s forests is estimated at 2.4 billion tonnes of carbon dioxide per year, which is equivalent to a third of the carbon dioxide released from burning fossil fuels (FAO, 2021b). Forests are also essential as water catchments and natural water purifiers, for water security and biodiversity, especially in the face of longer droughts and rising average temperatures. SDG data demonstrates the positive association between growing disaster occurrence and the ensuing rise in economic impact (SDG indicator  1.5.2 / Sendai Framework Target  C) with the observed steady decrease in global forest coverage (SDG indicator 15.1.1) (Figure 3.9). Figure 3.9. Relationship between direct economic loss attributed to disasters and global forest cover, 2015–2019 Source: UNDRR analysis based on Global Sustainable Development Goal Indicators Database (UN DESA, 2021) - 20,000 30,000 40,000 50,000 60,000 70,000 2015 2016 2017 2018 2019 4,050,000 4,055,000 4,090,000 4,060,000 4,065,000 4,070,000 4,085,000 4,080,000 4,075,000 10,000 80,000 90,000 100,000 SDG indicator 1.5.2 Direct economic loss attributed to disasters (current $ in million) SDG indicator 15.1.1 Forest area (thousands of hectares) Direct economic loss attributed to disasters (current $ in million) Forest area (thousands of hectares) 49 Human well-being depends on ecosystems that provide multiple livelihood benefits and, ultimately, all human life-support systems. Maintaining healthy ecosystems also plays an important direct role in reducing the overall vulnerability of communities to disasters, in terms of limiting their physical exposure to natural hazards and in providing them with the livelihood resources to withstand and recover from crises. The degradation of ecosystems and their exposure to destructive forces, such as wildfires, floods, drought and invasive species, are exacerbating vulnerabilities around the world. Disasters have a strong negative association with biodiversity. Direct economic loss from disasters is increasing (SDG indicator  1.5.2 / Sendai Framework Target  C) as the rate of biodiversity loss is accelerating and species extinction is intensifying, as captured by the Red List Index (SDG indicator  15.5.1) (IUCN, 2021). The International Union for Conservation of Nature Red List of Threatened Species is an indicator of the changing state of global biodiversity (Figure 3.10). One way to envision the long-term and systemic impacts and limits of the current model of economic growth and development is the concept of “planetary boundaries”, developed through the Stockholm Resilience Centre in 2009. It provides a “sciencebased analysis of the risk that human perturbations will destabilize the Earth system at the planetary scale” (Steffen et al., 2015). Figure 3.11 illustrates how far existing development has moved across and beyond certain tipping points (Cernev, 2022; Stockholm Resilience Centre, 2022). Figure 3.11 indicates that land system change and climate change have exceeded the “safe operating space” for the Earth system and are in the zone of uncertainty with increasing risk. Biochemical flows and “novel entities” (new engineered chemicals, materials or organisms and natural elements mobilized by human activity such as heavy metals) have far exceeded the safe operating space (Steffen et al., 2015). Recent analysis concludes that humanity is currently operating outside the planetary boundary for novel entities (Persson et al., Figure 3.10. Relationship between direct economic loss attributed to disasters and threatened species, 2005–2019 Source: UNDRR analysis based on Global Sustainable Development Goal Indicators Database (UN DESA, 2021) - 20,000 30,000 40,000 50,000 60,000 70,000 0.70 0.71 0.78 0.72 0.73 0.74 0.77 0.76 0.75 10,000 80,000 90,000 100,000 0.79 2005 2007 2008 2009 2010 2011 2012 2013 2014 2015 2016 2017 2018 2019 2006 SDG indicator 1.5.2 Direct economic loss attributed to disasters (current $ in million) SDG indicator 15.5.1 Red List of Threatened Species Direct economic loss attributed to disasters (current $ in million) Red List Index 50 2022). Some areas remain within the safe operating space: freshwater use, ozone depletion and ocean acidification. Some are not yet quantified, such as atmospheric aerosol loading and biosphere integrity overall, although species extinction is already close to the planetary boundary. When global collapse risk is analysed according to the nine planetary boundaries, scenarios that consider achievement of the SDGs and the Sendai Framework goal within the concept of planetary boundaries show a dangerous tendency for the world to move towards a global collapse scenario (Cernev, 2022) (Figure 3.12). At a local level, development planning is made up of many small and large decisions in particular circumstances, and the challenge is to engage with those decisions in the context of known planetary boundaries as well as with a risk reduction frame of mind (e.g. Box 3.1 and Figure 3.13). LAND-SYSTEM CHANGE FRESHWATER USE OCEAN ACIDIFICATION STRATOSPHERIC OZONE DEPLETION ATMOSPHERIC AEROSL LOADING (Not yet quantified) CLIMATE CHANGE BIOSPHERE INTEGRITY BII (Not yet quantified) BIOGEOCHEMICAL FLOWS P N E/MSY NOVEL ENTITIES Increasing risk Safe operating space Figure 3.11. Planetary boundaries Note: BII = biosphere integrity; E/MSY = extinctions per million species per year; N = nitrogen; P = phosphorous. Source: Designed by Azote for Stockholm Resilience Centre (2022), based on analysis in Persson et al. (2022) and Steffen et al. (2015) 51 Sustainable and risk-aware development pathways can prevent the creation of risk, but the challenge is how to make that happen in the everyday decisions of communities and policymakers. Information such as the dynamic modelling used in Zambia is a valuable tool (Box 3.1). But modelling tools need decision makers who understand their uses and their limitations; the decision-making process itself also needs to be investigated critically. There are also significant regional variations in how the relationship between disaster risk and development is understood and governed, and key risk drivers such as inequality may fall between the two, as illustrated during the COVID-19 pandemic in Latin America and the Caribbean (Lucatello and Alcántara-Ayala, 2022). 3.2 Ways forward Sustainable development requires a risk-informed approach that considers SDG interdependencies, synergies and tensions to devise effective, efficient and coherent development pathways to guide policy Figure 3.12. Planetary boundaries and global collapse risk scenarios Note: GCR = global collapse risk. Source: Cernev (2022) HIGH-RISK WORLD LOW RISK WORLD WITHIN LIMITS THE TIP EARTH UNDER UNCERTAINTY Planetary boundaries have not been extensively crossed High risk of GCR events GCR events have potentially occurred/are occurring Global targets are in danger STABLE EARTH Planetary boundaries have not been extensively crossed Successful policy implementation Low risk of GCR events Need for implementation of preventative policy EARTH UNDER THREAT Planetary boundaries have been extensively crossed Low risk of GCR events; however, increasing due to planetary boundaries being crossed Global target achievement in danger GLOBAL COLLAPSE Planetary boundaries have been extensively crossed High risk of GCR events GCR events have potentially occurred/are occurring Global targets have not been achieved implementation. While disasters can hold back progress in achieving SDGs by 2030, targeted and evidence-based risk reduction can also bring the world closer to achieving them, along with the Sendai Framework and Paris Agreement commitments. Overall, risk reduction should be recognized as a central dimension of sustainable development. Riskproofing development policy can ensure disasters do not derail development progress and development does not inadvertently create new risks. Although, historically, economic development has been highly beneficial to human health, life expectancy and living standards, the pressures of population growth, increased consumption of natural resources and industrialization are producing ever greater negative impacts on environmental systems. Current development pathways need to be adjusted. If progress towards poverty reduction is to be sustainable, the global material footprint per capita needs to reduce. To foster sustainable development for all, there is a need for countries to consider how energy and products are produced and consumed, so that sustainable development and climate change targets can be achieved at a global scale. The current negative trends in environmental health are closely associated with disaster risk. Sustainable development pathways need to be premised on more sustainable consumption patterns that guarantee the provision of basic needs for the poor, while avoiding those unsustainable actions that are hazardous to the environment, and which are inefficient and contribute to systemic risk. While it can be difficult to garner public support for DRR investment in the face of other competing development priorities, techniques to model and evaluate policies and their wider systemic impacts are emerging. Later chapters therefore focus on moving towards a greater understanding of what needs to be valued, and how this can be done to better manage systemic risk. 52 Box 3.1. Using dynamic macroeconomic modelling projection techniques to make the case for DRR investment, Zambia In Zambia, a flood exposure reduction project was planned, involving land-use restriction and planned relocation from an area of land that was highly productive but very exposed to floods. Implementation of the DRR policy assumed that annually 8% of capital stock located in the exposed area would be relocated to a safer area, in addition to the restriction of all future development in the exposed area. The plan was evaluated using a framework to model macroeconomic co-benefits of the DRR investment over time – a Dynamic Model of Multi-hazard Mitigation CoBenefits. This indicated that, under the planned scenario, the annual average GDP growth would remain nearly constant at approximately 3%; an initial decline would be followed by an increase, and the loss would be cancelled out over 30 years. Further analysis showed that, over time, improved protection against floods through land-use restriction would foster investment in the safer area. Figure 3.13. Predicted total growth effect of restricting use of exposed land over 30 years (Zambia) Note: CPEE = co-benefit production expansion effect; figure shows Decomposition of Total Growth Effect (TGE) of exposure management (TGE = PDME + ARRE + CPEE) Source: Yokomatsu et al. (2022) 0.00 Indirect benefit effect ($ billion) 0.01 0.02 0 10 20 30 Years Ex-ante Risk Reduction Effect (ARRE) Ex-post Damage Mitigation Effect (PDME) Type of effect Total Growth Effect (TGE) ZAMBIA 53 4. How human choices drive vulnerability, exposure and disaster risk Disasters are not natural. They occur due to human choices and a lack of risk reduction. When disaster impacts cascade from one system or sector to another, as with systemic risks, pre-existing inequality and vulnerabilities amplify negative impacts. Even though experts cannot be certain about the exact timing, location and magnitude of a hazard event, they can be certain that those most affected will be communities living in unsafe conditions, such as in poorly built housing or in areas with substandard infrastructure. Disaster risk develops over time, due to complex interactions between the human and natural spheres. A disaster is not something that should be thought of as an isolated event in a particular moment (Cutter et al., 2015; Hagenlocher et al., 2020). Risk from hazards is being amplified by human interventions in nature. However, these changes tend to be confused with, or misinterpreted as, natural extreme events (IPCC, 2012, 2021a). For example, variability in rainfall is increasingly leading to drought in areas where human water-use practices are unsustainable. And human action is also creating some hazards such as air pollution (Lavell and Maskrey, 2014). To explore why current risk reduction efforts are insufficient, this chapter looks at the human actions that lead to increased disaster vulnerability and exposure. It highlights how social inequality and the decision-making processes of individuals and institutions create and amplify vulnerability and exposure, and therefore disaster and climate risk. It goes on to suggest actions such as stepping up “forensic” analysis of disasters, working across sectoral silos to identify weak points in system resilience and engaging communities to determine solutions, to help accelerate risk reduction action. 4.1 Systemic risk is increasing due to human actions Fuego Volcano in Guatemala erupted on 3  June  2018, causing 461 deaths and affecting over 1.7  million people (CRED, 2021). This event heightened international, regional and national awareness of advances in predicting volcanic hazards. Population growth and demographic shifts in the urban and peri-urban areas around the volcano heightened exposure to the eruption. Many of those who lost their lives were people from lower-income households who had recently moved into the area, and who were living in informal settlements in unsafe locations (World Bank, 2018a). Although government authorities in Guatemala had responsibility for scientific evidence and the communication and management of volcanic risk, private businesses and local communities played an essential role in early warning. For example, 54 owing to good information access and prior awareness, staff in a local resort and farm helped evacuate guests, personnel and local residents to safe locations (World Bank, 2018a, 2018b). This demonstrated there was sufficient advance warning for those who had access to information, and also the understanding and means to act on upon it. However, this was not the case for a significant portion of the area’s population. The exposure of populations and infrastructure to hazards has increased significantly over recent decades, most notably due to urbanization and unsustainable development in hazard-prone areas. Globalization, urbanization and an increasingly interconnected world are also increasing the likelihood of disaster impacts cascading across systems (Gousse-Lessard et al., 2022). Pre-existing risk and resilience factors affect the initial impacts of disasters and the way these impacts cascade (Figure 4.1). Hazard events that once might have caused localized impacts can now have cascading and even global impacts. For example, when severe flooding affected 66 of the 77 provinces of Thailand in 2011, the flooded area around Bangkok included industrial estates where production plants were highly concentrated (World Bank, 2012). Although this delta is naturally susceptible to flooding, government incentives encouraged industrial development, as the area had infrastructure and easy access to consumers and suppliers (Chongvilaivan, 2012). In this case, the higher level of exposure of private sector assets was one reason that 70% of the total damage and loss from the floods was in manufacturing. This then had cascading impacts on the wider economy, as manufacturing accounted for almost 40% of the country’s GDP at that time (World Bank, 2012). The Bangkok floods had a global ripple effect, significantly affecting supply chains as far away as Japan and the United States. This local flood ended up having systemic impacts across countries, regions and economic sectors. Key manufacturing sectors such as the automobile, electronics and electrical appliances industries experienced abrupt declines in production and exports (Chongvilaivan, 2012). Components manufactured in Thailand were essential for products finalized in other countries. Failure in any stage of production caused disruption or collapse of the entire production chain. Systems were not designed to be resilient to shocks. The root causes of what caused this flood hazard to become a disaster stemmed from human choices and the structural conditions implicit in a chosen mode of development and growth. These were amplified by political, management and technical choices in how disaster risk is addressed (Figure 4.2). A street is coated in ash after a volcanic eruption, Antigua, Guatemala Credit: © Shutterstock/Zahirul Alwan 55 Figure 4.1. Disaster impact and aftermath cascades are inherently affected by risk and resilience factors Source: Gousse-Lessard et al. (2022), adapted from Shultz et al. (2017) Individual / family context RISK FACTORS Hazards (climate change and variability) Vulnerability (health, social and psychosocial) Exposure (community and individual) Institutional / organizational context Societal / structural context DISASTER INTENSITY AFFECTED POPULATION DISASTER IMPACT RISK FACTORS RESILIENCE FACTORS Community context RESILIENCE FACTORS Support (social, community, financial) Stress management (self-care, coping strategies, proactivity and learning) Meaning (communication, engagement and a sense of community) HAZ A RD(S) VULNE R A BIL TI Y & RISK D VI ERS EXP OSURE DISAST E R RISK ROOT CAUSES Less More Uncertainty Political Technical Management Figure 4.2. Levels of uncertainty in disaster risk and its management Credit: Mandira Shrestha / International Centre for Integrated Mountain Development, Kathmandu Focus group discussion on an early warning system in Kathmandu, Nepal Source: Wisner and Alcántara-Ayala (forthcoming) 56 4.1.1 Inequality, poverty, discrimination and environmental degradation drive risk An individual’s gender role or identity, race, disability, age, migration status and health conditions contribute to their unique vulnerability. All people play multiple roles in society, for example as parents, workers and members of social or demographic groups. Each of these roles brings with it capacities and vulnerabilities, and these identities intersect. This creates challenges for disaster risk policy formulation, which therefore cannot be based on a “one size fits all” approach (Chaplin et al., 2019). Factors such as socioeconomic disadvantages, differences in language and culture, and geographical isolation increase disaster risk (e.g. Box  4.1). Pre-existing mental or physical illness, lack of coping capacity, poor social networks, urban density, socioeconomic status, marginalization and gender inequality are among the risk factors that often intersect and increase vulnerability in disasters (NCCMH, 2005; Few, 2007; Neumayer and Plümper, 2007; Cutter and Finch, 2008; Haskett et al., 2008). The longest-lasting detrimental impacts of a disaster may be from indirect consequences. For example, school closures have been an indirect consequence of the COVID-19 pandemic. Schooling became impossible for half of the Asia and Pacific regions during 2020 who lacked access to the Internet, and the loss of household income made education unaffordable for many families. This especially affected girls’ education as one in five girls reported having increased domestic responsibilities in 2020 (Nguyen, 2021). Examples of other cascading impacts associated with disasters include increases in drug addiction, domestic violence and suicide (Cuthbertson et al., 2022). Vulnerability cannot be fully eliminated, so understanding it is essential for effective policymaking. Vulnerability should not be seen as a stigma or personal deficit of some people, but instead as an unevenly distributed and societally co-created characteristic present in all people. Policymaking can therefore be seen as granting a fairer distribution of vulnerability as part of more equitable governance (Gabel et al., 2022). 4.1.2 Human choices affect the severity of both intensive and extensive risk Small, recurring extensive disasters far outnumber intensive disasters, and their cumulative impact can be much higher (IFRC, 2020). Hazards such as seasonal flooding tend to recur in the same localities repeatedly, often amplifying existing situations of vulnerability, particularly among impoverished Box 4.1. Reaching vulnerable populations in Nepal with flood risk communication Nepal has implemented flood early warning systems and made significant progress in monitoring and forecasting floods. This has resulted in a reduction in the annual number of deaths due to flooding. The Department of Hydrology and Meteorology issues flood warnings based on real-time rainfall and water-level monitoring, including flood forecast information from various models. However, recent research has highlighted the need to tailor flood risk communication to take account of different social, economic and political factors. For example, consultation with the stakeholders of Ratu River indicated women and marginalized people in the area were less likely to receive information and be engaged in preparedness and evacuation activities. The research suggested warning messages and communication materials need to be co-designed with communities and tailored to meet the diverse needs of different users. Source: Shrestha et al. (2021) 57 or disadvantaged communities. Consultations undertaken by the Global Network of Civil Society Organisations for Disaster Reduction with 750 atrisk communities across 50 countries highlighted localized flooding as the single most damaging phenomenon (Chavda et al., 2022) (e.g. Box 4.2). It was also identified as one of the most complex risks to reduce and manage at local level. This is because its impacts are deeply shaped by development decisions, ecosystem exploitation/adaptation, and the different vulnerabilities and exposure within and among communities (Chavda et al., 2022). Skewed development priorities, climate change, fragile governance and environmental degradation are extending the footprint of extensive disaster risk. Factors such as loss of species and habitats, and trade in wildlife (legal and illegal), have even shaped emergent hazards such as zoonotic diseases that transfer from animals to humans, causing epidemics and pandemics such as COVID-19 (Alcántara-Ayala et al., 2021). 4.2 Understanding the root causes of vulnerability is essential Social science provides critical insights into the root causes and drivers of vulnerability that can help policymakers make decisions about how to manage systemic disaster risk. Taking a forensic approach to look at the root causes and drivers of risk can help identify and understand how best it can be addressed. For example, the Fuego Volcano disaster outlined in section  4.1 above was analysed from a forensic investigations of disasters perspective to examine what proportion of the damage and human loss was avoidable and what were the inherent consequences of this sudden and explosive eruption. About 54,000 people lived within a 10  km radius of Fuego Volcano, and more than 1  million within a 30  km radius. Analysis of the disaster unveiled a series of factors and processes that led to the materialization of a socially constructed disaster. Human choices resulted in increased vulnerability Box 4.2. Extensive risk for remote communities in the Lao People’s Democratic Republic In the Lao People’s Democratic Republic, the most remote rural communities are the poorest, many are minority ethnic groups, and they have difficulty accessing health services and education, thus limiting their opportunities in work and livelihoods. They also have higher rates of disability than national averages, due to injuries from war and unexploded ordnance (mainly men) and the effects of disease (mainly women), which is highly stigmatized and severely affects their ability to access education and work, especially women and girls with a disability (Holzaepfel et al., 2018; Government of the Lao People’s Democratic Republic, 2020). These social and economic disadvantages underpin the further impoverishment of many of these communities caused by frequent seasonal flooding, which has worsened in recent decades due to changes in rainfall patterns and to increased exposure with new settlements. Government and non-governmental organization efforts to enhance the prospects of these communities focus on the underlying socioeconomic vulnerabilities of their situation, aiming to increase their opportunities to exercise resilience through improved livelihoods as well as to address the physical aspects of flood management (Government of the Lao People’s Democratic Republic, 2018, 2021). 58 and exposure to the volcanic hazard, and the impacts were systemic. Governance systems and socioeconomically driven settlement patterns led to impacts being felt across systems and communities. In addition to the significance of the dense and fastmoving pyroclastic lava flow that occurred in Las Lajas ravine, four key elements were identified that contributed to the severity of the impact related to the social construction of risk: 1. The socioeconomic reasons why people had continued to settle in the area of high exposure to the volcanic hazard since the large eruption of 1974. 2. Poor risk communication strategies and lack of coordination between the early warning, response and evacuation procedures among localities. 3. Lack of volcanic hazard knowledge, including sustained volcanic monitoring and support to scientific institutions. 4. Deficient and fragmented information and communication among relevant DRR institutions, local authorities, leaders and the population (World Bank, 2018a). The substantial exposure of a population that had moved into the area due to socioeconomic pressures, despite the threat of the volcano, was a key factor in the Fuego eruption becoming a disaster. Further investment in volcanic instrumentation and monitoring systems and scientific and technological human resources was also needed, but this was not the main factor. Low participation of diverse stakeholders affected the effectiveness of early warning systems. Some early warning, evacuation and response systems did not operate in practice, and risk communication strategies had not been tested (World Bank, 2018a). Understanding vulnerability requires looking across sectors The Fuego Volcano example also highlights that risk management is more efficient if, instead of working from single disciplines and separate perspectives, transdisciplinary approaches are adopted that strengthen the co-production of knowledge and co-management of disaster risk. Such approaches aim to integrate knowledge from different disciplines (including natural and social sciences and humanities) and non-academic stakeholder communities. They allow for a better understanding of the social dimension of the systemic nature of risk (Sandoval et al., 2022). They require working in partnership with multiple actors, including the people affected by DRR and DRM decisions, and engaging in problem-solving, perspective sharing, negotiation, deliberation, knowledge generation, and joint learning and communication (Berkes, 2009). This represents a paradigm shift in research practice, requiring mutual learning, collaboration and exchange within academia, and also effective engagement of non-academic stakeholders (OECD, 2020). Some countries such as Mozambique have already begun to apply transdisciplinary, participatory mechanisms in planning processes (Box 4.3). In addition to transdisciplinary approaches, the forensic investigations of disasters method has been used to identify the underlying risk drivers behind the 2015 flood damage in Artigas, Uruguay (Box 4.4). One of the families displaced by Hurricane Idai in 2019 in Mozambique Credit: United Nations/Eskinder Debebe 59 Box 4.3. Multisectoral and transdisciplinary strategy on internal displacement in Mozambique The National Policy and Strategy for Internal Displacement Management in Mozambique addresses Sendai Framework Target B, to substantially reduce the number of people affected by disasters. The policy covers all forms of displacement within Mozambique, as the country is greatly exposed to climate hazards and has recently faced conflict leading to displacement. Under the policy, the National Institute for Disaster Risk Reduction and Management is responsible for addressing displacement and tasked with ensuring all government ministries and agencies coordinate their actions. The relevant ministries (e.g. education, health and social services) must each fulfil assigned tasks to ensure services to and protection of displaced people. They are required to include these in their yearly programming and budget plans. Mozambique ensured ownership across the government by creating a national-level multisectoral transdisciplinary team to develop the policy. Members of the team visited the resettlement camps, listening to displaced people’s needs and meeting with local-level DRR managers. The media were invited to report on these visits, bringing national attention to the plight of the thousands of displaced people, and resulting in highlevel political commitment to drafting and approving the policy in record time. The policy mandates action once displacement has occurred and, crucially, focuses on prevention, resilience building and finding durable solutions for displaced people. Mozambique is now strengthening capacity to ensure the policy is put into action at the local level. Sources: B. Gualandi, S. Llosa and N. Tivane, personal communications (2021) Box 4.4. Using forensic analysis in 2015 floods in Artigas, Uruguay In northern Uruguay, the cities of Artigas and Bella Union are highly dependent on two rivers for their daily activities, the Cuareim and Uruguay. The economic, social and cultural aspects of development of Artigas Department lie in a fragile balance and coexistence between these cities and the rivers. Furthermore, the river basins cross international borders with Argentina and Brazil. Recent evidence indicates some changes may be occurring in the relationship between the cities and the rivers, some of which are induced by changes in El Niño–Southern Oscillation patterns. One indicator is the increasing trend of flood events such as the 2015 floods. The 2015 floods were so serious that they drew the attention of national media and governmental authorities, changing the debate about how climate change could affect known disaster risks in Uruguay (Verde et al., 2017). A consortium of the National System for Emergencies and international organizations embarked on a forensic analysis. They applied the forensic investigation of flood disasters method (Ramírez and Herrera-Lozano, 2015) to identify the underlying risk drivers behind the disaster, to enhance the analytical capacities of the local government and to define an action plan for reducing future flood impacts. The critical areas for discussion were the following. (a)  How unusual were the 2015 floods? (b)  Which socioeconomic features could explain the concentration and distribution of impacts? (c)  What kind of evidence is available for identifying changes in climate features in the area? 60 4.3 Improving data supports a better understanding of vulnerability and exposure Understanding the diverse dimensions of vulnerability and exposure, and the interdependency across systems, can accelerate the effectiveness of risk reduction. However, doing this requires access to data and analysis. Local vulnerability information is often not available, or coverage is inconsistent. Information on disasters is also often siloed from information on vulnerability. National statistical offices have traditionally produced geospatially enabled population, environmental and economic information at national and subnational scales. However, they have not been involved in producing data related to disasters or disaster risk. Disaster information is usually provided by the institutions devoted to disaster response or civil protection at the national level. At the global level, initiatives undertaken through EM-DAT, DesInventar, SFM, the World Bank and the INFORM Natural Hazard Risk Index provide information or evaluations on the impacts of disasters. Global disaster reporting systems tend to undercount small-scale extensive disasters such as localized flooding. These “silent disasters” are often missed due to under-reporting at national level and thresholds applied in global databases (e.g. economic loss and numbers affected) (IFRC, 2021). For example, looking at historical records of flooding in Uganda, far fewer flooding events were reported in the national DesInventar records compared with in the local media. A much smaller (d)  Which institutional mechanisms are in place for regulating the human influence (urban and agriculture expansion) in the vicinities of the rivers? These questions led the local consultation and resulted in findings and conclusions to inform the department’s planning document: ● Better data and modelling are needed for multinational basin analysis. Although insufficient, the scientific evidence shows changes in the climate features of the river basins, which require further analysis to foresee the new average values in the Cuareim and Uruguay River basins. Argentina, Brazil and Uruguay share the basins; however, cooperation efforts for joint analysis remain unexplored, despite the significant potential this initiative could have for the three countries. ● The socioeconomic context highlighted the relevance of comprehensive social interventions. Impacts and losses were concentrated in low-income areas. Most of the families affected by the 2015 flood lacked stable income sources and did not have options for reallocation without governmental support. Many affected families returned to their homes after the flood, increasing the risk of being affected during the next El Niño–Southern Oscillation episode. Relocation efforts developed in the past failed to install families in a new context with access to labour markets. As a result, most of the families left their new houses and returned to the margins of the rivers. ● Local regulation requires enhanced risk zoning. Governance is at the core of risk reduction initiatives in Artigas. Normative instruments such as the urban plan can issue mandatory zoning to avoid further occupation of areas close to the river margins. Although it is well known that these areas contain most of the flood risk, the urban plan does not restrict occupation in all the areas. Moreover, the local capacity to enforce the plan is low, and families keep moving to the flood-plains. Source: A. Brenes Torres, personal communication (2021) 61 number again was recorded in the global EM-DAT, which uses a threshold that reflects mostly mediumto large-scale intensive events (van den Homberg et al., 2022). The need to involve national statistical offices in the production of geographic and temporally comparable disaster-related statistical series and indicators is increasingly being recognized. Achieving this requires: (a)  inter-agency training and technical assistance capacity; (b)  institutionbuilding expressed through political will; and (c)  sufficient resources for the development of a national system of statistics related to the environment, climate change and disasters (Bello et al., 2021). The wealth of vulnerability data collected as part of tracking the SDGs represents an often untapped resource for accelerating development, and also for increasing disaster risk understanding, with geography being a key foundation to integrate other forms of data (UN-GGIM, 2022). Reporting under the 2030 Agenda (including the Sendai Framework targets) is key to the measurement and monitoring of progress on reducing risk and social vulnerability. The 17 SDGs of the 2030 Agenda are supported by 169 targets and 231 unique indicators that aim to show national and global progress. However, at the midpoint of the race to 2030, there is a significant challenge in the availability of timely, reliable and actionable SDG data (Figure 4.3). There are date gaps in reporting on key SDGs for disaster resilience. For the SDG target on zero hunger (SDG  2), there is approximately 77% of the full reporting data available, and for affordable and clean energy (SDG  7), 89% of data has been provided. However, in areas such as sustainable cities and communities (SDG 11), there is only 20% data available, and for climate action (SDG 13), only 19% of the data. For the goal of no poverty (SDG 1), there is 36% of the nationally reported data, while for gender equality (SDG  5), there is only 20% of the data needed (UNSD, 2021). Equally concerning is that available data is heavily skewed towards developed countries with mature national statistical systems. Furthermore, despite recommendations that SDG indicators be disaggregated where possible, by income, sex, age, ethnicity, migratory status, disability, geographic location or other characteristics, this is often not the case. As outlined in Chapters  10 and 11, new strategies, tools, integrated sampling frames and platforms are also required to enable enhanced risk understanding and analytics. These need to reflect the characteristics and socioeconomic processes in the local context. In particular, national policies need to draw on specific information on marginalized and excluded groups, and on data on communities most affected by conflict and insecurity, disabilities and intrahousehold disparities. They should avoid using prevalence estimates and national averages, which do not give sufficient granularity (OECD, 2018b). Where data is available, forensic analysis of risk can also be helpful in supporting policymakers and communities to consider potential future pathways for risk reduction. For example, in northern Uganda, projects are under way that aim to combine disaster risk and downscaled climate risk data to enable local pastoralists and other stakeholders to access localized, timely and easily understood seasonal forecasting and water reserves data to plan optimum grazing routes and to take preventive action in case of forecast drought (Lwasa et al., 2017). Drawing on past trajectories of root causes that were disaster risk drivers, forensic forecasting methods also can help project future dynamics including patterns of demographic and economic change, infrastructure development and vulnerabilities. Although forensic disaster scenariobuilding is a qualitative method that has subjective elements, it can be valuable in shaping adaptation and risk reduction strategies (Oliver-Smith et al., 2016) (Box  4.4). It is also increasingly being used to help evaluate the social vulnerability conditions that aggravate or amplify disaster risk in other areas, such as urban planning and socioeconomic development (Cardona et al., 2018). Finland and Norway use foresight processes to investigate and provide information about future land use and impacts of decision-making on society, the economy and the environment. The development of digital stakeholder engagement platforms of open, comparable and consistent spatial data has enhanced participation of diverse actors, including the public in planning-related processes. These processes involve participatory planning goals that also respond to the fundamental principles of sustainable local development (Weber et al., 2017). 62 Figure 4.3. Percentage availability of SDG indicator data with at least 2 years of data since 2015 Source: UNSD (2021) 1 No poverty 1.1.1 57.77% 1.2.1 35.23% 1.2.2 9.64% 1.3.1 57.94% 1.4.1 99.48% 1.4.2 10.02% 1.5.1 55.13% 1.5.2 37.68% 1.5.3 67.88% 1.5.4 55.27% 1.a.1 44.82% 1.a.2 71.50% 1.b. 1 0% 2 Zero hunger 2.1.1 100.00% 2.1.2 100.00% 2.2.1 63.73% 2.2.2 55.44% 2.2.3 98.45% 2.3.1 100.00% 2.3.2 100.00% 2.4.1 0% 2.5.1 100.00% 2.5.2 100.00% 2.a.1 100.00% 2.a.2 90.91% 2.b.1 9.84% 2.c.1 100.00% 3 Good health and well-being 3.1.1 94.82% 3.1.2 81.87% 3.2.1 99.48% 3.2.2 99.48% 3.3.1 61.14% 3.3.2 99.48% 3.3.3 73.29% 3.3.4 99.48% 3.3.5 99.48% 3.4.1 94.82% 3.4.2 94.82% 3.5.1 56.22% 3.5.2 96.37% 3.6.1 94.82% 3.7.1 44.04% 3.7.2 81.35% 3.8.1 94.82% 3.8.2 19.69% 3.9.1 93.78% 3.9.2 94.82% 3.9.3 94.82% 3.a.1 81.35% 3.b.1 85.75% 3.b.2 90.91% 3.b.3 8.81% 3.c.1 85.75% 3.d.1 100.00% 3.d.2 32.90% 4 Quality education 4.1.1 68.91% 4.1.2 38.86% 4.2.1 29.02% 4.2.2 78.24% 4.3.1 36.79% 4.4.1 50.78% 4.5.1 38.45% 4.6.1 7.77% 4.7.1 100.00% 4.a.1 51.22% 4.b.1 90.91% 4.c.1 60.10% 5 Gender equality 5.1.1 48.70% 5.2.1 79.79% 5.2.2 0% 5.3.1 43.78% 5.3.2 27.78% 5.4.1 15.72% 5.5.1 94.30% 5.5.2 56.99% 5.6.1 19.69% 5.6.2 50.43% 5.a.1 97.41% 5.a.2 100.00% 5.b.1 49.22% 5.c.1 33.68% 6 Clean water and sanitation 6.1.1 66.84% 6.2.1 73.06% 6.3.1 34.72% 6.3.2 41.71% 6.4.1 100.00% 6.4.2 100.00% 6.5.1 96.37% 6.5.2 100.00% 6.6.1 68.37% 6.a.1 90.91% 6.b.1 62.18% 7 Affordable and clean energy 7.1.1 100.00% 7.1.2 97.41% 7.2.1 98.96% 7.3.1 98.96% 7.a.1 67.88% 7.b.1 74.09% 8 Decent work and economic growth 8.1.1 100.00% 8.10.1 88.86% 8.10.2 72.54% 8.2.1 92.23% 8.3.1 36.27% 8.4.1 0% 8.4.2 95.85% 8.5.1 43.01% 8.5.2 47.15% 8.6.1 65.80% 8.7.1 28.50% 8.8.1 34.97% 8.8.2 70.47% 8.9.1 31.61% 8.a.1 43.26% 8.b.1 54.92% 9 Industry, innovation and infrastructure 9.1.1 9.84% 9.1.2 92.57% 9.2.1 98.96% 9.2.2 72.54% 9.3.1 30.57% 9.3.2 47.67% 9.4.1 72.54% 9.5.1 59.59% 9.5.2 52.33% 9.a.1 90.91% 9.b.1 76.17% 9.c.1 99.31% 10 Reduced inequalities 10.1.1 45.60% 10.2.1 53.37% 10.3.1 20.73% 10.4.1 92.23% 10.4.2 32.64% 10.5.1 66.32% 10.6.1 100.00% 10.7.1 0% 10.7.2 57.51% 10.7.3 100.00% 10.7.4 100.00% 10.a.1 99.48% 10.b.1 48.19% 10.c.1 34.37% 11 Sustainable cities and communities 11.1.1 63.21% 11.2.1 0% 11.3.1 0% 11.3.2 0% 11.4.1 5.60% 11.5.1 55.13% 11.5.2 31.16% 11.6.1 22.28% 11.6.2 99.48% 11.7.1 0% 11.7.2 0% 11.a.1 100.00% 11.b.1 67.88% 11.b.2 55.27% 12 Responsible consumption and productin 12.1.1 28.70% 12.2.1 0% 12.2.2 95.85% 12.3.1 100.00% 12.4.1 86.01% 12.4.2 18.94% 12.5.1 17.62% 12.6.1 100.00% 12.7.1 7.25% 12.8.1 100.00% 12.a.1 74.09% 12.b.1 72.02% 12.c.1 65.11% 13 Climate action 13.1.1 55.13% 13.1.2 67.88% 13.1.3 55.27% 13.2.1 0% 13.2.2 14.77% 13.3.1 100.00% 13.a.1 0% 13.b.1 0% 14 Life below water 14.1.1 70.64% 14.2.1 0% 14.3.1 13.47% 14.4.1 100.00% 14.5.1 88.61% 14.6.1 100.00% 14.7.1 100.00% 14.a.1 18.63% 14.b.1 100.00% 14.c.1 23.32% 15 Life on land 15.1.1 100.00% 15.1.2 88.86% 15.2.1 100.00% 15.3.1 100.00% 15.4.1 83.42% 15.4.2 100.00% 15.5.1 100.00% 15.6.1 61.45% 15.7.1 0% 15.8.1 88.60% 15.9.1 72.80% 15.a.1 43.01% 15.b.1 43.01% 15.c.1 0% 16 Peace, justice and strong institutions 16.1.1 53.63% 16.1.2 0% 16.1.3 13.13% 16.1.4 15.54% 16.10.1 0% 16.10.2 65.28% 16.2.1 28.50% 16.2.2 33.78% 16.2.3 19.69% 16.3.1 10.02% 16.3.2 75.13% 16.3.3 0% 16.4.1 0% 16.4.2 7.25% 16.5.1 6.74% 16.5.2 44.56% 16.6.1 65.28% 16.6.2 0% 16.7.1 50.14% 16.7.2 0% 16.8.1 100.00% 16.9.1 61.66% 16.a.1 28.24% 16.b.1 20.73% 17 Partnerships for goals 17.1.1 78.76% 17.1.2 78.24% 17.10.1 79.79% 17.11.1 0% 17.12.1 98.60% 17.13.1 79.59% 17.14.1 13.47% 17.15.1 27.40% 17.16.1 12.95% 17.17.1 65.80% 17.18.1 0% 17.18.2 100.00% 17.18.3 100.00% 17.19.1 100.00% 17.19.2 59.93% 17.2.1 56.00% 17.3.1 96.89% 17.3.2 93.26% 17.4.1 60.10% 17.5.1 0% 17.6.1 97.93% 17.7.1 0% 17.8.1 98.96% 17.9.1 90.91% 0-25% 25-50% 50-75% 75-100% Not applicable 63 Recognizing data challenges, a recently developed SDGs Geospatial Roadmap aims to encourage the use of geospatial and location-based information to augment official data for SDG reporting to help fill data gaps (IAEG-SDGs WGGI, 2022). Chapter 10 further explores emerging innovative uses of these approaches. Future scenario-building approaches for environmental sustainability and development are also being applied to planning of water usage and river basin management in the transboundary Indus basin (Box 4.5). Policy choices can accelerate risk reduction Policy choices can promote resilience building, or can become root causes, drivers and amplifiers of disaster risk. For example, a policy of housing evictions of low-income residents can accentuate disaster vulnerability in cities. The dismantling of environmental laws that protect natural reserves can exacerbate climate change and lead to deforestation, reduced water quality and a higher risk of flooding or landslides. Top-down reconstruction and social protection approaches that require affected communities to accept government or institutional plans while limiting community active participation and agency in enacting post-disaster efforts can also become drivers of disaster risk rather than creating long-term resilience (Bowen et al., 2020; Wu, 2022). The absence of grass-roots input can maintain systemic risks and societal inequalities, jeopardizing long-term sustainable development (Wu and Drolet, 2016; Chavda et al., 2022; Wu, 2022). Conversely, well-designed adaptive social protection efforts can reduce vulnerability and exposure (e.g. geographic, social and economic) and build Box 4.5. Co-designing future water resource pathways in the Indus basin The Indus basin is home to about 250 million people across Afghanistan, China, India and Pakistan. Approximately 110  million people living in the basin are living in extreme poverty (Wada et al., 2019). With low to moderate levels of access to basic services, health care and education, large parts of the basin’s population are vulnerable to climate change impacts and have low adaptive capacity, with the population expected to increase. Strategic decisions need to be made across the different sectors and countries to ensure sustainable development pathways for the basin’s region. These are especially relevant in managing the transboundary governance of risks that transcend multiple jurisdictions and hazards and which may have impacts over long distances in other surrounding areas, such as in mountainous regions. Stakeholders across different sectors and countries representing three basin development priorities – economy, society and environment – used a game-like scenario policy tool to develop and co-define a joint vision about existing challenges and possible pathways for the Indus basin. Figure  4.4 illustrates a business-as-usual scenario agreed by stakeholders as the likely future based on current development pathways, which is one of increasing risk. Then it indicates three resilient future scenarios according to different stakeholder preferences, values and world-views. The pathways to each of these identify trade-offs that need to be weighted to reach them, for example, developing large-scale water infrastructure versus small-scale nature-based solutions may lead to alternative pathways. The internal drivers represented are measures and policies that basin stakeholders (subnational to regional) have the ability to agree and adopt. The external drivers are global factors such as climate change and economic shocks that are the sphere of uncertainty against which regional pathways need to be adapted to become robust. Source: Schinko et al. (2022) 64 community resilience (World Bank, 2001; Davies et al., 2013). For example, after the 2015 earthquake near Kathmandu in Nepal, many international nongovernmental organizations entered the country to help local reconstruction and recovery through the official adaptive social protection scheme (Holmes et al., 2019; Rayamajhee et al., 2020). An innovative cities and infrastructure research project aimed to counter top-down approaches, and was successful in fostering cooperation between local residents and external helpers to swiftly identify the reconstruction and recovery priorities of local communities (Knowles, 2018). This cooperation also encouraged local residents to share their traditional construction techniques with the external sponsors, which resulted in outcomes better suited to their physical and socioeconomic context (Wu, 2022). Similarly, community and ecosystem-based DRR projects aimed to integrate local and scientific knowledge, and explicitly considered issues of wellbeing and equity in the design process (Klein et al., 2019). Better joint planning across sectors can increase the efficient use of scarce resources and reduce the underlying causes of risk. Cooperative crosssectoral planning can also help create governance approaches that are clearer and easier to implement, INTERNAL (PATHWAYS) RESILIENT FUTURE 1 RESILIENT FUTURE 2 RESILIENT FUTURE 3 Resilient Futures Differentiated by value differences between stakeholders BUSINESS AS USUAL CURRENT SITUATION provide reference for PAST AND PRESENT POSSIBLE FUTURE Constraints Input based on SSPs Risks EXTERNAL (SCENARIOS) Challenges Synergies Trade-offs Solutions = Policies, Technologies, Infrastructure Figure 4.4. Conceptual representation of the co-development of the nexus visions and transition pathways in the Indus basin Note: SSP = shared socioeconomic pathway. Source: Wada et al. (2019) 65 thus reducing the administrative burden of local governments. For example, research in Jagobiao Barangay in the Philippines identified the siloed nature of local policymaking. Local government officials reported there were nearly 40 separate national plans they were required to implement in their district (GNDR, 2019). Better joint planning can reduce such fragmentation. Efforts to reduce the root causes of vulnerability and exposure can be particularly effective during a postdisaster recovery and reconstruction period. For example, after the devastation of the 2010 Chilean earthquake and tsunami, in several of the worst-hit communities in Constitución, Chile, the Government provided disaster survivors with “half a good house” living units (Moore, 2016; Wu, 2022). The unfinished half allowed dwellers freedom to expand according to their own needs (Zilliacus, 2016). This type of housing structure was highly appreciated by the local residents, especially low-income families, who could arrange their limited resources to meet their urgent priorities (Franco, 2016). The long-term benefits strongly illustrated that these residents continually improved their housing, to support their ongoing recovery and prepare for prospective extreme events (Moore, 2016). This example portrays the capacity of communities to facilitate their post-disaster housing reconstruction and carry out their own recovery agenda (Wu, 2022). 4.4 Ways forward Disasters are the result of dynamic interactions among hazards, pre-existing local vulnerability and exposure. They are the effects of human choices, and are affected by the socioeconomic, technological and demographic characteristics of a society (IPCC, 2018a; UNDRR, 2019; GousseLessard et al., 2022). Good disaster risk governance aims to avoid the creation of situations of vulnerability and exposure by tackling drivers and root causes of risk. Addressing the root causes and drivers of vulnerability and exposure reduces risk and contributes to sustainable development. Development pathways, whether planned or unplanned, frequently increase vulnerability and exposure to known hazards. The Fuego Volcano example shows how forensic disaster analysis approaches are useful for decision makers. Forensic approaches combine retrospective longitudinal analysis, disaster scenarios, comparative case analysis and meta-analysis research, along with enhanced involvement of development stakeholders. This gives a holistic understanding of particular events and ways to accelerate future risk reduction (Burton, 2015; Oliver-Smith et al., 2016, 2017). However, understanding risks requires investing in data and analysis that can help better understand how and why disasters occur. Disaster data is used as an input to policy formulation and practice and to measure the outcomes, so these should be mutually reinforcing processes. The adoption of green or transformative approaches in disaster recovery is sometimes seen as the way to transformation, and it is true that such efforts have long been needed. Green recovery, regenerative agriculture and similar practices should be in place to support implementation of the Sendai Framework and the SDGs. However, these need to be considered within broader efforts to address structural inequalities and wider human development. Addressing the root causes of disasters requires a political and social commitment to sociocultural change. Present and future dimensions of vulnerability, exposure and hazards of communities, sectors and systems are intertwined with modes of governance and development planning in each geographic area, whether national, regional or local. Disaster risk governance should be backed by open and transparent collective action, vertical and horizontal cooperation and coordination among actors, and different ways of defining and reaching consensus regarding sectoral policies with positive impact in a geographic region. It implies multichannel governance, with horizontal relations among actors and their territories (Davoudi et al., 2008). It also needs to focus on the local level, including local government resources and capacity, and deeper collaboration with civil society and communities (Chavda et al., 2022). 66 5. How systems undervalue key assets and opportunities for learning Risk assessment has traditionally favoured quantitative data analysis based on short-term and economics-based approaches. However, in the context of today’s increasingly complex systemic risk, there is often a gap between the information available and accessible and the knowledge that needs to be used. This chapter looks at this challenge from three key angles. First, it argues there is a need to get better at collecting “traditional” data, particularly on vulnerability, exposure and disaster loss and damage. Second, it is necessary to acknowledge that systems often measure the wrong things, and take a risky short-term, myopic approach. Third, it highlights that the very concept of cause-and-effect risk assessment needs to be reconsidered, and that systemic risk assessment has much to learn from emerging good practices in management of so-called “wicked” problems that require flexible, curious and participatory management. Then, it concludes by presenting the evolutions needed to overcome shortcomings to better assess and manage systemic risk. 5.1 Shortcomings of incumbent approaches to risk management Governance systems are not collecting the right data, key assets are being undervalued in decision-making and learning opportunities are being missed. Measuring value more holistically is essential to reducing and managing risk. This needs to be considered across governance systems and the private sector, not only within DRM authorities. Disasters are intrinsically interlinked with systemic disaster risks from development, and vice versa (Keating et al., 2016; Keating and Hanger-Kopp, 2020). There are three pitfalls with the way in which value is defined in the incumbent approach to risk management: indices measure the wrong things, they take a short-term approach and they are myopic in that they fail to take into account cascading impacts and/or transboundary risks. All three of these limitations hinder the ability to effectively understand, assess and act on complex and systemic risk. 5.1.1 Measuring the wrong things The old adage that “what gets measured gets managed” is highly relevant in the risk management space. Factors not measured are excluded from financial balance sheets and governance decisionmaking. Current risk reduction efforts focus largely on valuing a narrow set of immediate, short-term impacts, but therefore fail to measure other factors such as biodiversity loss, deforestation and unpaid care. Systems also fail to account for the value of lesstangible assets that become crucial when lesspredictable systemic risks emerge. For example, 67 during the COVID-19 crisis, it has become evident that countries do not have a way to measure the value of having strong, flexible, well-managed companies that can produce essential key items such as medicine and hand sanitizer during crises. Non-market values to humans in areas such as social and religious customs and aesthetic value are also undervalued; these are key to human wellbeing, as is the value of biodiversity to ecosystems including the human ability to survive. Other important indices (e.g. the economic value of human life) remain ethically contentious and are therefore often excluded from corporate balance sheets and government decision-making. Better quantification of the real extent of financial and social assets at risk is essential, particularly in an uncertain and volatile climate future. Furthermore, the understanding and application of how to account for impacts that cascade into or over one another is limited. A building designed to withstand flooding and high winds may simultaneously contain no design consideration for airflow in the event of a pandemic. Equally, the design of a dam in one jurisdiction traditionally considers only the risk to the communities and environments in that same jurisdiction. Such design decisions are also usually made based on historical and limited trend data. In the context of systemic risks such as climate change, this means that infrastructure may rapidly become “out of date” and vulnerable. 5.1.2 Short-term thinking The second pitfall is the time frame over which the destruction and creation of value is considered in risk management. Most disaster impact assessments typically take a short-term view. This short-termism means little data and insights on indirect or concatenated impacts, or ripple effects, are available for risk managers wanting to understand more comprehensively the potential positive and negative consequences of events (Ladds et al., 2017). In addition, there is considerable empirical evidence that individuals exhibit a myopic bias when making risk-based decisions for lowprobability events (Meyer and Kunreuther, 2017) (Chapter 8). There have recently been changes in the legislation of jurisdictions across the world to balance Milton Friedman’s theory that a company’s sole responsibility is to its shareholders (Harris, 2018; Atkins, 2019). In corporate reporting, a wider range of risks is beginning to be considered alongside the financial balance sheet. Such a change represents a significant shift in what corporations consider valuable and therefore what risks they manage; however, more remains to be done. Private sector risk assessments typically consider the value created or lost over 12  months. This is evidenced by the alignment to this time frame of shareholder reporting and incentive schemes such as employee bonuses. There is often a lack of experience in to how to integrate systemic risk reduction initiatives with much longer time frames. However, there are also some good counterexamples, such as the work of the Economic Commission for Latin America and the Caribbean over the last four decades. This has made a major contribution to changing short-term corporate thinking on disaster risk, in particular through the development of a widely recognized disaster impact assessment methodology (ECLAC, 2014). Even staying exclusively in the economics sphere, the indirect and long-term impacts of disasters are likely much greater than the acknowledged short-term ones. Hochrainer-Stigler et al. (2019) estimated the available financial resources and expected annual disaster loss for Austria, including direct and indirect damage. They found an urgent need for increased investment in prospective risk management, even for medium-level risk (50–100  year return periods) due to the largely unacknowledged risk from indirect losses. Social and environmental values are often created and lost during financial value creation. The impact of the short time frame is that, even when they are accounted for, the time frame over which the value of social or environmental assets is lost is considerably shorter than the time taken to repair them. For example, a balance sheet will not yet include the destruction of groundwater by mining over 40 years of production against the 200+ years it will take to recover, or take into account the 68 species loss as a result of such destruction. Many balance sheets would be shown to be untenable if loss were accounted for in this way. Likewise, many risk assessments would be deemed to require urgent and widespread attention if assessed over longer time frames, such as those related to climate change. This short-termism is a dangerous form of simplification that masks latent and potentially highly expensive risks built into financial systems. However, long-term risk assessment is possible, and there are examples in other sectors and systems that provide sources for learning. Within the insurance industry and some parts of the investment communities, financial returns are routinely assessed over multiple decades, but this thinking is not prevalent in other parts of the financial system. Similarly, the private sector has developed methods for consideration of safety factors in infrastructure design that look at cascading impacts of design choices. These can provide lessons for other sectors. In the public sector, risk assessments typically take a longer view than 12  months, particularly in the case of infrastructure, but the practice of discounting means impacts beyond 20– 30 years effectively become ignored. It is particularly concerning that even where longerterm time frames are considered, the mechanisms for integrating systemic risks, particularly from climate change, are not yet developed. This represents a growing and potentially gamechanging risk to current systems and longer-term investments. Reconsidering the choice of discount rate and better accounting for climate change present opportunities to act on investment risk and promote intergenerational equity. 5.1.3 Myopia that ignores transboundary and systemic impacts The third pitfall of current systems is that they tend to align with political and geopolitical borders, thereby ignoring systemic and transboundary risks. The impact of a virus or risk to biodiversity from consumptive behaviours in one country may be minimal or even invisible in that country, but devastating for an adjacent, economically and politically separate community. For example, in February 2021, a cold wave in Texas, United States, left semiconductor plants without electricity, affecting microchip manufacturing and consumers across the world, disrupting an estimated $30 billion of global trade (Williams, 2021). Semiconductor supply chain shortages in Taiwan Province of China in mid-2021 due to the COVID-19 pandemic have also had global impacts on manufacturing supply chains (Feigenbaum and Nelson, 2021). Global corporations span political and geographical boundaries, and hold more financial resources than many nations, so the choices they make about which risks to govern and who they regard as their primary stakeholders have the potential for significant positive impacts on systemic risk. Improving understanding of the transboundary nature of risk can also positively reinforce disaster resilience. For example, during the COVID-19 outbreak, a major distributor of electronic components in China, TTI, temporarily locked down due to the country’s pandemic prevention policy. However, TTI took rapid actions to scale up the operation of its warehouses in the Americas, Asia and Europe to receive incoming shipments from suppliers and make outgoing shipments to customers to fill the resulting supply chain gap (TTI, 2020; Haraguchi et al., 2022). Similarly, around the world, during the first waves of the COVID-19 pandemic, the flexibility of global manufacturers to rapidly adapt and adjust manufacturing capacity to meet new and unexpected demand for products such as hand sanitizer and face masks became a key asset in addressing the pandemic (Table  5.1). The DRR community can potentially learn from such examples of flexibility. There are few mechanisms measuring transboundary systemic risks, let alone planning for and providing redress from transboundary impacts. The maturity of models that convert the value of these elements to the common economic unit – money – has increased significantly in recent years, but a gap remains (Chapter  10). Although independent models exist, integration and dependencies are complicated and messy and are usually considered only partially, if at all (Steffen et al., 2020). And this is where it is important to complement such models with approaches that recognize how “messy” interdependencies are part 69 of all human and natural systems, and that these can be perceived in relational ways without either controlling or eliminating such variables from consideration (Chapter 6). 5.1.4 Results of measuring the wrong things Floods and droughts have significant impacts on poverty, because of their extensive, low-intensity, high-frequency nature. Such recurrent disasters may not be highly visible (and may not even be recorded in the media and usual databases), but nevertheless have a large impact on people’s wellbeing and long-term prospects (Erman et al., 2019, 2020). Earthquakes and tsunamis have lower average impacts on poverty because they are less frequent, but they have massive and acute impacts when they do occur. A single earthquake or tsunami can push millions into poverty overnight (Hallegatte et al., 2020). A World Bank study considering the impacts of disasters related to natural hazards suggests that, in the Philippines alone, almost half a million people a year face transient consumption poverty due to disasters (Walsh and Hallegatte, 2019). These impacts are missed in current damage and loss reporting methods. As these costs are not well counted, they are also not well managed. A myopically narrow definition of value in scope and time frame decreases the incentive for investment in reducing longer-term negative impacts and pays insufficient attention to recovery planning when value is depleted. Product Industries/sectors Countries Examples Hand sanitizer Manufacture of alcoholic beverages, sugar and alcohol mills, manufacture of paints, manufacture of cleaning products, refrigeration industry, university laboratories, Argentine and Brazilian Armed Forces Argentina, Brazil, Chile, Colombia, El Salvador, Guatemala, Mexico National and international groups using the alcohol byproduct from the production of non-alcoholic beers Cosmetic groups: L’Oréal in Argentina, Natura in Brazil Masks Textiles, paper and cardboard manufacturing Argentina, Brazil, Chile, Colombia, Dominican Republic, Guatemala, Haiti In Chile, Caffarena and Monarch, manufacturers of socks, stockings and T-shirts, produce masks Personal protective equipment for health professionals (e.g. masks and shields) Automotive industry, household appliance manufacturing, plastics industry, threedimensional printing in technology centres and universities, machinery and equipment manufacturers Argentina, Brazil, Chile, Colombia, Costa Rica, Uruguay In Argentina, Ford, Volkswagen, Mercedes-Benz and Fiat Chrysler produce face shields In Chile, Comberplast, a plastics company, produces masks and face shields with recycled plastics Table 5.1. Example initiatives by the manufacturing sector in Economic Commission for Latin America and the Caribbean countries to convert production capacity in support of health system supply needs during the COVID-19 pandemic Source: Haraguchi et al. (2022), adapted from ECLAC (2020) 70 The way in which people assess time and value is creating a compounding negative impact on systemic risk and inhibiting achievement of the Sendai Framework goal and the 2030 Agenda. A short-term focus can miss significant disaster impacts, and also fail to understand and ultimately address the dynamic interconnections between disaster risk and long-term well-being (Keating et al., 2016). A shift is required from an almost exclusive focus on the protection of privatized gains in financial systems, strategic economic infrastructure and global supply chains, towards the management and reduction of socialized risks (Maskrey et al., 2022). Consideration of safety factors requires a longterm view, but even in this context, the importance of systemic features is not always recognized. Furthermore, the understanding and the application of how to account for impacts that cascade into or over one another are limited. Myopia affects approaches to handling complex, existential systemic risk such as biodiversity loss. Despite being high on the list of grand societal challenges, biodiversity does not receive the focus that is intuitively appropriate for something widely accepted as being essential to food security and human well-being (FAO, 2019; Zeng et al., 2020). Deforestation, changes in forest habitats, poorly regulated agricultural land and mismanaged urban growth have resulted in a range of conditions that increase the likelihood and impact of globally significant health events such as outbreaks of vector-borne diseases and pandemics. These changes have altered the composition of wildlife communities, greatly increased the contact of humans with wildlife, and altered niches that harbour pathogens, increasing the chance they will come into contact with humans (UNESCO, 2020; Platto et al., 2021). The current system of risk determination and mitigation deals predominantly with market exchange values. Although these may be used to justify biodiversity protection measures, the exchange values for biodiversity and ecosystems constitute only a fraction of the real benefit of these systems (Gowdy, 1997; Alho, 2008; Conniff, 2010). Lessons can be learned from Costa Rica, which effectively combined protecting areas for conservation with innovative payments for ecosystem services and strict enforcement of regulations on biodiversity protection, hydrological services and carbon sequestration (section  8.3.1). Forest protection measures in Brazil and Indonesia have also shown that human disease risk can be reduced indirectly by management of the landscape, ecosystems and the biodiversity they contain (Whitmee et al., 2015). One of the starkest examples of this circular logic or complex interactions is that of disaster poverty traps. Poverty traps occur when a household or community’s response to a disaster reduces their well-being in the longer term and ultimately reinforces their vulnerability to the next disaster event, resulting in a vicious cycle from which it is almost impossible to escape. A family might get caught in a disaster poverty trap when forced to use erosive coping strategies following losses from a disaster (Heltberg et al., 2012). Erosive coping strategies are short-term fixes with devastating long-term consequences, such as selling productive livestock, removing children from formal education, arranging for girls to marry early to relieve economic pressure or gain income, or taking out a high-interest loan. Recent examples of erosive coping strategies during the COVID-19 pandemic are the national policies in Australia and Chile that allowed pension fund contributors to draw on savings in their pension funds to cover basic needs during the crisis. In Chile, this was a frank process of impoverishment whose impact will be seen in future years when those who used these funds in advance will see their pensions severely diminished: “Official data shows that, up to February 2021, close to 10.5 million people withdrew money using the first or second withdrawals and, of those, 30  percent depleted their accounts” (Evans and Pienknagura, 2021). In the worst cases, industries, governments and individuals can contribute “negative resilience” (Gallopín, 2006) or “perverse resilience” (Holling, 2001; Ráez-Luna, 2008). This occurs when systems that are oppressive and exploitative of humans and ecosystems are resistant to change. 71 Given the need to measure more things to effectively manage systemic risk, the challenge becomes how to keep track of multiple variables, some of which are inherently uncertain. In this regard, the thinking around management of wicked problems may provide DRR practitioners with an opportunity for learning. The toucan of South America is one of many species endangered by loss of rainforest Credit: © Shutterstock/Ondrej Prosicky Photography the (wicked) problem may create other problems elsewhere in the complex dynamic system. Wicked problems display many of the characteristics of systemic risk. A wicked problem is difficult (or impossible) to resolve fully due to incomplete and at times contradictory information and frequent changes in requirements and output functions in a turbulent context (Forrester et al., 2018). It refers to an issue that cannot be fixed but which constitutes a moving target without a single (simple) solution where the term “wicked” denotes resistance to resolution, rather than evil (Andersen and Gatti, 2022). Wicked domains are situations in which feedback in the form of outcomes of actions or observations is poor, misleading or even missing. In contrast, in “tame” or “kind” domains, feedback links outcomes directly to the appropriate actions or judgments and is accurate and plentiful (Rittel and Webber, 1973; Hogarth et al., 2015). A wicked environment cannot be reduced to a kind one just because it can be assessed. Yet this is what people often attempt to do, by continuing to use standard tools and processes on these complex areas, even though there are no repeatable patterns in complexity. Hence, the ability to deal with wicked problems in social systems requires cross-functional and collective processes induced by supportive values and leadership principles. Conventional decisionmaking models assume reasonable stability around tasks and organizational design parameters, in contrast with situations where decision makers face unprecedented interdependencies of unpredictable factors or forces embedded in complex wicked problems. However, there are certain actions policymakers and analysts can take to better understand and devise solutions to managing wicked problems. Sections  5.2.1–5.2.5 below set out some key elements. 5.2.1 Enable systems thinking and systems approaches Humans are exceptional at recognizing and learning patterns (e.g. chess grand masters). They are capable of doing so in kind environments and in wicked environments. Yet, since the industrial revolution, education systems have optimized 5.2 Wicked problems and systems-based approaches In organizational, social and societal settings, the term “wicked problem” is often used to refer to an issue with a high level of complexity without any determinable final point of stability. Due to highly complex dependencies among many moving elements, the resolution to one aspect of 72 delving deeper and more narrowly, transmitting information rather than connecting it. However, a resurgence of systems thinking is now occurring, from the structure of projects to the role of intergenerational facilitators (Hogan, 2019). A similar revolution is needed in the realm of work to combat many of the processes that discourage people from identifying and connecting information or seeking external “non-expert” input. It is these types of connections that are needed to respond to the wicked problems that risk governance seeks to address. In practice, systems thinking is reflected in many day-to-day skills. Providing room in the work environment to hone the habits of systems thinking can be a first small step towards mainstreaming systems approaches (Waters Center for Systems Thinking, 2020). 5.2.2 Integrate diverse knowledge The system of learning in most countries is designed to reward early and hyper specialization, sinking people deeper into the trenches of highly specialized knowledge (Epstein, 2019). While this is necessary to advance knowledge, it can also miss the opportunity to seize insights generated in interdisciplinary, intersectoral, interdepartmental, integration of knowledge. This does not mean specialized knowledge is not important, but it also needs to be integrated effectively with broader transdisciplinary approaches, as well as indigenous and traditional knowledge systems and polycultural ways of knowing (Chapter 6). 5.2.3 Recognize that deep uncertainty is a characteristic of wicked problems Existing approaches for planning under deep uncertainty are likely to be most useful when they seize opportunities to draw on collective intelligence. Adaptation pathway approaches, which are popular also in flood risk management, are gaining traction as a method in this area. They have the capacity to explicitly address systemic characteristics such as path dependencies (Werners et al., 2021; HangerKopp et al., 2022). 5.2.4 Use diagnostic approaches Diagnostic approaches (checklists) can also be useful to identify problems and decide whether their environment or their constituent parts are wicked or kind (Peters and Tarpey, 2019). This is part of the evolution needed in how to approach the problems and generation of responses to systemic risk. 5.2.5 Use a variation of the “precautionary principle” and “planetary boundaries” Principle  15 of the 1992 Rio Declaration on Environment and Development is now an established principle of environmental law. It adopts the precautionary approach to threats that are serious or could potentially cause irreversible damage. This means that cost-effective measures should be taken to prevent the threats being realized, rather than waiting for full scientific certainty, which may come too late or be impossible to determine in complex systems (United Nations, 1992; PintoBazurco, 2020). The idea of outer limits can also be applied, such as the concept of planetary boundaries developed by the Stockholm Resilience Centre (2021). The concept of planetary boundaries certainly applies to existential threats if not to lesser global ones. 5.3 A long-term, holistic and systemic perspective In an increasingly interconnected and complex world, where the risks faced are compounding and cascading, the dominant approach to risk management is no longer fit for purpose. A systems-based approach is needed to understand contemporary drivers of risk and of impacts when risks are realized. Fortunately, there are promising signs that systems are beginning to transform to take into account some of the present limitations in managing systemic risk. The Group of Twenty (G20) Financial Stability Board created the Task Force on Climate-related Financial Disclosures to improve and increase reporting of 73 climate-related financial information (TFCFD, n.d.). As climate change presents financial risk to the global economy, the task force aims to help financial markets access clear, comprehensive, high-quality information on the impacts of climate change. This includes the risks and opportunities presented by rising temperatures, climate-related policy and emerging technologies in a changing world. Similarly, the G20 Taskforce on Nature-related Financial Disclosure aims to deliver risk management and disclosure frameworks for organizations to report and act on nature-related risks, which underpin an estimated $44  trillion of global economic output (TNFD, n.d.). The end goal of this second task force is to support a shift in global financial flows away from nature-negative outcomes and towards nature-positive outcomes, starting with a shift in risk perception and the value of natural systems, based on the incentive to protect organizations’ economic bases and revenue from nature-related risks. In 2020, the Dutch Central Bank and financial supervisor, De Nederlandsche Bank, became “the first central bank to highlight biodiversity as a material financial risk”, highlighting that 36% of the portfolio values of the Dutch financial institutions were exposed to nature-related risks (UNEP, 2020). Parts of the financial sector, including investment managers and insurance firms, which act at a global scale across markets and geographies, are relying firmly on long-term value creation for profitability. They are playing a significant role in mobilizing funding away from activities such as use of fossil fuels, which were traditionally unaccounted for as drivers of systemic risk from climate change (Buchner et al., 2019). This may be partly driven by a shift from shareholder primacy to stakeholder primacy, witnessed most recently in Canada, but also in Bhutan, New Zealand and Wales (Borduas, 2019). Key to unlocking the potential of this shift as a way to address stagnation in progress towards the Sendai Framework goal, will be for these same actors to include the reduction of social vulnerability and exposure as a key part of the value creation process. Or, more broadly, to see these risk drivers as progressive opportunities for change rather than defensive drivers that need to be reduced and controlled (Møller, 2011). At the same time, there are also emerging good practices of better valuing a wider range of assets. As an example, biodiversity credits or “biocredits” are coherent units of measurement that track conservation actions and outcomes and can help to improve tracking and transparency. When they are well designed, they can make investments in biodiversity management more financially attractive, for example, by attaining private sector finance. They can be used by governments to monitor their actions and report on biodiversity commitments. As much of the world’s biodiversity and its richest biodiversity spots are found in remote and poor tropical regions, biocredits must be inclusive and founded on fair benefit-sharing principles (Porras and Steele, 2020). Figure 5.1 illustrates an example of an institutional set-up for biocredits based on these principles. Systemic risk is inherently uncertain due to its complexity. Therefore, new approaches to better reduce systemic risk are building uncertainty into how they approach risk. While older, rigid tools and processes favour inaction when faced with uncertainty, new tools are finding ways to embrace it as a planning parameter. Adaptive planning, evolutionary development, early delivery and continual improvement encourage flexible responses to understanding the problems that need to be solved and to finding the solutions, which are both key elements in understanding systemic risk. For example, in software development, Agile Project Management is now the accepted method when developing a complex response to a complex system. Use of tools such as Sense Maker (The Cynefin Co, 2021) enables the collection and interpretation of multiple types of data from across a range of scales and data types. The Association of Southeast Asian Nations has developed a flood hazard and risk analysis framework that integrates climate change projections into disaster risk assessments to help address future systemic risk. A similar integration was piloted in a case study survey from coastal areas in Ghana, which explored improvements in adaptive capacity indexes to treat climate change as one of the threats to be addressed in all-hazards risk reduction (Frazier et al., 2022). The systemic risks associated with floods and landslides in the Lao People’s Democratic Republic and Myanmar have been assessed using multi-stakeholder 74 Local supply Communities and technical experts Aggregation/ bio-bank, trust fund Credits demand Resellers and final buyers Biocredit 1. Community and local engagement 2. Project idea note 3. Project design 7. Sales of credits (or certificates) to buyers, e.g. governments and companies 6. Periodic third-party verification 5. Reporting and issuance of certificates 4. Validation and project registration Actions CO2 8. Money is transferred to a bio-bank/ conservation trust fund and through them to those engaged in local actions Figure 5.1. Example of an institutional set-up for biocredits founded on fair benefit-sharing principles Source: Based on Porras and Steele (2020), using Plan Vivo Foundation’s process for community-based biocredits 75 transdisciplinary consultation processes and community engagement at the river basin level in combination with dynamic simulation models and tools for assessing systemic risk (Keaokiriya et al., 2022). 5.4 Ways forward The terms “systemic” and “complex” convey connection and dynamism. This means that every risk, every potential negative outcome, may at the same time be a driver that can potentially cause another negative outcome. These outcomes may either amplify or dampen one another, thus increasing or decreasing the impacts on the system. It is important to note this dynamic interconnectedness can also reduce risk and increase resilience; this is what systemic risk governance seeks to achieve. Current practices of attributing measurement and value linked to traditional economic practices also need to evolve to better address systemic risk at the global level. There are two emerging ways forward for assessing and managing systemic risk: (a)  the application of systems-based approaches to address the dynamic drivers of risk and (b) the mobilization of collective intelligence for these approaches to provide impactful outcomes. Existing knowledge, including from the management of wicked problems, points to logical steps to take and methods that can be employed immediately. New ways of combining modelling and data-driven approaches with community consultations are emerging. As the chapters in Part III outline in more detail, knowledge co-production efforts need to be more closely linked to improve large-scale modelling efforts. Increasing the value of attributes such as flexibility and the ability to work across traditional sectoral and geographical boundaries are key in the effective management of systemic risk (Haraguchi et al., 2022). Having diverse subject matter experts contribute to developing shared outcomes will highlight differences and create confrontation at collective and individual levels. Most people do not willingly put themselves in situations where their expertise is questioned. Confrontation and conflict are created because people are taught that in such situations, there are those who gain something and those who lose something. It is essential that governance systems, not DRM institutions only, engage in risk reduction efforts. To be effective for a systemic approach, risk reduction cannot be viewed as a competitive advantage or information to be protected, as that limits damage control to the impact on each corporation or institution. Managing the complex systemic risks of the future will require mobilization of large numbers of people and significant financial resources. It is cost-effective to invest in a sustainable future, but the investment will be possible only if government as a whole, and the private sector, acknowledge its importance and invest in building resilience. A landslide renders a mountain road impassable, cutting off rural villages in northern Lao People’s Democratic Republic Credit: © Shutterstock/Matyas Rehak 76 6. Shifting perceptions on risk When does linear problem-solving fail, and how can people’s decision-making become better informed to understand and manage the systemic nature of risk? Later chapters look at managing risk from the perspective of new conceptual, mathematical and computational methods, predominantly in network and complexity science. This chapter recognizes that complex problems are not susceptible to simple, predetermined solutions, and examines the question from a different angle. Focusing on ecological–social risk, it aims to look from the perspective of different world-views and knowledge systems about how humans understand and act in the world they inhabit. This is required to explore, recognize and move beyond some established habits of mind and to see in new ways that enable human societies to tackle ecological–social risk at the local and planetary scales. This chapter also argues that knowledge systems based in linear causality and clear-cut concepts of true and false rarely recognize that the creation of that knowledge is selective and relative to the knower’s context. Such an approach to risk focuses on some contexts to the exclusion of others, effectively hampering a systemic understanding of human and planetary systems and risk. For example, in community-based DRR, there is usually a strong dichotomy maintained between local or traditional knowledge and scientific knowledge. A critical review of such approaches is needed to see how they can become truly inclusive of local communities and their knowledge. Otherwise, they may be processes that are done at community level by outsiders rather than with communities (Maskrey, 2011). This can mask exclusion, dichotomy and the dominance of one knowledge system over another, behind the “promise of participation” delivered through community-based approaches (Trogrlic et al., 2022). A first step is to shift from the idea of people and systems being simply interconnected, to the concepts of interdependent and interrelational thinking and acting in systems. This requires a shift from thinking of individuals and organizations as external and separate entities to an understanding that they are all part of the same system. Approaches also need to change, from a focus on control, quantification and competition, to the idea of exploration, mutual learning and compassion. This process requires humility, curiosity and a new scientific respect for relational world-views. Innovative approaches such as the collection of “warm data” can help this process (section 6.3.2). Such approaches can help improve risk understanding, and point at ways of routinizing, even bureaucratizing, the exercise of imagination, which is essential to understanding the systemic nature of risk (Pozek, 2022). The chapter next gives some insights into indigenous or traditional knowledges from a relational worldview. It demonstrates how indigenous communities are adapting and integrating new technologies and participating in and influencing government and official processes for risk reduction. It then explores how scientific values and habits of mind can inhibit human capacity to find new ways of knowing, and looks at some recent innovations in how to move beyond these limitations. It concludes by suggesting some possible ways forward. 77 6.1 Learning from indigenous knowledge and ways of knowing “Manawa whenua, wē moana uriuri, hōkikitanga kawenga” “From the heart of the land, to the depths of the sea; repositories of knowledge abound” A Maori proverb (Reilly, 2008) The traditional indigenous Maori world-view in New Zealand is formed around the understanding that humanity is created through eco-genealogical connections to the land, which is understood as a foundational ancestor. Many indigenous peoples’ appreciation of ancestral lands, and all they contain, manifest in deep emotional, spiritual and familial attachments. Acknowledging the interconnectedness and interdependencies of humanity and the natural world also draws attention to the intergenerational obligations imposed by this material heritage, and the moral responsibility of enacting continual and considered stewardship at all times (Kenney and Phibbs, 2014, 2015). Similar deep relational ties are common to many indigenous and traditional cultures that bind successive generations to maintaining the environmental, social and spiritual well-being of living lands, which are intimately linked to the embodiment of identities (both human and nonhuman) (Marsden, 1992; Agrawal, 1995; King et al., 2007; Langton et al., 2012). Elements of the natural world – fauna, flora, waterways and terrains – are considered to have agency alongside humanity, as illustrated in the personification of rivers and mountains in Maori culture (Whyte, 2014). This systemic approach to understanding the connection between communities and ecosystems is increasingly being understood within wider political systems. For example, in the New Zealand legal system (O’Donnell and Talbot-Jones, 2018), the Whanganui River is recognized as a legal person (New Zealand Government, 2017). Drawing on similar cultural traditions, the constitutions of the Plurinational State of Bolivia and of Ecuador also recognize Mother Nature as having rights that governments are required to protect (Shelton, 2015). Rather than excluding contexts, this approach to decision-making embraces contexts and works adaptively with, instead of attempting to control or conquer, complex living systems. Local or traditional knowledge is also highly dynamic and includes opportunities for communities to create “hybrid knowledge” on risk by using traditional methods and triangulating with data gained through science and technology (Trogrlic et al., 2022). In the face of changes in planetary systems due to climate change and overexploitation of ecosystems, communities around the world are seeking new ways to understand and manage ecological–social risk. On the island of Sulawesi, Indonesia, Kaili communities are the largest ethnic group in the city of Palu. They have built past knowledge of hazards into specific names for disaster-related phenomena, such as lingu (earthquake), lembotalu (for tsunamis, which literally means three big waves) and nalodo (for post-earthquake liquefaction), as well as informative folk songs about previous events. The Kaili communities also established safe areas named kinta, which they believed to be safe from liquefaction phenomena. During a mass liquefaction in the Petobo district of Palu in 2018, the houses in kinta proximity were only mildly affected, with their use as safe areas avoiding loss of life and significant damage and loss (Triyanti et al., 2022). “Getting scientists to consider the validity of indigenous knowledge is like swimming upstream in cold, cold water. They’ve been so conditioned to be sceptical of even the hardest of hard data that bending their minds towards theories that are verified without the expected graphs or equations is tough. Couple that with the unblinking assumption that science has cornered the market on truth and there’s not much room for discussion.” (Kimmerer, 2020) 78 In New Zealand, following the 2010–2011 and 2016 earthquakes in Canterbury, the local Maori tribe Ngāi Tahu partnered with central and local governments in ensuring environmental restoration, biodiversity and future sustainability of the region. Collaboration with Environment Canterbury encompassed the geophysical profiling of Ngāi Tahu lands and earthquake changes, global information system mapping of sites of tribal significance and restoration of traditional food gathering sites (Kenney, 2019). Project results have shaped measures for protecting cultural heritage values, informed regional planning and supported economic recovery in Canterbury. Longer-term outcomes include the development of heritage risk models that map risks to traditional assets and the creation of heritage risk alerts that categorize graduated outcomes in terms of risk exposure (ECan, 2013). Also in New Zealand, the Maori tribe Ngāti Rangi resident around the active stratovolcano Mount Ruapehu uses traditional knowledge of volcanic activity to inform contemporary risk management planning (Pardo et al., 2015). Indigenous indicators of increasing volcanic activity, changes in fauna behaviour and the reaction of flora to altered soil chemistry are documented, while digital sensors and cameras have also been deployed at ancestral monitoring locations (Gabrielsen et al., 2017). In this context, modern scientific technologies are operationalized alongside service to holistic cultural stewardship and the preservation of an ecogenealogical relationship, because Mount Ruapehu is considered an eponymous ancestor by Ngāti Rangi (New Zealand Government, 2019). As climate change has exacerbated the incidence and intensity of extreme weather events globally (IPCC, 2021b), flooding disasters have also increased, creating social devastation, economic destabilization, infrastructure destruction, and environmental erosion and collapse, especially in indigenous communities (Kelman, 2015). Yet, there is evidence of indigenous or traditional cultural attributes being mobilized (Saunders, 2017; Dube and Munsaka, 2018) to predict flood risks and facilitate broader community recovery and resilience following significant flooding events (Hiwasaki et al., 2014). Flood management planning in some areas in Nepal and on the Tibetan Plateau rely on traditional approaches to forecasting and responding to floods. Flood mitigation and prevention practices include cultivating flood-resilient crops and creating drainage channels and moats. Community-based early warning systems use environmental indicators to identify patterns associated with the onset of flooding. These may range from cloud shapes, rainfall patterns and fauna activity, to wind velocity, star positions and outside temperatures (Gautam et al., 2007; Dewan, 2015). Local communities respond with emergency preparedness measures, including stockpiling resources, raising storage areas for essential supplies, moving living spaces to the second storey of houses, relocating animals to higher ground and establishing evacuation routes. Immediately following flooding events, traditional health remedies (e.g. green coconut water used to treat diarrhoea, cholera and dysentery; Adams and Bratt, 1992) are also used in the absence of other “conventional” response and recovery resources. “In a culture where the myth of objectivism is very much alive and truth is always absolute truth, the people who get to impose their metaphors on the culture get to define what we consider to be true – absolutely and objectively true. All cultures have myths, and people cannot function without myth any more than they can function without metaphor. And just as we often take the metaphors of our own culture as truths, so we often take the myths of our own cultures as truths. The myth of objectivism is particularly insidious in this way. Not only does it purport not to be a myth, but it makes both myths and metaphors objects of belittlement and scorn: according to the objectivist myth, myths and metaphors cannot be taken seriously because they are not objectively true. However, the myth of objectivism is itself not objectively true.” (Lakoff and Johnson, 2003) 79 Box 6.1. Australian Aboriginal cultural burning and wildfire management Much of the Australian landscape is prone to large-scale devastating wildfires. For example, the “Black Summer” fires of 2019–2020 burned so fiercely that they created their own firestorms, burned almost 19 million ha of land, destroyed 3,113 houses, resulted in the deaths of 33 people (Filkov et al., 2020) and killed at least 1  billion mammals, birds and reptiles (Dickman and McDonald, 2020). Such fires cannot be extinguished and can be controlled only at the margins. They are also occurring more frequently, with droughts becoming more severe and average temperatures increasing due to climate change (Abram et al., 2021). There is an ongoing debate about how to manage forests to reduce these human and ecological impacts, which has focused on the binary options of: (a) planned burning by fire authorities to mitigate wildfire risk by reducing fuel load in forests or (b)  preserving the forests in their natural state, knowing they will be devastated by spontaneous fires (e.g. due to lightning) every few years. Government authorities have also recently begun to consider a third way – that of Aboriginal fire management. After the Black Summer fires, Aboriginal techniques of “mosaic burns” or “cultural burning” were promoted strongly as an effective measure to reduce the risk of recurrence (Betigeri, 2020). Such burning is done in small areas, and its timing and frequency is informed by local knowledge of the environment and weather patterns. This creates cooler fires that clear fuel such as broken branches, fallen trees and underbrush, but without killing trees (Gerretsen, 2018), and allows fauna to escape and flora to regenerate from the unburned neighbouring areas. In contrast, contemporary risk reduction burns employed by fire services tend to be larger in scale, occur more frequently and have an increased propensity for causing uncontrolled wildfires (Bowman et al., 2004). Where cultural burning is practised, fire risk is reduced overall, and even when larger fires pass through these areas, they do not burn as hot or cause such devastation. These techniques, often described as “firestick farming”, were practised by Aboriginal peoples in Australia before European settlement (Bird et al., 2013), to reduce the incidence and level of fire intensity, to regenerate pasture for game animals such as kangaroos and to select for staple food plants (Gammage, 2012; Pascoe, 2018). New progress in wider acceptance of cultural burning was marked in 2020 in the State of Victoria, with the government’s adoption of The Victorian Traditional Owner Cultural Fire Strategy, co-developed with Traditional Owners to reintroduce cultural fire practices (The Victorian Traditional Owner Cultural Fire Knowledge Group, 2020). Credit: Gareth Catt/Kanyirninpa Jukurrpa Minyawu Miller, an elder in the Punmu Aboriginal Community, lights fires in the Great Sandy Desert in Australia 80 Extreme heat events, drought and wildfire also challenge indigenous and traditional communities’ adaptive capacities, as they do for industrial agriculture, forestry and water resources management (Berkes, 1999; Langton, 2010). The burning practices of indigenous peoples have also played a critical role in the creation and stewardship of ecosystems in North America, including by the Karuk and Yurok in California, United States, in particular to manage the California hazelnut tree (Bibby, 2004; Kalies and Yocom Kent, 2016; Lake et al., 2017). Polycultural knowledge about such risk can sometimes be made through governments and institutional actors learning from indigenous cultures about ecological management practices that go back millenniums, such as Australian Aboriginal techniques for land management through fire (Box 6.1). 6.2 Established “scripts” and the systemic nature of risk The current scientific world-view is a representation (or manifestation) of the culture and the conditions of the system in which people are making their decisions, despite its foundation in the idea of objective knowledge. However, people and institutions inside this world-view rarely recognize the extent to which it is a way of knowing that operates within a particular context. A perspective that allows for the complexity and multiplicity of contexts is needed to understand the systemic nature of risk. 6.2.1 Limitations of habits A key challenge of operating and making decisions under conditions of significant uncertainty is the human tendency towards the formation of habits. Everyone forms habits, it is how human brains have evolved, or not evolved. A habit always begins with a single decision at some point in time. Repeating that decision, or that way of making a decision, becomes a habit over time. And habits are undeniably hard to change, particularly when it comes to decisions made under uncertainty when the holding to scripts and scripted ways of making decisions dominate. These are habits of thinking that are “efficient”, but they limit people’s capacity to understand and act on the systemic nature of risk. The world-view that people bring when approaching challenging decision-making moments is also an underlying and rarely acknowledged habit. However, it can lead to a simple dualistic (“right” or “wrong”) approach, which provides an increased sense of certainty that gives decision makers an illusion of control. These scripts can serve useful purposes at times. Seeing a lion charging means run. But what do these scripts mean for decision makers in complex institutional or bureaucratic settings? What if running from the lion is not, after all, the best way to avoid becoming prey, and that deeper knowledge of lions and their environment could lead to avoiding the risk, or responding more effectively? The scripted approach can prevent decision makers from being able to recognize patterns outside the dimensions or parameters of the scripts they are effectively working within – for example, outside the protocols of their institutional setting. It means if people are making decisions within a setting where it is implicitly understood that decisions always have a right or wrong answer, then they will act accordingly and seek simple answers to complex questions. Over time, this behaviour can lock in significant limitations and flaws that create additional risk when viewed from a systems perspective. The challenge, then, is how to break free from dualistic decision-making approaches and get into new habits of examining old habits when making a decision that is itself a result of a habit. Making decisions based on the systemic nature of risk is never simple, and it is important to find ways to release people from their scripts. There is a need to find ways of managing systemic or complex cascading risk within dynamic societal and environmental contexts (and within the contexts of those contexts), all of which are constantly shifting. Complex decision-making environments require decision makers to allow all, or as many as possible, of the different contexts to be perceived at the same time; not just those that are convenient to expedite a decision, such as focusing only on the economic or political outcomes. 81 People will often continue to try to make sense or understand a risk-related problem (or come to an “objective” decision point) based on the elimination or exclusion of many of the contexts. This may feel like an appropriate way to navigate the complexity of the systemic nature of risk and yet it excludes relevant contexts. How can the curiosity needed to address complex systemic risk be reconciled with the need for those in positions of governance and decision-making authority to make decisions? Box 6.2. Deep demonstration and small business in a circular economy future in Viet Nam The UNDP deep demonstration approach, called the Sensemaking and Acceleration Protocol, is being used in programmes for building resilience in micro-, small- and medium-sized enterprises (MSMEs) in Viet Nam in the wake of COVID-19 (Ulziikhuu, 2020). It takes a systems perspective in terms of sectoral scope and timescale, asking how to boost the performance of MSMEs in COVID-19 recovery and also how they can be part of a long-term “circular economic rebound” in Viet Nam (Wiesen et al., 2021). MSMEs are the backbone of the Viet Nam economy, accounting for 98% of all enterprises and 40% of GDP (Wiesen et al., 2021). However, the question of their future resilience is not simply about growth. The country’s economic growth in recent years has been based on the linear “take–make–waste” model that has put increasing pressure on ecosystems and depleted natural capital. Continuing this growth model would not meet the country’s long-term goal of development based on increased productivity, innovation and competitiveness that is in harmony with sustainable development. Such change will not occur merely by applying new environmental regulations to current linear, extractive and polluting economic growth. It is not a matter only of preserving the environment, and it does not belong only to a single ministry. It needs to be rooted in governance innovation and cross-ministerial collaboration. The approach of aiming for a circular economy requires wider system change that is transformative of the current socioeconomic logics. The challenge is how to achieve such transformation. The model being applied is described as a “sense–reframe–position–transform” model. Currently in the sensing phase, it aims to “see” the system in a new way and understand various drivers and their connections, before attempting to plan how to change them. One of the contexts this phase is looking at is the role of financial capital in changing behaviours in the system, investigating the effects that leveraging existing capital and resources could have across different programmes to catalyse transformation. It is also looking at distinctive features of Vietnamese culture and building on traditional understandings, such as the circular economy practices used in the agriculture sector for decades. However, there is a gap in public awareness about what the transition would mean and what changes are needed in consumption and production practices. The model establishes a process for identifying the dimensions of these challenges and working experimentally and collaboratively towards a broad vision, but the intermediate components of the system transformation are not yet known because these will emerge from the process. Source: Wiesen et al. (2021) 82 6.2.2 Learning about the properties of systems An alternative approach to scripted decision-making in the midst of complexity and with significant uncertainty is being able to adopt a perspective that can perceive a much wider range of contexts. An example is the UNDP systems innovation approach being used in Viet Nam (Box  6.2). This approach focuses on the conditions of the system in which a decision is made, rather than focusing solely on the decision itself as if it is made in isolation. The Viet Nam initiative will appear too open ended for many observers. How will anyone know whether or not it was successful if the outcomes are not predetermined? This involves a shift in thinking, to explore how different systems of learning and knowing can inform each other to help scientists and policymakers step outside some old habits of thought in reducing risk. However, supporters of this approach note it is the very state of uncertainty that creates potential to learn about the properties of the systems through the process of making decisions. This is a powerful form of learning that can shift the structures (or the conditions of the system), and ultimately shift the culture and world-views in which the decision makers exist. It is potentially critical in opening new possibilities for decisions based on a more adaptive understanding of the systemic nature of risk rather than maintaining a rigid certain approach to the irreducible complexity of challenges like the climate crisis, ecological breakdown or transitioning energy systems. Another example of adopting a “learning about the properties of systems” approach within a complex system is the Inclusive City-Community Forecasting and Early Warning Service, known as Developing Risk Awareness through Joint Action, being used in Kenya and the United Republic of Tanzania (Resurgence, 2020a). It is a practical, ecosystemic approach that is working in Dar es Salaam and Nairobi with a wide range of interested people including those living in informal settlements and municipal and national government representatives (Box 6.3, including Figure 6.1). 6.2.3 No more fixing The challenges of reducing loss of life, limiting economic and wider ecological impacts, and minimizing loss of systems function are difficult to approach. However, when a decision is approached as a way to achieve a pre-specified outcome, this constrains the possibilities for learning to the decision itself. Instead, approaching from the perspective of perceiving the wider sets of constantly shifting, dynamically interacting contexts embraces unprecedented opportunities for learning about the properties of the systems. This learning is possible by releasing decision makers from the perceived need to fix a specific problem and work on issues identified from the relationships of the systems in which the problem exists. It is important to establish a learning culture that allows those who are making the decisions to start a journey of “building their muscles”, developing their capabilities and building their ability to perceive the conditions of the system that give rise to the manifestation of risk, as was done in Australia (Box 6.4). 6.2.4 Building habits of examining habits Decision makers need to be humble about their ability to perceive all of the multiple contexts giving rise to the conditions of the systems that result in risks being manifest. In doing so, they will then be building on the ability to focus attention increasingly on the drivers – the messy, constantly shifting dynamics of all of the systems that are interacting with each other – that give rise to the contexts which establish the conditions of the systems that result in the risks that drive disasters. This will kickstart a new habit of examining habits. The global community now needs to decide to restore relationships by embracing pluralistic ways of knowing, rather than perpetuating dualistic ways, to build human understanding and ways of managing the systemic nature of risk. 83 DARAJA stakeholder group Value added to information Actor Information channel Feedback flow Less dominant flow Dominant flow Kenya Meteorological Department Red Cross Nairobi City County / NMS Urban intermediaries (NGOs) Community media City media National media Community leaders Website Social media Community response groups Local administration SMS Facebook WhatsApp Face to face Radio Social media Radio Social media Newspaper Radio Phone call SMS Face to face Residents of informal settlements Face to face WhatsApp / Facebook Phone call/ SMS TV Figure 6.1. Inclusive and dynamic weather and early warning information in Nairobi Note: DARAJA = Developing Risk Awareness through Joint Action; NGO = non-governmental organization; NMS = Nairobi Metropolitan Services. Source: Resurgence (2020b) Box 6.3. Developing Risk Awareness through Joint Action on weather data in Kenya and the United Republic of Tanzania The Developing Risk Awareness through Joint Action approach is focusing on translating technical weather and climate information produced by scientists and forecasters at the national meteorological agencies into useful and accessible knowledge for community users. It aims to shift perceptions and change the conditions for real-time preventive or preparatory actions on the ground for populations largely in informal settlements who are exposed to a full range of risks, including rapid urban flooding. A significant component of the challenge of preventing loss of life, livelihood and property from urban flooding addressed by this ecosystemic approach is building the confidence of the affected populations in the highly technical information produced. Such information is not accessible unless it is transformed for those who may benefit most from using it. This requires a change in the scientists’ and the communities’ perceptions and engaging in the forecasting system in a new way. The approach embeds mutual learning about what information is possible and what information is necessary, relevant and understandable. Figure 6.1 shows Nairobi’s inclusive and dynamic weather and early warning Information Ecosystem Map pioneered under the Developing Risk Awareness through Joint Action approach. 84 Box 6.4. Profiling interconnected causes and cascading systemic disaster risk in Australia Australia has undertaken a national learning process about the properties of systems without a predetermined form for the outcomes. The Government’s National Resilience Taskforce, together with Emergency Management Australia, led an interactive process to investigate what makes Australia vulnerable to disaster. The results were published in the report Profiling Australia’s Vulnerability: The Interconnected Causes and Cascading Effects of Systemic Disaster Risk (National Resilience Taskforce, 2018) and informed the Australian national DRR framework. At the start of the process, not much was known nationally about what people’s preferences and value priorities were when at risk of being severely affected by disaster loss. Significantly, profiling systemic vulnerability recognized that everyone and everything is vulnerable to the effects or disruption caused by severe to catastrophic events. Often, vulnerability is mistakenly perceived as a sign of weakness, with a tendency to downplay personal, institutional and community vulnerability, especially for people of affluence or in power. The process had two principal objectives and products to deliver: 1. New knowledge, in the form of stories, concepts, understanding, narratives and/or data about key drivers of vulnerability from a wide cross section of people through workshops designed for this purpose. 2. A national vulnerability profile that reflected inclusive understandings of the complex interdependent nature of the causes of vulnerability, the roles and responsibilities for tackling these, and the hope and agency for driving change. The approach and methods were designed to be repeatable and adaptable, and to result in co-producing a systems understanding of disaster. They used visual representation of cause and effect, and generated associated stories of lived experience that underwent extensive synthesizing and sense-making. The report narrates how risk and vulnerability are created, transferred and experienced during disasters, including stories of experiences and the values affected or lost. These stories and the system patterns identified highlight that tensions, conflicts in values and different ideas on acceptable trade-offs can arise among different parts of society and among different roles within organizations. For example: a prosperous now versus a prosperous future; ourselves versus others; blame versus learning; stability versus change; people versus planet; tangible versus intangible; and liberties versus regulation. A “resilience checklist” was also developed that assists in the discovery of what “doing things differently” looks like. Figure 6.2 builds on the resilience checklist and illustrates the three different pathways or ways of thinking, deciding and acting in the Australian context: doing things the same, doing things better and doing things differently. Sources: O’Connell et al. (2018, 2020); Buchtmann (nee Osuchowski) et al. (2022) 85 Figure 6.2. A DRR system narrative in Australia Note: VRK = values rules knowledge. Source: O’Connell et al. (2020) 86 87 6.3 Relational practices to explore the way forward Practical explorations for de-patterning, challenging hard-programmed habits (scripts) and repatterning for culture level shifts are already under way. The UNDP deep demonstration model applied in Viet Nam, the Developing Risk Awareness through Joint Action approach in Kenya and the United Republic of Tanzania, and the cascading and systemic risk approach in Australia are examples of moving beyond the usual scripts. There are also other varied and experimental typologies aiming to develop a shared practice to better understand and navigate the shifting contexts of the systems in which risk management decisions must be made. 6.3.1 Enhancing the technical practice of disaster risk management Practitioners are increasingly experimenting with ways to bring relational approaches into bureaucracies and design processes (e.g. Box 6.5). Box 6.5. Practical experiments in DRM critical technical practice To uncover and highlight the benefits of interdisciplinary collaboration and reflexivity in disaster risk modelling, communication and management, a team of researchers from the Nanyang Technological University Singapore undertook an experiment with new ways of approaching DRM beyond the engineering discipline (Lallemant et al., 2022). Workshops, outreach events and professional collaborations were designed to enhance DRM technical practice through events such as: ● Artathon: A 2 day event in San Francisco, United States, that brought together engineers, artists and scientists to collaborate on new works of art based on local disaster and climate data. It was conducted as a team-based marathon that culminated in an exhibition. ● Understanding Risk Field Lab: A month-long arts and technology “un-conference” exploring critical design practices, collaborative technology production, hacking and art to address complex issues of urban flooding in Chiang Mai, a medium-sized, flood-prone city in northern Thailand. ● A virtual workshop held over a 4 month period in 2020 on responsible engineering, science and technology for DRM, with 17 participants recruited via an online call. These events aimed to apply four key design principles: 1. Egalitarian interdisciplinarity: To give equal weight to people and approaches from different disciplines, not merely to use them in support of technical solutions. 2. Inclusivity: To avoid reinforcing unequal power relations and engage meaningfully with a “diverse spectrum of stakeholders of risk reduction interventions” (Wobbrock and Kientz, 2016; Meng et al., 2019), going beyond interdisciplinarity to consider ways of knowing that are more diverse (Ford et al., 2016), including those outside academia. 3. Creativity: To use novel ways to engage, analyse and implement risk reduction measures and support climate risk understanding and communication by working past the “delimited solution space created by narrow and siloed approaches to problems” (Lallemant et al., 2022), including novel collaborations (Scheffer et al., 2017; Lehmann and Gaskins, 2019). 4. Reflexivity: To develop a reflexive process, prior to and following innovation in DRM, aiming at discovering successes and challenges from practice. For communities of practice, this reflexive process may take place at professional events like scientific conferences, inclusive events and workshops, or through participatory or human-centred design events. Source: Lallemant et al. (2022) 88 GOAL: Initiatives for a critical technical practice in disaster risk management DESIGN ELEMENTS DESIGN PRINCIPLES Participant selection Time Output-orientated activities Open-space technology Place-based activities Budget and resources Creativity Egalitarian interdisciplinarity Inclusivity Reflexivity Figure 6.3. Design principles and elements to promote critical technical practice Source: Lallemant et al. (2022) Figure  6.3 illustrates how the four design principles can be integrated into events and programmes to move beyond the scripts of engineering and technology by foregrounding the contexts and assumptions underpinning the way they create knowledge and data and pushing the technical disciplines to evolve (Lallemant et al., 2022). 89 6.3.2 Generating and using warm data “One of the biggest shifts in my thinking thanks to the warm data lab has been around the nature of technology. I used to believe that technology was inherently neutral, but I now see that line of reasoning as naïve. A technology does not exist independently from its contexts. And these contexts are part of complex systems. So, it’s clear to me now that we need to think hard about whether certain technologies should ever be built or released.” David Jones, Executive Producer/Principal Program Manager, Office Envisioning, Microsoft (International Bateson Institute, n.d.) As ecological–social systems are relational in nature, some practitioners such as the International Bateson Institute are experimenting with methods to gather and impart relational information in new ways. Warm data is a type of information to develop in tandem with existing forms of data. Since the subject being perceived dictates the need to understand in different ways, these methods aim to produce different kinds of information. However, the kind of information produced is intentionally a slippery mess of variables, changes and ambiguities. It does not sit nicely in graphs or models, and it takes longer to produce. As it describes relational interdependencies, it must also include the necessary contradictions, paradoxes, binds, double-binds and inconsistencies that occur in interrelational processes over time. The creation of warm data is the delivery of these multiple descriptions in active comparison, usually in a form that permits and even encourages the subjectivity of the observer (Box 6.6). Box 6.6. Zero Step Warm Data Project on Energy, International Bateson Institute and UNDP The International Bateson Institute, together with UNDP and other partners, facilitated the Zero Step Warm Data Project prototype in May and June 2021 as a complementary process to the formal United Nations High-Level Dialogue on Energy. It used a “people need people” online format to bring together more than 700 people on all continents across more than 25 countries in 67 warm data sessions (People Need People, 2020). Participants in the prototype, including United Nations staff, private sector businesses, governments and communities, were able to experience a shift in perception, and to appreciate that shifting perceptions is the action that shifts everything and opens new possibilities for a range of decisions that could previously not be seen or acted upon. The zero-step prototype opened a new space to explore that the problems of energy access and energy transition are not about the amount of energy, not the access to technology, not the availability of data and not the amount of finance. Energy access and energy transition problems are within the business models, within the economic models, within the politics, within the history, within the education and, ultimately, within the culture, all of which are descriptions of each other. It was agreed it was important to find ways together across the wider high-level dialogue on energy processes. The aim was to be quicker to mutually learn that choices being made to continue current (linear) trajectories of change, and not to challenge deeply embedded habits, assumptions and relationships with energy are the exact choices that are resulting in a collective inability to manage the results of those choices. Source: People Need People (2020) 90 6.4 Ways forward The examples of traditional and experimental approaches to understanding ecological–social risk presented in this chapter constitute a wide range of possibilities to use and create new polycultural and transcontextual knowledges and to apply them in practice. The common characteristics are that these approaches aim to be non-linear, relational and inclusive of different world-views, to bring an awareness of different contexts and the way that knowledge is being created and used. They aim to help create a picture of systems and relations among ecosystems, and to encourage a shift towards humility and curiosity in decision-making. These methods shift away from measures of success that reinforce narrowly defined behaviours which hold decision makers into scripted ways of perceiving. Instead, the exploratory methods aim to help people see the constantly shifting patterns within the complex systems in which they are being asked to make decisions. They have the potential to bring a deeper understanding of the systems of knowledge and decision-making, and the risks that are part of current models of understanding ecological–social risk. These traditional and new approaches involve: ● Communities who continue to practice risk management from within their indigenous and traditional knowledge systems, who also bring relational and interdependent world-views into wider community engagement and their own use of technology. ● Groups of governmental and scientific experts intent on working with communities to “translate” the systemic nature of risk and scientific data for use with and by a range of groups. ● Methods to push technical disciplines engaged in DRR to evolve towards a greater understanding of their own contexts and to adopt relational approaches. ● Open-ended collaborative deep learning processes intended to leave behind the scripts and understand the contexts to create the new forms of knowledge and data needed to address ecological–social risk. All of these are showing promise. Some may ultimately reinforce, in different ways, the scriptedness and the narrowness of contexts from which their proponents are trying to achieve escape velocity. It is the experimentation with new patterns of behaviours and new patterns of relationships that is most important in finding a way, or finding multiple ways, to tackle the legacy of past and future patterns of human thought and action that increase ecological–social risk. Fundamentally, these explorations include holding and honouring each other’s stories, connecting and caring, investing in flexibility and relationships, and exploring new metaphors and myths that create possibilities for new realities for decision makers through wider and less-constrained perceptions. These approaches help decision makers focus on the appropriate modalities for risk management and risk reduction interventions in complex, adaptive systems contexts (i.e. within societies and nature). They are needed to work in parallel with other forms of data and analysis of risk in systems, to reframe how to see and address risk at local and planetary scales. 91 X X Part II The role of biases and communication in risk reduction 7. How human biases and decision processes affect risk reduction outcomes Although humans have classified themselves as Homo sapiens (wise hominids), in most daily situations people rely on quick short cuts (heuristics) to allow mostly accurate decisions, rather than on a deep and full assessment of the relative costs and benefits of each decision. Research into decisionmaking has concluded this occurs for a variety of reasons relating to the basic architecture of human minds and the large amount of information processed every waking minute. Habits of mind become biases that interact with people’s social motives and the world around them to determine the decisions they make. This also affects the decisions made individually and collectively about how to cope with disasters. This chapter offers insights into why human minds form habits that are resistant to change, how these cognitive biases can result in suboptimal decision-making around disasters and also how understanding this can be harnessed to accelerate effective risk reduction. 7.1 Why human decisionmaking processes matter In 2007, the people of Iceland endured the largest banking collapse as a percentage of an economy ever (The Economist, 2008). This crash led to sharp, albeit short-lived decreases in human security including cuts to government programmes, increases in unemployment and a significant loss of faith in Icelandic political institutions. These contributed to political instability and street protests. The collapse was eminently predictable when viewed from a historical perspective. So, how was it that this systemic risk went “unseen” for so long? On close inspection, the investments that underpinned the growth of the financial system in Iceland, but also internationally, were based on unsustainable beliefs about the growth in global housing markets and on loans that were increasingly unlikely to ever be repaid. After the crash, the Government of Iceland confronted the fact that the systems designed to prevent this kind of failure – from the formal regulatory systems to the informal governance mechanisms – had failed (Hreinsson et al., 2010). It then established an investigative commission, which concluded that the Government and the larger social environment had allowed a slow and steady growth of systemic risk until it reached the point of collapse. The investigative commission’s Working Group on Ethics specifically examined questions of what influenced the decision-making that drove the systemic risk. It concluded the formal and informal systems that surrounded the financial institutions – the corporate culture inside the banks, the incentivebased salaries and the weak financial regulatory system – were set up to reward short-term decision93 B4 - = + + + + + + - - - + + + + + + + + + + + + + + + + + - - - = - - + - + + - + + - - + + + - + + + + - + - - - - + + + + + + + + + + Reinforcing effects Natural GDP Balancing effects Output gap (GDP – nGDP) GDP R2 MACROECONOMY R1 B1 Credit availability Solvency/ capital ratio Growth of balance sheet Cost of interest payments MARKET DISCIPLINE R National pride Complicated business environment POLITICAL INTERVENTION Goal-driven thinking “Good news” Public image of bank Press uncriticality Foreign criticism discredited SOCIETAL FACTORS R R PR work and donations Public trust towards banks Small population Enforcement strictness Political Material leverage rewards Authorities’ discipline Risk Fiscal policy Size of balance sheet B3 B2 Profits Authorities’ ability to provide liquidity and backup Central bank currency reserves Perceived run Liquidation premium Market manipulation Shareholder leverage Risk-seeking behaviour Socially responsible behaviour Bad owner selection BANK MANAGEMENT Management cohesiveness Internal social reward R2 R Figure 7.1. Systemic risk in the Icelandic financial system, 2007 Note: nGDP = nominal GDP; PR = public relations. Source: Arnarson et al. (2011) 94 making and emphasize narrow, immediate concerns about short-term financial gain. In addition, the principle that ownership and responsibility must go hand in hand had been deactivated (as it had in most countries around the world) as the Government had become the ultimate guarantor of the financial institutions. For these reasons, the deeper or more systemic concerns, including questions of overall sustainability, were regularly overlooked by the government and social environment (Arnarson et al., 2011). All this took place within a particular cultural context that further compounded the risk factors. Iceland is a small, homogeneous society with a strong sense of national identity. In the years before the crisis, bankers and business people were perceived as the nation’s representatives who were raising the country’s status abroad and enhancing wealth at home. Almost everyone in Iceland was benefiting from the financial boom, so there was little motivation to critically question the bankers’ behaviour. The Iceland example illustrates the key challenge that is also central to understanding inaction around DRR. It is easy for governance systems to create conditions that reward decisions made on the basis of incomplete information and that emphasize short-term benefits at the expense of real longerterm risk (Figure 7.1). While biases are part of the human cognitive system, it does not mean such negative outcomes are inevitable. The underlying biases people bring to the table affect the collective response to disaster risk, but they are not inherently negative. Rather, they interact with larger cultural and institutional systems to cause outcomes. Larger systems can shift towards rewarding and encouraging effective risk reduction, but this requires action. This shift is all the more urgent given the current levels of global risk, especially arising from climate change. Changes to basic incentive structures can support different behavioural outcomes in the case of financial systems. Changing how such systems price risk is a powerful tool. For example, in Florida, United States, although the State Government intervened to subsidize the increasing costs of insuring buildings constructed in areas increasingly at risk to hurricanes, several companies ceased offering insurance at all, on the basis that the future risk was too significant (Kunreuther, 2011). This highlights the cost of the risk. It also underscores the importance of interactions between governments and markets in pricing risk, which can be significant. It reveals opportunities for connecting private insurance approaches with governmental compensation, or combining private responsibility with nationwide solidarity. This may be a valuable systems-based approach to support long-term thinking where the cost of bearing such risk is weighed and considered a public good (Danielson and Ekenberg, 2013). 7.2 Bounded rationality The information processing ability of any human is orders of magnitude more complex than that of any computer, but it is not infinite. Analysing the world and making decisions about how to act takes time and energy. The complexity of the world often pushes people to engage with more information than they can consider consciously. Human minds therefore use different tricks and short cuts to help prioritize what issues and events to focus on, and how deeply to process the information related to those issues and events. Psychologists like to say humans have evolved to be “cognitive misers” (Fiske and Taylor, 1991). In general, human systems use the smallest amount of focus and attention necessary to understand and solve problems. Doing so is evolutionarily smart – it allows humans to juggle multiple different tasks simultaneously and maintain awareness of their environment to keep scanning for potential threats. People can devote their full attention to reasoned examination of best solutions to any question they are considering, but such attention is not the typical way they interact with decisions. If everyone went about their grocery shopping by thinking thoroughly and rationally for every single item and the combination of how to maximize health, price, environmental and any other 95 concerns they may have, they would spend hours at the supermarket each time. Instead, under most conditions, people use heuristics, or mental short cuts. On average, these create generally acceptable solutions to problems, rather than a full and complete calculation of a best overall answer (Figure 7.2). Importantly, people are almost never aware of their use of mental short cuts, as they mostly originate in the part of the brain that processes automatic behaviours. Automatic behaviours (e.g. walking and even reading) have been extensively practised to the point of requiring minimal cognitive effort. This idea of effortful versus automatic cognition has been studied in psychology under the general term of the “dual-process theory” of reasoning (Evans, 2003). It is so named because it specifically argues human minds have two separate ways of processing information and reacting to the social environment. Heuristics-based decision-making is one of these two modes of thinking. This “intuitive thinking” approach is fast and relatively low effort in terms of the amount of mental attention it requires, and is also termed “thinking fast” (Kahneman, 2013). Humans tend to use this approach to make decisions in situations that either require relatively little attention or that are complex and rapidly evolving. When presented with the need to make rapid decisions, especially in conditions where there are multiple issues competing for their attention, heuristic-based decisions allow people to make a decision and move on relatively quickly. This is significant for DRR because when sudden-onset disasters occur, there is a need for rapid decisions under situations of incomplete information with many issues competing for attention – conditions in which intuitive thinking is the typical approach to decision-making. Experts also use these mental short cuts, as shown in a study of decision-making in humanitarian disaster response that showed intuitive, heuristic-based decisions were the dominant approach to decisions Non-conscious Faster, low-effort, heuristics-based decision-making Conscious Slower, effortful, reasoned decisionmaking X X Decision point Figure 7.2. Heuristics and decision-making Source: Infographic courtesy of © One Earth Future Foundation (2022) 96 in disaster response (Comes, 2016). In contrast, decision-making to prevent the development of new risk, to reduce known risk outside the context of an immediate crisis, and to perceive and address systemic risk requires deliberative thinking, or “thinking slow”. Heuristics may also be tuned to optimize perceptions of cost and benefit in a person’s local environment. They provide quick answers to common problems and have developed precisely because they work well in most situations. However, these heuristics introduce identifiable biases that do not always result in good decisions, especially when the situation is complex or high pressured. Heuristics respond to specific and immediate environmental cues. They focus attention and decisions on imminent crises, but they mean that slower-moving risks, frequent low-impact disasters or crises with long lead times, and their systemic impacts, can easily be overlooked by intuitive thinking (Broomell, 2020). While, in general, any individual person can be successful in operating according to deep or engaged decision-making, on aggregate, “thinking fast” represents the most common way that people engage with decisions. Biases, or heuristics, that can emerge and which are particularly relevant in disaster decisionmaking include: ● Myopia and simplification, or the tendency to simplify complex problems and make decisions based on limited and personally relevant information. ● The tendency to overemphasize information that is more easily remembered or made salient by a specific environment. ● Anchoring, or using an irrelevant number as the basis for decision under conditions of great uncertainty. ● Optimism and overconfidence, or a general tendency for people to see situations as less threatening than they are and to see themselves as more capable than they are. ● The status quo bias and loss aversion, or the tendency to accept existing situations (even if negative) and to be concerned more about the risk of loss than the potential gain. Not all decisions are made by heuristics. The second process of decision-making, “deliberative thinking”, involves a conscious consideration of the different benefits and risks of different possible choices. Such rational decision-making is exceptionally powerful and is at the core of humans’ evolutionary success – but it is also effortful in time and attention, and is something people do not always do. Some theories suggest people do it only if they feel the automatic response needs to be double checked or corrected. People are more likely to use deliberative models when aware that the decisions are highly important, when they have time to make a decision and when they feel they have sufficient information to make a good decision. In practice, this means people are more likely to take problems seriously and engage with the need for DRR when those problems are consequential, made salient or active by the environment, when they threaten direct and personal loss, and when they affect individuals directly. An example of this comes from risk reduction decisions around volcanic activity. Some volcanic eruptions easily meet the criteria above: they are characterized by visible indicators of danger or rapidly evolving situations that focus attention, loud noises, or other elements that drive salience, loss aversion and other heuristics to encourage people to pay attention – and react – to imminent risk of disaster. In contrast, other types of volcanic activity have fewer of these elements but are equally dangerous. An assessment of the social dynamics of volcanic risk found successful communication was facilitated in part by the consistent transmission of specific risk information, particularly in locally relevant languages and by locally trusted representatives (Barclay et al., 2008). When the risk was seen as a slower developing risk over a longer term, or was less clear or politically polarized – as in volcanic dangers in Guadeloupe, Montserrat and Tenerife – at-risk populations were much less likely to engage effectively in DRR. Therefore, the challenges for governments are how to promote good decisions and how to create systems to expose risky cognitive biases to incentivize those good decisions instead. 97 7.3 Social, psychological and individual factors influencing risk perception People have a variety of social needs, arising from a collective approach as social animals to collaboration and community development. In general, people want to seek out situations and understandings of the world that meet these needs. This makes it easier to convince people of information or understandings that reinforce or align with their core social motives. These biases exist in a feedback loop with many institutions. As people want to get this information from their social environment, it is easy to reward political systems or governance institutions providing this information, which then incentivizes establishment of systems that interact with the biases. In the disaster context, this means risk reduction may be more (or less) likely, depending on how messages and incentives are framed and understood. 7.3.1 Core social motives Core social motives include belonging, self-identity and place in the world, agency (ability to act), enhancing positive views of the self as a community member and trusting others. Belonging People want to feel they belong to social groups and are part of socially cohesive communities. They are willing to adapt their beliefs and behaviour significantly to fit into social communities (Baumeister and Leary, 1995). In some cases, it is more important for a person to belong than to be right. In the context of risk behaviour, this can easily lead to “herding” situations, where groups develop a shared attitude around risk, leading to members of the group complying with that shared understanding without directly engaging with the underlying information. This can have implications for risk reduction. A study of Australian students found those who strongly identified with newly developing groups focusing on climate change prevention were more likely to commit to activities to prevent climate change, compared to students who cared just as much about the issue but felt less connected to it as an identity (Bongiorno et al., 2016). When risk issues become polarized or factionalized in such a way that “risky behaviour” becomes a signifier of group membership, then the commitment to risky behaviour can also become attractive. For example, in the United States, some people have Australian youth hold signs and banners calling for action on climate change at a rally in Victoria Credit: © Shutterstock/Christie Cooper Plymouth on the island of Montserrat, buried under deep ash after the 1995 eruption of the Soufrière Hills volcano, remains abandoned today Credit: © Shutterstock/James Davies Photography 98 modified their diesel trucks to deliberately produce large clouds of black soot. This practice of “rolling coal” is a way to demonstrate their commitment to political ideologies that dismiss the threat of climate change (Tabuchi, 2016). Self-identity Generally, people do not feel comfortable when their beliefs about themselves or their view of the world are challenged. They will seek out information confirming their beliefs, even when it is upsetting (Swann and Read, 1981). As an example, a study of wildfire preparedness in Australia found people within the same communities reacted differently to the idea of wildfire mitigation strategies depending on what deeply held belief they saw as most significant to them. Some people saw wildfire risk reduction strategies as inconsistent with their commitment to environmental preservation (as it required clearing vegetation), while others saw the strategies as a demonstration of commitment to keeping the community safe. The result was tension between people prioritizing risk reduction and those prioritizing one form of environmental protection, with decisions to clear vegetation (or not) being a public signal of which stance was taken (Paton and Buergelt, 2012) (Figure 7.3). Agency In general, people need to feel they have control over their lives, and they react differently to a loss of control. Experiences can range from anger I’m worried Australia’s native forests and unique wildlife will never be the same This is a wake-up call for the world on the impacts of climate change Leadership on the bushfire response requires the Prime Minister to lead on climate change action The current bushfires demonstrate the cost of climate inaction Climate change is making bushfires worse Governments should mobilise all of society to tackle climate change, like they mobilised... Climate change makes bushfire hazard reduction more difficult to complete safely Mining and burning coal makes bushfires worse The federal Coalition government has done a good job managing the climate crisis There is no connection between climate change and bushfires Have been directly impacted Have not been directly impacted 85% 70% 83% 57% 82% 59% 79% 48% 79% 52% 77% 51% 73% 47% 61% 32% 34% 32% 31% 34% Figure 7.3. Attitudes towards wildfires and climate change risk for people affected and not affected by past events in Australia Source: The Australia Institute (2020) 99 and hostility to passiveness, mental distress and emotional dysregulation (Fiske and Dépret, 1996). This is particularly relevant to DRR. If mandates or other government actions are perceived as limiting people’s agency, or not engaging with them, some people may resist. In contrast, those who feel more engaged in the decisions made around risk reduction may be more likely to comply. An unfortunate example of resisting public measures comes from the town of Güssing in Austria, where a climate risk reduction programme including an ambitious transition to clean energy was rejected. This was partly because of a sense by the community that the programme was being forced on it through a non-inclusive process (Komendantova et al., 2018). History is also important. Communities experiencing chronic states of uncertainty (e.g. about their safety, finances or health) and which are typically the most marginalized are especially likely to experience a lack of agency with associated distrust of governments (Afifi and Afifi, 2021). The 2012 special report of the IPCC highlighted this specifically in the context of climate-related disaster risk, pointing out how marginalization and a lack of information tended to compound each other to create heightened vulnerability. This was seen as due to “an inability to understand extreme event-related information due to language problems, prioritization of finding employment and housing, and distrust of authorities” (IPCC, 2012). At the same time, for communities with a greater historical experience of agency, the threat to perceived ability to act that characterizes disaster can strongly motivate careful information search and associated risk reduction behaviour (Pittman and D’Agostino, 1989). Enhancing People generally like to feel they are good people with positive characteristics. Given the choice of different stories about themselves and the world, they usually choose to believe the interpretations that describe them in the most positive ways. This occurs especially when these interpretations reinforce other motives such as understanding or social connection (Kwang and Swann, 2010). In the disaster context, this can support DRR behaviour. If people see themselves as heroic or in positive terms for engaging in risk reduction, they may do so. However, it can also support the optimism bias, the tendency of people to see the world as less risky than it is or to see risks to themselves as less significant than they are (Caponecchia, 2010). Trusting People have a strong need to see others as trustworthy, and they object strongly when expectations of fairness are violated (Brosnan, 2006). In the context of disaster response, this can support quick community organization. The early phase of community response to disasters is often characterized by collective support and a strong sense of collective community. For example, an assessment of a 2004 fire in the informal community of Imizamo Yethu in South Africa found that in the initial response and early recovery periods, the community came together to share resources such as food and shelter, as well as childcare, access to education and other elements. While such collective support does not always persist in disaster recovery, the community remained strong and cohesive several years later (Harte et al., 2009). The same motive to trust and support each other can also lead to systemic impacts after disaster. Governance institutions that fail to respond well to disasters often suffer significant damage to their perceived legitimacy. For example, the Icelandic commission identified a large drop in trust in government following the financial crisis. Similarly, the perceived failures of the Government of the Republic of Korea in response to the 2015 MERS outbreak contributed to a change of government, and arguably were one reason for the effective early response by the new government to the COVID-19 outbreak (Thompson, 2020). 100 7.3.2 Social environment and culture The personal and individual processes described in this chapter are only part of the story in understanding risk and human behaviour. People are all individuals embedded in complex social systems, and their behaviour is the result of individual characteristics, histories and biases interacting with these environments (Lewin, 1936). The social environments in which people grow and interact mean their biases and social motives play out in different ways across cultures. In the case of risk decision-making, in general, men and members of dominant ethnicities perceive less risk from risky behaviours than women and members of minority groups (Kahan et al., 2007). This effect appears to be related to cultural expectations around gender roles and the objective differences in risk faced by different groups. There is also a tendency for policymakers and those particularly committed to existing social structures to defend them, and to explain why systems are appropriate and not risky (Feygina et al., 2010). In reality, the objective risk faced by dominant groups is often less than that faced by marginalized ones. Structural inequality, manifesting in behaviours such as racism and sexism, influences individual decision-making around risk and perceptions of institutional decisions. Marginalized ethnic groups report more awareness of risk than people from dominant ethnicities, probably reflecting the real disparities in risk associated with systemic exclusion and social vulnerability, including greater exposure to hazards. In these circumstances, people may know behaviours are risky, but in the face of systemic exclusion and the socioeconomic consequences for them, they prioritize fulfilment of immediate and basic necessities rather than other personal risk reduction. Culture strongly influences which voices are seen as credible and shapes people’s understanding of narratives and what kinds of evidence or arguments are trusted. Culture is significant at the national and organizational levels (Bye and Lamvik, 2007). It affects risk perception through several pathways, including the relative centrality of different values that can affect risk perception and risk behaviour, as well as discrete shared social attitudes about specific systemic risks such as climate change (van der Linden, 2017). For example, cultural traditions on burial practices presented a challenge during the 2014–2016 Ebola virus disease outbreak in West Africa. It was only through close and respectful collaboration with local communities that the risk could be reduced (Box 7.1). Kitchen staff distribute food to community members in an outreach programme in Johannesburg, South Africa Credit: © Shutterstock/Sunshine Seeds 101 Box 7.1. Burial rites and risk during the Ebola outbreak in Liberia, 2014 Ebola is transmitted in part through contact with infected people. Therefore, an important component of limiting its spread is limiting unprotected physical contact with infected people – alive and dead. However, funeral traditions often involve rituals requiring close contact with the dead, thus creating a risk of infection. Recognizing this, in Liberia, in 2014, the government formed a partnership with the Red Cross, the entity designated as the lead for burial management in the Ebola epidemic response. A review of the work of the Safe and Dignified Burial programme – implemented by the Liberian Red Cross and technically supported by the International Federation of Red Cross and Red Crescent Societies (IFRC) – found that early in the response, local communities strongly resisted safe burials (Johnson et al., 2015). Doubts about the reality of Ebola or its specific transmission pathways interacted with strong cultural norms about appropriate burial practices to generate significant resistance to implementing safe and dignified burials. Safe burial practices, including cremation and disinfection of bodies with chlorine solutions, restrictions on physically handling the deceased and other approaches, were directly in contradiction of cultural norms about how to treat the dead respectfully. This created the conditions for socially motivated reasoning: people wanted to treat their loved ones respectfully, to honour their connection and live up to what was expected of them as good and moral people. In this context, it was easier for people to doubt the information presented about Ebola risk, or for them to accept the risk as a part of doing what was right. The result was violence directed against the Safe and Dignified Burial teams and an increase in “secret burials”, where loved ones would bury a deceased person in secret according to their traditions rather than notify health authorities of the death so that a safe burial could be carried out. Recognizing this, the Red Cross improved the training of team members on how to communicate about risk and stepped up work with local leaders trusted by the community to improve risk communication and community engagement. A Red Cross burial team member disinfects her hands after taking a sample from the body of a suspected Ebola fatality in Paynesville, Liberia The Red Cross strategy also included direct adaptation of burial methods to be more in line with local expectations. It ended the use of cremation as an approach and adapted protocols to introduce culturally appropriate rituals that safely replaced those that posed a risk of transmission. The IFRC evaluation of the programme indicated that the combination of these different approaches contributed to a change in local behaviour, leading to an effective reduction in transmission of Ebola. Sources: Johnson et al. (2015); IFRC, personal communication (2022) Credit: © Victor Lacken/IFRC 102 7.4 Engaging across decisionmaking processes 7.4.1 Awareness is not enough Research into decision-making has found awareness of risk is not enough to drive behaviour change. In fact, people regularly fail to reduce their personal risk even when they know in the abstract that such risk is real. This is because risk decisionmaking is a process (Ajzen, 2020). Biases and motivated reasoning can influence the decision and its execution at each step – from awareness of risk, to understanding options, to confidence that such options can be executed, to selection of a course of action, to execution of that action. One aspect of the challenge in promoting effective risk reduction relates to the availability of accurate information about risk. Forecasts may be accurate but uncertain, so governance systems and decision makers must accept a certain tolerance for uncertainty in decision-making, to manage systemic risk. However, as discussed in section  7.3, people are more likely to engage in risk reduction behaviour when they are aware of a risk, feel confident they have specific knowledge about what to do to reduce the risk and have the agency to act. For example, in Japan, people increasingly sought information about COVID-19 during early 2020. Surveys indicated that their first concern was to protect their own health, followed by other personal concerns such as education, welfare of family members and visa status of foreign residents. Their information-seeking also increased in frequency after the state of emergency was declared, indicating they perceived it as a real and increasing risk to them personally as case numbers grew (Robles, 2022) (Table 7.1). Table 7.1 summarizes the distribution of COVID-19 information-seeking by survey respondents in Japan across three periods. The significant time marker was the declaration of a first state of emergency in April 2020. Before the state of emergency, twothirds of 223 survey respondents had already been looking for information related to COVID-19 at least once a day, including 44.4% seeking information more than once a day. By the time the first state of emergency was enforced, more respondents (74.1%) reported seeking information at least once a day. After the first state of emergency was lifted, the survey respondents continued to look for such information regularly, but a little less frequently, with 22.4% checking more than once per day, 31.3% seeking information daily and 31.7% weekly (Robles, 2022). Frequency of information-seeking Percentage of survey respondents seeking COVID-19 information (%) Before state of emergency Mid Jan–7 April 2020 During first state of emergency 8 April–27 May 2020 After first state of emergency 28 May–Dec 2020 More than once a day 44.4 46.7 22.4 Once a day 23.2 27.4 31.3 More than once a week 15.8 10.0 20.5 Once a week 4.2 4.2 11.2 Rarely/never 2.3 1.2 4.6 Table 7.1. Frequency of information-seeking about the COVID-19 pandemic in Japan, 2020 Source: Based on Robles (2022) 103 Governments or other stakeholders that emphasize risk reduction methods requiring specific capacity run the risk of overlooking capacity limitations, such as calls for evacuation that assume people will have the transportation necessary to evacuate, or that the evacuating population is sufficiently able-bodied to do so. Even if people know risk exists and if they have the capacity to reduce it – two big “ifs” – they may not execute the recommended risk reduction behaviour. The biases discussed in this chapter can also lead to a status quo bias in which people are comfortable with situations even as they become increasingly risky. Those “biases” may also, in some cases, represent accurate judgments. Some people and communities may have historical reasons not to engage in risk reduction behaviour advocated by sources with little to no knowledge or appreciation of the conditions of their lives and restrictions therein (Komendantova et al., 2016). For example, wildfire risk is increasing in many countries, due to increasing construction in the urban–wildland interface and the systemic risks of climate change. Residents and property owners in high-risk areas can take risk reduction actions if they have the means, some through their own labour and some requiring financial investments not available to everyone. Research from Australia (McLennan et al., 2015) and the United States (Martin et al., 2009) has consistently found people who are more aware of the potential risk of wildfires report more intention to take steps to reduce risk. However, this is mediated in part by whether people feel they have options they can take to meaningfully reduce risk – if people feel less capable of executing mitigation strategies or less aware of them, they report less willingness to take risk reduction action. The selection of strategies is also important. Research from Australian at-risk communities suggests a significant proportion of the respondents reported plans to stay in place and defend their buildings from wildfires using strategies that would likely not work (McLennan et al., 2015). 7.4.2 Individual and structural pressures in risk decision systems To understand behavioural outcomes, it is necessary to think less in terms of individual-based approaches and more in larger structural and systemic ways that show how individual decisions are influenced by larger social systems. These may include issues such as laws, policies, systems, physical designs, discrimination, restricted access, financial constraints and other aspects of lived experience that help facilitate or constrain behaviours (Blankenship et al., 2006). Individual decisions and individual abilities to make good choices about DRR have to be understood in the context of community histories and the structural reasons that prevent individuals effectively accessing the information and resources needed to reduce risk. Their decisions are influenced by social norms, due to direct capacity limitations and even through the impact of chronic uncertainty on the neurology of those who live with it (Fugariu et al., 2020). As a rule, people are also inclined to attribute their success to internal factors (e.g. intelligence or personality), whereas unfortunate outcomes are blamed on unfortunate circumstances. Unfortunately, institutional structures often appear to reinforce biases towards higher-risk behaviour, as shown by the Iceland example in section  7.1 above. Before the systemic failure, when there was an abundance of liquidity and most investments turned a profit due to unusually favourable market conditions, bankers attributed this to their own brilliance or hard work (Thórisdóttir and Karólínudóttir, 2014). This led to an overestimation of their ability to take appropriate business risks, and resulted in a lack of critical assessment, ever riskier decision-making or both. Such optimism is particularly risky when it coincides with formal and informal incentives within wider systems. For example, in the financial system, investments in stocks are nominally based on longterm assessments of the economic performance 104 of the investment vehicle. In practice, investors are much more likely to make decisions based on short-term gains and losses. This creates a cyclical incentive structure where recipients of investment are incentivized to do whatever they can to deliver short-term performance increases, which then rewards short-term investors (Rappaport, 2005). In the case of the 2008 global financial crash, the focus on short-term performance created conditions where those people taking risky decisions were rewarded more than those who were not – right up until the crash happened. In the face of this pressure, it is easy for motivated reasoning to encourage herding behaviour. If peers are being rewarded for behaviour that is perhaps risky, but perhaps not, the combination of social pressure, optimism biases and fear of missing out can encourage people to take risks that a more sober assessment might suggest are unwise. Individual investors may harbour doubts about the increasingly risky investment behaviour of their colleagues but will hesitate to voice their concerns because of the false belief that nobody else shares them. This demonstrates the importance of the need for social belonging and avoiding anything that might lead to ostracism. However, this same characteristic can also be harnessed for positive social change. If members of a group believe others in their group care about disaster preparedness and have made adequate arrangements, they too will be more likely to follow suit. These same cognitive biases in social systems can also be used to positive effect. An example from Indonesia helps provide insights on how better understanding cognitive biases can accelerate effective disaster recovery (Box 7.2). Box 7.2. Social connection for resilient recovery in East Java, Indonesia In 2006, a mudflow inundated 12  villages and destroyed more than 10,000  homes in the Sidoarjo district of East Java (Farida, 2014). In responding to this disaster, the local government unintentionally took two separate approaches to supporting recovery: one more in line with existing social motives for social connection and identity maintenance, and one less supportive of these motives. Survivors from one village, Renokenongo, were housed in temporary camps set up close to each other and close to their original village. Survivors from another village, Siring, were dispersed. While survivors of both villages were provided with some compensation for their loss, the community of Renokenongo was able to re-establish community identities and community rituals as well as establish networks of mutual support in ways that the Siring community was less supported in doing. Survivors from Siring originally struggled to reconnect with each other and with the loss of their connection to the village itself (including opposition from the government to their listing their residence as Siring instead of the locations they were placed), but over time they were able to establish community connections with each other through electronic communications. Both communities organized to support each other and demand fair treatment from the government and the natural gas company identified as the cause of the disaster. However, the preservation of the Renokenongo social and cultural context appears to have had a significant impact on its community resilience, while the inadvertent intervention in the Siring social structures had the opposite effect (Farida, 2014). 105 7.4.3 How understanding biases can help accelerate disaster risk reduction Governance systems work best when they understand the basic drivers that influence people’s risk decisions and, importantly, what these specific drivers look like in their social and cultural environments. Effective DRR is more likely to occur when risk is apparent and captures people’s attention. This provides an opening for deliberative thinking to avoid or reduce risk. Where this is not the case, social, governance and structural pressures need to be aligned with existing biases or mental short cuts, to encourage effective risk reduction behaviour. Crisis moments challenge many core social motives including desires for agency or control in the world. They often create moments where people are highly motivated to seek out good information about what can be done to reduce risk. Such moments can lead to significant calls for reform if governance institutions are found to be underperforming, and can lead to the creation of stronger systems for prevention and response to disasters. If they are not effectively captured by governance institutions and translated into systems that can maintain forward A small house is washed away by a torrential mudflow Credit: © Shutterstock/Dark\_Side motion, there is a significant risk that recognized threats may shift from salient and immediate concerns into background threats where the underlying biases discussed above work against risk-informed decisions. Crisis moments aside, the biases discussed in section  7.3 are particularly problematic in longerterm or slow-moving crises, in prolonged and small disasters that are less media focused, and in preventing and reducing risk outside the context of a disaster. Smaller-scale recurrent disasters such as landslides or floods cause systemic threats that undermine economies and can account for up to 50% of global losses due to disasters (UNISDR, 2015). These threats are often underappreciated, as the relative lack of attention they get from media or public discussion means they are not seen as relevant, or they are dismissed as not being immediate or significant threats. In these conditions, issues of bias-informed approaches to governance or social systems may be important. These issues also underscore the critical need for institutions that act for the long term. Specifically, because it is difficult for individuals to track and prioritize longterm or slow-developing issues, effective collective institutions need to address these issues. 106 7.5 Ways forward Greater public awareness of human biases and how they play out may help reduce their impact. Ensuring meaningful opportunities for engagement and participation, for example in the early warning or communication processes, may also be useful. Clearly and transparently communicating preferences, criteria and trade-offs during policy development can enhance the quality of decisionmaking processes (Ekenberg et al., 2017). For example, preferences may differ around economic or safety-oriented considerations, short-term versus long-term effects and risks affecting local communities directly compared with systemic risk from more distant sources. Further analysis is needed on how biases and heuristics dampen or amplify perceptions about potential risk scenarios in the present or the future. To reduce the impact of behavioural and cognitive biases, people should have access to data describing situations they can relate to psychologically, and authorities must design risk communication and programmes that take into account these known heuristics and biases. Developing social systems that engage directly with existing biases to support more just and more effective systems for risk reduction can also be useful. There is no reason why social systems cannot be developed that deliberately build on human predispositions to support effective risk reduction. Bias-informed incentives can shape behaviour in ways that produce positive and effective action. One way to do this is by formally changing incentives to align rewards with longterm and short-term or heuristic-driven decisions. Such changes can improve risk performance by supporting behaviour in line with what would be expected from risk-informed decisions, even if the decisions are made for reasons other than a full assessment. Increasing the accessibility of tools to manage risk is also fundamental to a stable climate future and continued sustainable development. For example, changing pricing systems to move the costs of environmental challenges closer in time to the decisions that generate them may be a tool for using short-term and salience-driven biases to support effective climate action. Overall, this chapter has highlighted that: ● DRR actions should be informed by an awareness that engagement, uptake and compliance will not be the same across different communities. Structural, historical, cultural and individual factors will influence how people are motivated to engage with risk reduction recommendations. ● Governments and other stakeholders should incorporate an analysis of biases and social motives into planning for behaviour change to reduce risk. Whenever possible, actions should be designed to reinforce social motives and align with biases rather than require people to behave contrary to them. ● Structural constraints on behaviour should also be considered in making risk reduction recommendations, including issues such as the capacity and history of different communities and their existing resources. 107 8. Addressing biases to increase investment in risk reduction Why is it that individuals and governments still do not invest enough in DRR, despite experience and evidence of its value? Why is there such a gap between the intention to reduce risk and action taken to build resilience, despite the availability of scientific data and advice on risk? What are the cognitive biases and financial incentives that work for and against smarter investments in risk reduction? This chapter suggests that the cognitive biases and mental short cuts (heuristics) outlined in Chapter 7 influence the decision processes of those at risk from disasters and of the key decision makers concerned with their welfare. It outlines how an understanding of biases and heuristics can make action to promote risk reduction more effective. In many countries, tools such as insurance are not widely available or are seldom applied to cover losses from disasters. Investment in pre-emptive risk reduction is also insufficient. Governments often rely on other economic incentives or regulations to encourage investment in DRR. These include lowinterest loans or grants and community engagement processes, and the enforcement of risk reduction policies, building codes and land-use regulations. This chapter suggests an understanding of biases and heuristics in decision-making can help make the design of such products, policies, regulations and standards more effective. The first section looks at how individuals make decisions about risk reduction and how cognitive biases affect those decisions. The second section considers how this knowledge can be applied in governance and financial systems. The third section outlines the role that different stakeholders (e.g. individuals, communities, the private sector and the public sector) can play in this process. Overall, the chapter highlights the need to rework the way current institutional arrangements design and account for the costs of disaster-related losses, particularly long-term risks. Adjusting the design of products can make them more effective, but new financial products and incentives that can better address the impacts of systemic risks are also needed. Just as green bonds have helped accelerate renewable energy finance, similar products are needed to incentivize and ease investment in disaster- and climate-resilient products. 8.1 The impact of biases and heuristics on risk-related decision-making Recent experience of a disaster event often creates a willingness to invest in risk reduction, which leads to long-term benefits for a community facing recurring hazards. For example, in the United States, following Hurricane Andrew in 1992, the State of Florida re-evaluated its standards and enacted a new building code in 2001. It moved from being a state with poorly enforced building codes to having one of the most effective codes in the country. A study of the difference in realized damage from hurricanes 108 in Florida during the period 2001–2010 found homes built to the new standards suffered 53% less damage than homes built before enactment of the building code (Simmons et al., 2017). Similarly, in 1990, a major fire destroyed 427 homes in Montecito, United States, after which homeowners were required by law to make their homes more resistant to embers by putting screens over vents and replacing external cladding with less-flammable materials. When another major fire struck in 2017, the residents of Montecito emerged with no fatalities, no injuries and only seven homes lost, even though winds gusting over 96  km/hour pushed fire and embers deep into the community (Kolden and Henson, 2019). However, the cognitive biases described in Chapter  7 can create resistance to DRR action, investment and regulatory measures. They can also lead to individual and institutional decisionmaking processes that fail to consider the costs of disasters and the benefits of risk reduction. This is particularly the case in novel, rare or compound risk or events where individuals have limited or no personal experience, such as for systemic risk or extreme events. People have a tendency to either not pay attention to the potential consequences of risk or to overreact based on experience of a recent event. This tendency has been revealed in surveys of homeowners in flood- and earthquake-prone areas (Kunreuther et al., 1978; Botzen et al., 2015; Paudel et al., 2015) and those facing wildfire risks (Arvai et al., 2006). Many of the errors decision makers exhibit in dealing with extreme events can be traced to misperceptions of risk (Slovic, 2000), coupled with systemic biases and heuristics (Meyer and Kunreuther, 2017). These include myopia, simplification, optimism, amnesia, inertia and herding. People’s perceptions about whether they have the capacity to make a difference through their actions also play a role. The impacts that cognitive biases and heuristics have on risk-related decisions affect individuals, communities, and private and public sector organizations alike, leading to challenges as well as opportunities. Cognitive biases are not the only factors influencing decision-making and action on DRR. Challenges such as poverty, lack of agency or insufficient access to technical advice also need to be considered. However, key decision makers in the private and public sectors are unlikely to take effective measures or actions to reduce current and future disaster risk and loss if they do not perceive risk accurately. The three fictitious cases below present examples of cognitive biases and heuristics that may affect Apartments destroyed by Hurricane Michael in October 2018, Mexico Beach, Florida Credit: © Shutterstock/Terry Kelly 109 individual- or community-level decisions about investing in DRR. The examples relate to key systemic risk challenges, namely protecting against catastrophic hazard damage and taking action to reduce the impacts of climate change by switching from fossil fuels to energy-efficient and renewable energy technologies. 8.1.1 Example 1: Failure to invest in wildfire risk reduction measures The Rai family purchased a house in a community subject to wildfire damage, but none of the family members have themselves experienced a fire. They decide not to invest in fire-proofing measures and not to clear vegetation in the front yard. These are decisions that reflect various biases, such as: ● Myopia: This is reflected in the decision not to invest in wildfire risk reduction because the upfront costs of making the property safer are perceived to be too high relative to the shortterm benefits of undertaking these measures. ● Simplification: This is evidenced by the focus on the short term, and a belief that the chances of a wildfire are so low that the potential consequences on the house are not considered. ● Optimism: This often goes hand in hand with simplification. In this case, their inaction is based on an optimistic underestimation of the likelihood of a recurrent disaster causing damage to the property. 8.1.2 Example 2: Failure to purchase flood insurance The Kamau family, whose residence is in a floodprone area, did not purchase flood insurance until after flooding damaged the house, even though coverage to pay for losses was highly subsidized. Instead of learning from that experience, the Kamau family members decided to cancel their flood insurance policy several years later because they did not suffer losses from another flood. As in the previous example, several biases are at play: ● Optimism: Before suffering damage, the likelihood of a disaster was perceived as being so low that they did not pay attention to potential consequences and concluded they did not need insurance. ● Simplification: After a disaster they focused on uninsured losses and decided to buy coverage without fully considering the likelihood of another flood occurring that would cause damage to the house. ● Amnesia: Having not experienced losses from floods in the following years, they cancelled their insurance policy because the impact of being uninsured before the previous flood faded from memory and they felt premiums had been wasted. 8.1.3 Example 3: Failure to invest in solar panels to reduce the risk from climate change The Gonzalez family members are considering installing solar panels on the roof of their home because they are concerned about the impacts of climate change and know this action reduces greenhouse gas (GHG) emissions. After reflecting on whether to do it now, given there are other pressing issues on their agenda and budget constraints, they decide to wait due to the following biases: ● Myopia: This is reflected in the decision to focus on the high upfront costs of installing solar panels without considering savings from lower electricity expenses in the years to come and the potential to be self-sufficient if the grid is damaged during a disaster. ● Inertia: The family is unsure about the best course of action, so decide to maintain the status quo even when a more desirable alternative exists. ● Herding: As none of the neighbours have invested in solar panels, why should they? 110 8.2 Reworking risk messaging and incentives to promote financial investment in disaster risk reduction Understanding the cognitive biases at work in the above examples helps to suggest how public policy and financial incentives can be reworked to promote risk reduction more effectively. A solid risk analysis based on listening to experts remains the bedrock for effective DRR. However, the way this information is applied is of equal importance. This section looks at four elements essential to risk reduction action: ● Listening to experts. ● Reframing the presentation of risk information. ● Redirecting financial incentives and regulatory frameworks towards resilience. ● Evaluating strategies. 8.2.1 Listening to experts Scientific risk assessments by experts are essential in designing strategies for reducing risk and future losses from extreme events. They can assist members of the public and key decision makers by providing the most accurate available information on risk. This information needs to be communicated in a clear and transparent manner. To illustrate what “listening the experts” might mean, consider each of the three examples discussed in section 8.1. Failure to invest in wildfire risk reduction measures For key decision makers to reduce the risk associated with wildfires, they need the following data from experts and informed interested parties: ● The probabilities of primary fires from external sources (e.g. nearby forests) that can damage or destroy properties in their community and the uncertainties associated with these probabilities. ● The potential direct damage to properties and indirect losses to the community from fires of different magnitudes and the uncertainties surrounding these estimates. ● The risk of fires that spread from one property to another as a function of whether each of these properties has invested in mitigation measures. ● The most cost-effective mitigation measures to protect individual properties. ● The expected costs and benefits, should a wildfire occur, if the property owners and communities adopt specific mitigation measures. ● The impacts of climate change on the above estimates. Failure to purchase insurance against catastrophic damage Those considering purchasing insurance against potential losses from future disasters need the following information from experts and informed interested parties: ● The probability of future disasters causing damage to the property. ● The magnitude of the damage that would occur using different scenarios of future disasters. ● The cost of insurance as a function of the deductible and coverage amount. ● The reduction in the insurance premium for investing in DRR measures. Failure to install solar panels For key decision makers to advise property owners on whether to install solar panels on their homes or facilities, they need the following data: ● The upfront costs of installing solar panels and how these costs can be spread over time. ● The expected benefits from the reduction in electricity costs, including the possibility that excess electricity generated can be resold to the grid. ● The reduction in GHG emissions over time when switching from fossil fuel energy to solar power. ● The impact that utilizing energy-efficient technologies will have on reducing losses from future disasters related to natural hazards and other extreme events. Expert insights are essential to provide sound advice on each of the issues above, and solutions will vary based on the specific hazards and vulnerabilities encountered. Such insights are invaluable in helping design products and services tailored to local conditions, and in ensuring individuals have the information they need to make good decisions. 111 8.2.2 Reframing the presentation of risk information Reframing the way risk information is presented can have a practical and powerful impact on its efficacy in promoting risk reduction action among individuals, communities and governments (Thaler and Sunstein, 2021). Several practical approaches have proven particularly effective in this regard. Address the myopia bias: Stretch the time-horizon In some cases, the simple action of stretching the time-horizon may be an effective way of dealing with the myopia bias. Empirical studies have shown key decision makers are much more likely to consider risk reduction measures if they are told that over the next 25 years, there is a greater than 1 in 5 chance of having at least one disaster that causes damage to their property instead of describing it as a 1 in 100 annual probability (Chaudhry et al., 2020; Robinson et al., 2021). A similar reframing of probabilities over time was successful a number of years ago to encourage people to wear seat belts while driving, by indicating the likelihood of an accident over a 50 year lifetime of driving rather than per single trip (Slovic et al., 1978). Address the optimism bias: Be constructive Communicating risk often involves conveying statistics on the magnitude of damage, number of fatalities and other losses. The optimism bias leads people to believe such disasters will not happen to them, or if they do, the consequences will not Box 8.1. Effective and constructive communication: the Blue Planet II television series David Attenborough, a pioneer in using captivating television documentaries to galvanize concern for the environment, has long issued warnings. However, he has recently stepped up a focus on practical actions that ordinary people can take to protect the natural world, combined with advocacy towards policymakers (WWF, 2020). His Blue Planet II wildlife documentary series raised the alarm about plastic waste, but also included information on practical actions that viewers could take to address the problem. Studies report that Twitter activity related to plastic waste more than doubled following the series, compared to the same period in the previous year. Nearly 9 in 10 people (88%) who watched it have since changed their behaviour. One food retailer reported it received an 800% increase in questions about plastic after the series (Collins, 2018). Without dedicated research to measure the impact of the television series, it can be difficult to attribute actions directly to it (Dunn et al., 2020), but it is likely that information on the problem and the options for practical action were more effective than bleak warnings alone. The impact of plastic pollution on marine life Credit: © Shutterstock/Tanya Sid 112 be severe. Some communicators attempt to shake audiences out of their optimism bias via vivid, sometimes horrific, descriptions of just how dire outcomes can be. A review of public health communication studies found that if fear was used, people were more likely to act if it was also combined with strong efficacy messages (Witte and Allen, 2000). This implies negative framing should be accompanied by communication that supports a sense of agency, hope, motivation, self- and collective-efficacy, and, importantly, practical steps required for change. Failing to do so can leave people feeling powerless, anxious and overwhelmed – sentiments that can provoke mental shutdown and crush the ingenuity and energy required to tackle big challenges. For example, a recent study of a wildfire-prone community in the city of Valparaíso, Chile, found psychological factors like a perceived lack of control over their lives and the environment crucially influenced people’s risk management behaviour. It hindered preventive actions and also made risk reduction a secondary issue for many. Even if people were aware of the risk and experienced fires several times per year, few collaborative actions resulted from the risk awareness (Lara Mesa, 2021). Pointing to positive and practical actions individuals can take is often a more effective approach (Box 8.1). Address the simplification bias: Construct scenarios One way to frame risk more effectively to address the simplification bias is to construct a range of scenarios to highlight the consequences of disasters occurring, including a worst-case scenario. For example, Mexico City faces seismic hazards that depend on the occurrence of various types of earthquakes, primarily due to site effects that amplify the ground motion (Reinoso and Ordaz, 1999). A recent project by the National University of Mexico considered the uncertainties associated with future earthquakes in Mexico City using three groups of seismic scenarios: (a) scenarios reflecting the likelihood of damage from future earthquakes, (b)  scenarios estimating maximum and recurring losses from earthquakes and (c)  historical, wellknown seismic scenarios and their consequences. These scenarios were then used to develop estimates of structural damage to the city for use by decision makers in risk reduction planning (Reinoso et al., 2022). To better address systemic risks, scenarios can also be developed that assess cascading and compound risks and indirect disaster losses. Showing potential direct and indirect losses can help highlight the necessity of pre-emptive risk reduction across a range of sectors. Such scenarios should not rely on economic metrics only, as this can lead to a tendency to highlight DRR interventions as successful if they protect high-value areas rather than high-vulnerability areas (Lallemant et al., 2020; Markhvida et al., 2020). Additional metrics can include the number or measure of “years of life saved”, which is calculated consistently in the field of public health (Tengs et al., 1995), and broader impacts across wider sectors, including impacts on potential tax revenue. For example, in Barbados, the cascading economic impacts of hurricanes have been analysed to estimate direct and indirect losses, including potential cascading impacts across the economy and society (Box 8.2). Scenarios can be even more effective if they also compare the costs of action and inaction. If this calculation is not done, there is a danger that investments may become “invisible” to observers, because when a hazard occurs losses are not incurred (as the disaster has been effectively prevented). Figure  8.1 shows how this “invisibility” can manifest following an investment in constructing houses on stilts in a flood-prone area. In this case, four scenarios (A to D) contrasting the costs of action with inaction can help make the benefits of DRR clearer, using visual representation and description. Scenarios are also particularly important in making the case for climate change action, as the negative impacts of this major risk are undervalued in economic and social systems. To illustrate this point, consider the expected flood damage due to sea-level rise combined with population growth in high-risk areas. An analysis of 136 major coastal cities around the world revealed that sea-level rise of an optimistic 20  cm by 2050 will cause the average annual flood losses in those cities to increase to $1.2 trillion in that year, compared to only $52  billion in 2005. A more pessimistic scenario in 113 Box 8.2. Scenario of cascading systemic economic impacts of a hurricane in Barbados Barbados faces high levels of risk from hurricanes. Tourism is a major component of its economy. As part of its planning for DRR, analysts constructed a Category  5 hurricane scenario and estimated the expected direct and indirect economic impacts. In the scenario, the hurricane moved across Barbados with 250  km/hour winds and corresponding storm surge flooding. The exercise used the Economic Consequences Assessment Model to estimate indirect economic losses and the Hazus Multi-hazard Loss Estimation to estimate direct economic losses. Under this scenario it was estimated that: ● Some 8.5% of hotels, residences, factories and distribution centres would be flooded and could not be used until extensive remediation work was done. ● Some 11.5% of the population would be displaced for at least 6  months, either fleeing internationally, or residing with friends and relatives – causing an effective average rate of 6% reduction in workforce availability after the event. ● Several transit corridors would be damaged in this event, further limiting the ability for commerce and tourism on the island for a duration of 6–12 months. ● Government tax revenues would decline by between 6.8% and 13.3%, depending upon the tax stream. Table  8.1 gives examples of the percentage outputs/production losses based on detailed costings under this scenario. There are some surprising results, such as the high impact on quarrying and the low impact on restaurants, that signal the importance of using and costing the realistic scenario to estimate direct and indirect losses due to the systemic nature of the risk (Lehman et al., 2022). Table 8.1. Sample of sector estimated losses in Barbados in the 12 months following a Category 5 hurricane scenario Selected sectors experiencing a decline in output/ production Decline (%) Hotels, apartments and guest houses 13.3 Crude petroleum and natural gas extraction 11.2 Quarrying of stone, sand and clay 8.1 Communications 7.6 Agricultural production (all types) 7.5 Construction 3.8 Restaurants 2.9 Overall decline in output/production 7.0 Source: Lehman et al. (2022) 114 which sea levels increase by 40 cm by 2050 would bring average annual flood losses of $1.6  trillion (Hallegatte et al., 2013). It is essential to link this kind of data to incentives for risk reduction, in addition to encouraging a switch to renewable energy, which can slow the pace of climate change. Address the inertia bias: Bundle risks and use “optout” options Another way to get individuals, including institutional decision makers, to pay attention to low-probability risks is to bundle several risks into one insurance policy or risk reduction product (Slovic et al., 1978). For example, a study of natural hazard insurance in Europe found insurance coverage is more widespread in countries where a range of risks are bundled into a single policy (Hudson et al., 2020). In Veneto, Italy, residents of this highly flood-prone area were surveyed after recent major flooding. While most expressed reluctance to buy flood insurance as individuals, many said they would find it acceptable for the government to introduce a compulsory insurance scheme that required them to participate (Roder et al., 2019). Figure 8.1. Schematic of invisibilities in DRR success using stilt houses as flood mitigation Source: Rabonza et al. (2022) 115 In addition, field and controlled experiments in behavioural economics reveal consumers are more likely to stick with the default options rather than going to the trouble of opting out in favour of some other alternative (Jachimowicz et al., 2019). This tendency was highlighted in a study of 1,187  homeowners in flood-prone areas of the Netherlands and the United Kingdom. It compared two options: (a)  providing flood insurance as the default on an existing insurance policy, with a choice to opt out of this coverage, and (b)  giving a homeowner the option to add flood coverage to the existing policy. The first product design option resulted in a higher proportion of homeowners having flood insurance, including those with little to no flood-related experience (Robinson et al., 2021). These examples of working with, not against, how people make decisions about insurance can also be applied to other areas to promote effective risk reduction and climate change action. For example, property developers can make solar panels the default by informing buyers they will be installed on the roof of a new house unless the owners decide they would prefer not to have them. Lenders and realestate agents can provide an economic incentive to maintain solar panels by indicating electricity bills would be lower than if fossil fuels were the source of energy (Kunreuther et al., 2021). Address the herding bias: Create social norms Working with, and building upon, existing social norms and practices can help address the herding bias and contribute to positive risk reduction practices. Religion, customs, social norms and other dimensions influence how people think and behave around risk. Attempting to change fundamental beliefs is likely to be counterproductive and unethical, and may risk undermining existing local and indigenous knowledge (Chapter  6). However, well-designed policies can help encourage change towards positive behaviours. For example, if policies promote a social norm for property owners to invest in solar panels, or adhere to building codes, and those who adopt these measures are given a seal of approval, neighbours will be more likely to follow suit. The success of any social norm campaign will require the media to help promote it. Box 8.3 shows how communications campaigns were used to convince residents in Nepal to invest in seismicresistant measures when rebuilding damaged homes following the 2015 earthquake. Risk communication can also hold up common beliefs and practices for reflection and discussion, particularly if trusted peers help lead the discussion. For example, in Australia and the United States, research shows men more often than women drive into flood water without knowing its depth and thus have higher death rates. A man who feels driving through flood water or working through extreme heat is a sign of masculinity might be reminded by a colleague that dying needlessly is not heroic and will devastate his family. People who feel there is no point taking precautions ahead of a storm because fate is in the hands of God might be gently challenged by a religious leader who points out that God also gave them the ability to develop evacuation plans. Special arrangements and specific formats for communications may also be required to address the needs of minority communities within a targeted region. These should take into account existing community decision-making systems and approaches (Mercer et al., 2009; Chapter 6 above). Using tools such as role modelling uncommon or “unthinkable” behaviour can help prompt discussion across groups, spark innovation, push boundaries and give people confidence to do things differently, as in flood-affected communities in Bangladesh (Box 8.4). It can also prompt critical reflection on the trade-offs between short-term and longer-term benefits, and help people check their assumptions, weigh their options and recognize near-term incentives for longer-term planning. 8.2.3 Redirecting financial incentives and regulatory frameworks towards resilience Economic incentives to invest in DRR and other policies to encourage risk reduction can help to overcome the disadvantages of myopia and shortterm thinking. Short-term economic incentives Well-designed policies and products can make it easier for people to invest in benefits that become visible over several years. For example, offering a 116 Box 8.3. Changing social norms on earthquake-resilient home construction in Nepal In Nepal, following the 2015 earthquake, many people rebuilding their homes were deterred from following earthquake-safe techniques because they felt it would require funds and materials they could not afford and skills they did not have. A long-running weekly radio programme, Milijuli Nepali, and a connected drama, Kathamaala, supported listeners to access the government incentive scheme that rewarded safe rebuilding techniques. Expert advice was shared on using affordable locally sourced materials. A platform was provided to swap ideas among ordinary people for saving money to invest in retrofitting and women retraining as skilled masons to boost their livelihoods were shown as role models. Stories were showcased from homeowners who recognized immediate benefits on top of the long-term risk reduction, including a sense of satisfaction in retaining traditional homes built by ancestors, the memories that come with them, and the ability to continue religious and cultural practices through the design and style of the houses. Listeners also reported a sense of pride and comfort at having a unique home within their community that supports livelihoods and social gatherings in their customary ways. A Nepali woman is interviewed about rebuilding houses to be earthquake resistant Credit: BBC Media Action (OI-m8020) Impact research showed nearly two thirds (62%) of regular listeners learned about governmentapproved rebuilding techniques for earthquake-resistant foundations, and nearly a half (45%) reported using these techniques. Statistical analysis supported that regular listeners were more likely to mention taking action than non-listeners (Saha et al., 2021). Creative storytelling and talented radio production skills, deep understanding of audience realities, up-to-date technical advice and a clear strategy for supporting decision-making combined to create programming that was highly appealing to audiences. So much so that listenership continued to grow years after the earthquake. This underscores the point that high-quality, engaging media is important for sustaining audience interest in risk issues and for sustaining commercial viability (Saha et al., 2021). 117 loan for investing in risk reduction measures tied to a multi-year mortgage can significantly reduce the annual costs, making the investment more affordable upfront. By making the investment financially attractive in the short term, homeowners are more likely to invest in making their house safer from future disasters. In countries where property owners are required to purchase insurance as a condition for a mortgage, the reduction in annual risk-based premiums due to lower claims from a disaster will likely exceed the yearly loan payments. In countries where insurance is not required, or the property owner cannot afford the annual loan payment, a pre-specified grant to the household based on the annual income (i.e. a means-tested voucher) or tax credits may provide incentives to invest in insurance or other risk reduction measures (Kousky and Kunreuther, 2014). Such incentives are also effective in promoting climate change action. By 2030, solar energy will become the cheapest source of power in Canada, China, the United States and 14 other nations (Manghani, 2021). To encourage homeowners to invest in solar panels, leases and power purchase agreements could cover the cost and maintenance of the panels. The homeowner would pay a regional Box 8.4. Television, social norms and flood and storm preparedness in Bangladesh In Bangladesh, research showed people were not undertaking measures to reduce risk before seasonal storms for many reasons, including the fear of being judged by their neighbours as doing something out of the ordinary. In one instance, a family that tied the house roof down ahead of a storm, was accused of witchcraft when everyone else’s roof blew away. In response to these types of social factors, a national television reality programme showcased communities coming together to take action to adapt to climate change and reduce risks. Normalizing risk reduction activities by showing large groups acting made it easier for people to talk about possible changes within their own communities and explore options together. The programme reached over 22.5 million people, with 78% reporting a better understanding of how to prepare for hazards and 47% reporting taking action to prepare. Source: Whitehead (2017) A local woman is interviewed about flood and storm DRR Credit: BBC Media Action (OI-m1560) 118 government or a private company a fee lower than the savings in the electricity bill (Sendy, 2020). This can contribute to a positive cycle where greater economies of scale, increased competition and improved institutional arrangements (e.g. streamlined permitting processes) reduce costs and create incentives for further technological innovation and supply chain efficiencies. Experts estimate such factors will drive the cost of solar energy down from the current price by 15–20% over the next decade, making this investment even more attractive. In California, a government regulation builds the long-term economic benefits of solar energy into new constructions. Since 2020, all new singlefamily and multifamily residences must be built with solar panels (Rogers, 2019). The California Energy Commission, which approved this legislation, estimates the monthly mortgage payment on a house will increase by $40 a month but the owner will save an average of $80 a month on electricity. As the cost of the solar panels is included in the mortgage, the owner’s costs are effectively lowered from the moment they purchase the house. A further regulation will place similar requirements on new commercial structures and high-rise residential projects from 2023 (Penn, 2021), which will also become part of the Building Standards Code. Over the next 30  years, this regulation will reduce GHG emissions equivalent to taking nearly 2.2  million cars off the road for a year (Rogers, 2019). Risk-based insurance premiums Risk-based insurance premiums are another tool that can help overcome the challenge that investment appears too costly relative to the shorter-term reduction in damage. Such premiums can offer lower costs to entities that have invested in preventive risk reduction measures. Catastrophe models have been developed and improved over the past 30  years, to assess the likelihood and damage from disasters of different magnitudes and intensities. Insurers and reinsurers utilize the estimates from these models to determine riskbased premiums and how much coverage to offer in hazard-prone areas (Grossi and Kunreuther, 2005). The estimates can also be used as a baseline for understanding which DRR activities can best reduce the risk to a particular asset. In France, a disaster insurance system called Catastrophes Naturelles incentivizes implementation of risk prevention plans to reduce risk as part of local flood risk management. These plans can prescribe high-risk zones in which new development is not allowed and recommend or require risk reduction measures to reduce floodrelated damage. The insurance system encourages communities to implement their plans by imposing higher deductibles on those who lag behind in implementation (Poussin et al., 2013). A continued reliance on short time-horizons as the basis for financial decisions remains a significant contributor to the failure of policymakers, investors, corporations and project developers to fully consider and respond to disaster risks. Much of the policy, regulation and accounting practice does not mandate consideration or disclosure of the financial impacts of disasters. However, mispricing or underestimating these risks can have a financial impact on an institution’s income statement or balance sheet, whether it is a company, a credit organization or an institutional investor. The consequences of this are significant and growing. By contrast, a taxation system that measures the real cost and provides an incentive by returning a portion of revenue to taxpayer’s local regions changes the financial and social incentives (e.g. Box 8.5). Box 8.5. Carbon taxes in Costa Rica Costa Rica was one of the earliest countries to begin to combat climate change through financial levers, when it adopted an innovative carbon tax on fuel in 1997. There is a connection for taxpayers between fuel use and benefits to their own communities, since a portion of the revenue goes to pay farmers and indigenous communities to protect and regrow tropical forests. The tax generates $33 million annually for these groups; it has helped reverse deforestation and benefited the economy. In 2018, 98% of the electricity in Costa Rica came from renewable energy sources. Source: King (2019) 119 8.2.4 Evaluating strategies Strategies for DRR at any geographic scale must be able to address the following questions: how well do proposed strategies prevent losses over time and are the monitoring metrics of choice properly capturing progress towards the goal of reducing losses as early as possible? Addressing these is not easy, and solutions often require a trade-off between efficiency and equity. Efficiency is normally determined by undertaking a cost–benefit analysis that compares the risk reduction benefits with the investment and maintenance costs of DRR measures. Equity is measured by comparing the utility of the poorest families under the proposed strategy relative to the current programme (Boardman et al., 2018). It is also increasingly important to consider how future generations will fare under different risk management strategies, given the significant negative impacts of climate change. 8.3 Role of key stakeholders in implementing disaster risk reduction measures Ensuring the values and agendas of key stakeholders are aligned towards risk reduction, ideally in a single strategic direction, is essential for effective DRR programmes and policies. However, different stakeholders will have different roles and responsibilities, as outlined below. 8.3.1 Public sector Governments and public sector entities play perhaps the most crucial role in ensuring the frameworks to accelerate risk reduction are in place. They should also take steps to address equality of income and equity and fairness issues by assisting residents and small businesses financially so they can afford to invest in DRR. At the most basic level, governments need to ensure regulations are in place to prevent, reduce or ensure the resilience of construction in unsafe locations, such as flood-plains, areas subject to sea-level rise or areas at extremely high risk of fire or other hazards. To do this, governments also need to better understand the climate projections for their jurisdictions. They should work with experts to update design standards to ensure resilient infrastructure design, particularly against increased temperatures, higher-intensity rainfall and drought impacts. In parallel, assessing the risks to current critical infrastructure under a range of future scenarios likely to occur within their lifetime is essential. Implementing these cost-effective protection measures can help reduce the need for costly humanitarian assessments, saving money and suffering. It is imperative for the public sector to incentivize the transition from fossil fuel to renewable energy sources by subsidizing solar and wind power initiatives and aiding property owners interested in utilizing renewable energy as a source of power. Actions such as putting a price on carbon via emission trading systems or carbon taxes can reduce the emissions that are increasing disasters and stimulate the innovation, diffusion and adoption of renewable energy, as Costa Rica has done (Box  8.5). Where possible, the public sector can also help create quality new jobs by committing additional funds for research and development of innovations in areas key to the climate transition, such as solar and wind energy and battery storage development. Taking measures to improve the targeting of humanitarian assistance so grant-based assistance is provided to the most vulnerable people, and ensuring longer-term assistance is provided through loans not handouts for those with resources, can also help incentivize future risk reduction. Encouraging private sector enterprises to review the resilience and sustainability to systemic risks of their own operations can send important signals to encourage preparedness. Also, encouraging insurers to provide protection against losses from disasters by supplying reinsurance coverage against catastrophic losses for those who take preventive measures can help ensure safety nets are in place (van den Bergh and Botzen, 2020). The public sector is also key in creating a new “social contract” to incentivize investment in disaster resilience. It can help specify the responsibilities and liabilities of national governments, financing bodies and the private sector to manage the negative externalities arising from disaster risks. 120 National governments and regulators need to define sustainable, disaster-resilient investments and encode risk metrics to change investor behaviour and raise awareness of disaster risks. Box  8.6 provides examples of how this is increasingly occurring through the deployment of green finance instruments such as resilience bonds. The annual climate change adaptation costs for developing countries are estimated to be in the range $140 billion to $300 billion per year by 2030, and between $280 billion and $500 billion per year by 2050 if global warming is limited to 2°C above pre-industrial levels (UNEP, 2016). However, these estimates are likely underrepresenting the real need when taking into account the capital requirements for making existing and planned infrastructure investments resilient to climate change. Globally, the need for infrastructure investment is forecast to reach $94 trillion by 2040, and a further $3.5 trillion will be required to meet the United Nations SDGs on renewable energy and water (Oxford Economics, Box 8.6. Innovative finance for risk reduction: green bonds for climate resilience Bonds are a major source of investment for the public and private sectors. Since the first labelled green bond in 2007 by the European Investment Bank, $1.5 trillion of labelled green bonds has been issued worldwide from a diverse range of issuers, including sovereigns, municipalities, national development banks, financial institutions and corporates. About 16.4% (1,265) of green bonds (7,725 deals) have included activities related to adaptation and resilience, mostly in the water and water-related sectors. Of these, 79% were issued by developed markets, 15% from supranational institutions and only 6% from emerging markets (Qadir et al., 2021). Recent examples include: ● Société nationale des chemins de fer français, the French national state-owned railway company, has used green bonds to finance the protection of natural resources and biodiversity in addition to low-carbon transport and rail energy efficiency. ● The city of Malmö in Sweden, one of the earliest municipal green bond issuers, used two issuances to raise funds for climate change adaptation and resilience measures for sustainable management of water, wastewater, land and natural resources. ● The Asian Development Bank issued a bond in 2019 that prominently featured adaptation and resilience activities. Investments include the Mongolian Ulaanbaatar Green Affordable Housing and Resilient Urban Renewal Sector Project, which is building 10,000 energyefficient and low-carbon housing units as part of 20 new eco-districts with resilience infrastructure like roads, water, sewerage, heating pipes and greenhouses for urban farming. ● Grupo Rotoplas, a corporate entity in Mexico, issued a $523 million green bond in 2017 that included resilience finance for innovative water solutions in markets where clean water is scarce due to droughts, water pollution and unreliable water infrastructure. The benefits of green bonds include that they provide issuers access to low-cost capital to finance their investment pipelines and help broaden their investor base, as demand for green bonds far outstrips supply. They are also well suited to large-scale projects that require capital investment ahead of revenues and help unlock discounted finance through blended finance facilities and funds. They also help bring visibility to resilience features and improve internal processes that enhance risk management and strengthen internal relationships and commitment to sustainability (Qadir et al., 2021). 121 2017). Assuming all of these infrastructure investments will require resilience features, the adaptation finance gap is likely to be at the scale of trillions of dollars rather than billions. In the face of these needs, adaptation finance flows remain woefully insufficient. Total tracked public and private investment in climate adaptation in 2018 was $30  billion worldwide (Buchner et al., 2019). Public finance will be insufficient to meet adaptation financing needs, particularly in developing countries. While there is limited data on private investment flows, securing private investment for adaptation remains a challenge. However, in 2018, GHG emissions reduction finance accounted for 93% of total climate-related investment flows globally (Buchner et al., 2019). Climate resilience bonds could help increase investment in adaptation and accelerate a resilient sustainable climate transition (Qadir et al., 2021). 8.3.2 Risk assessment experts The scientific community and sectoral experts such as engineers have key roles to play in providing accurate estimates of the probability and consequences of maintaining the status quo or implementing adaptation measures to reduce future risks. For full transparency, these experts should also specify the uncertainty associated with the estimates. They can then advise households and government agencies which adaptation and risk reduction measures are desirable to implement and most cost-effective. Given the differences in expert estimates, members of the public are likely to focus on the views of those who support their decision on whether to undertake DRR measures. 8.3.3 Private sector The private sector also has a major role to play in accelerating risk reduction action and in reducing losses from future disasters. For example, banks and financial institutions that provide property improvement loans can require specific risk reduction measures to be undertaken as a condition for a mortgage. In designing new houses, apartments and business facilities, developers can avoid construction on flood-plains or in areas affected by sea-level rise. They can also elevate newly constructed buildings (Aerts et al., 2014) and install other DRR measures such as shutters on windows when constructing new property in coastal areas subject to hurricanes. Developers can also negotiate a wind energy land agreement with landowners for wind energy projects such as wind turbines (Frassetto et al., 2018). Real-estate agents can provide relevant information to potential buyers and sellers of environmental features and highlight how they may increase the value of properties. In this regard, a study by Zillow revealed that houses in the United States with solar energy systems sold for 4.1% more on average than comparable houses without solar power. For the median-valued house, this translated to an additional $9,274 (Mikhitarian, 2019). The insurance industry can provide coverage to residents and businesses facing a specific risk and offer premium discounts if they undertake measures that reduce future damage and hence insurance claims. Moreover, given the risk assessment expertise in the insurance industry, insurers can play an important role in informing policyholders on the risks they face and effective risk reduction measures, and in providing information on risk globally, even in areas where insurance penetration is low. All parts of the private sector can take action to reduce the risk of disasters, including by ensuring business continuity when disasters cannot be prevented and by reducing their carbon footprints. Learning from the COVID-19 crisis, the ability to pivot production to address systemic risks is a private sector strength. Looking across a range of risks, private health-care organizations and employers can play an important role in promoting safety and in addressing hazards such as pandemics (Bode et al., 2020). Indirect actions can also help create awareness of good practices. For example, the Netherlands introduced energy performance labels in 2008 to provide information on energy efficiency of homes to potential buyers, which has been capitalized into the purchase price of properties (Brounen and Kok, 2011). 122

[Paragraph Breaks Resume]

8.3.4 Communities and local governments

A major challenge in implementing protective measures to reduce current and future risk is convincing local governments and the public of the importance of reducing damage from future disasters. To address this challenge, communities can hold meetings or other outreach events where key leaders and experts highlight the impact of severe disasters on homes, including indirect losses, such as the economic and psychological costs of evacuating if homes are severely damaged during a disaster. They could point out that adopting DRR measures would likely have enabled them to remain at home. Community leaders can also emphasize that when it comes to hazards such as wildfires, making houses and commercial and public properties safer is likely to reduce the damage to neighbouring houses.

Local and national governments can also enact or modify building codes and impose land-use regulations to reduce future losses from floods, hurricanes, earthquakes and wildfires, and implement nature-based solutions to limit risk from natural hazards. For example, in the southern Cotswolds in the United Kingdom, local communities collaborated with landowners to create in-channel, riparian, field and woodland structures that lowered the flood risk by reducing high water flows and increasing the infiltration capacity of soils (Short et al., 2019).

The non-governmental sector also has a key role to play in highlighting actions that can be taken by individuals, and local, state/province/county and federal/national governments to reduce risks, pilot and test innovative approaches, and scale up good practices in risk reduction.

#### Moreover, journalism collapse guarantees mass partisanship and social cohesion breakdown.

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Hal J. Singer, “Addressing the Power Imbalance: A Legislative Proposal for Effectuating Competitive Payments from Platforms to Newspapers,” Columbia Journal of Law & The Arts, 2023, https://heinonline.org/HOL/Page?handle=hein.journals/cjla46&div=26&g\_sent=1&casa\_token=&collection=journals

C. THREATS TO DEMOCRACY FROM NEWS DESERTS

As a result of the deteriorating news media landscape described above, hundreds of local newspapers have been acquired or have declared bankruptcy.125 One study estimates that the United States has lost nearly 1,800 newspapers since 2004 either to closure or merger, leaving the majority of counties in America beholden to a single publisher of local news and 200 counties without any paper.126

The elimination of local news threatens democracy. A critical function of a local newsroom is coverage of local and state government affairs.127 Without this coverage, Americans are more likely to rely on national news and partisan heuristics to make political decisions.128 A robust local news business is also a natural pipeline by which government officials effectively communicate to an electorate (and vice versa). Research shows that in areas with higher local news coverage, voters are better informed on their congressmen and that politicians more actively pursue their constituents’ interests through moderating their partisan voting, more frequently standing witness to committee hearings, and generating more federal funding for their districts.129 Local newsrooms may also provide a check on local government corruption and mismanagement.130 Moreover, robust local news coverage is positively correlated with higher rates of voter turnout,131 more support for local services,132 and greater levels of social cohesion.133

#### Partisanship and social cohesion breakdown cause extinction.

Hamelink 20 – Emeritus Professor of International Communication at the University of Amsterdam, Professor of Knowledge at the University of Aruba, PhD in Psychology from the University of Amsterdam.

Cees Hamelink, “A Polarized Planet,” In book: Communication and Peace, Celebrating Moments of Sheer Human Togetherness, Palgrave Macmillan, 05/2020, https://www.researchgate.net/publication/341747127\_A\_Polarized\_Planet

Polarization

The Greek philosopher Herakleitos coined the phrase: “From differences results the most beautiful harmony”. Maybe he should have been somewhat more cautious because we are biologically, psychologically and linguistically wired to think in fragments as in most modern sciences where we are still haunted by Cartesian divisions. We understand the notion of “parts” better than the concept of “wholeness” because we tend to think in fragments and not in coherent patterns. Once we have fractured the world into stand-alone pieces, it is an illusion that simply connecting us through advanced technologies will create coherence. Through social media we connect but do not create togetherness. Common to all the forms of fragmentation—that I described—is a mode of thinking that William Isaacs (1999) called “thinking alone” which means being defensive about our positions, clinging to certainties and imposing judgements upon others. It reflects a binary discourse that categorizes people against each other. Men versus women, black versus white, impaired versus non-impaired, religious versus non-religious. Binary thinking fosters exclusion and discrimination. We have no shared discourse to converse about the fractures of humanity. Against this Isaacs argues that we need to “think together” which means listening, respecting, suspending assumptions and letting our inner voices speak up. “Thinking alone” fosters and feeds polarized fragmentation. The opposite poles are immobile and entrenched in their singular identities. Once people lose the capacity to think about themselves in terms of multiple identities, they are ready to believe that the others deserve to be dehumanized and eventually to be eliminated. The belief in singular identities tends to see violence as only way to protect your own identity. When fragmentation gets polarized, conflicting parties tend to forget that all have multiple identities and that identities are not static but dynamic lest we become each others’ enemies. Our identities and those of others are permanently in flow. We are “flaneurs” as Walter Benjamin phrased it. Especially in global cities there is a constant interaction between multiple identities and we need to reclaim the capacity to celebrate this. The city can only survive if we dance in the streets! There are no fixed identities; they are constructed labels for convenient purposes such as domination. Identities are fluid. As Kwame Appiah says in an interview with the Financial Times (31 August 2018) “Still, whatever their religion, sexuality, racial identity, or nationality, people should have a lighter hand with their use of these identity categories in a way that would mean that moments in our cultures where conflicts arise might be somewhat defused”. Essential identities do not exist however much many people care about them and get angry when what see as their identity is not taken sufficiently seriously. Identity can only develop in interaction with others. Appiah, “Beginning in infancy, it is in dialogue with other people’s understandings of who I am that I develop a conception of my own identity” (Appiah 2007, 20). As Appiah argues identity is not an authentic inner essence but it is—in the words of Charles Taylor—dialogically constituted. “Individuality presupposes sociability” (ibidem, 20) since we are social beings as Aristotle already knew. In Appiah’s felicitous phrasing “so much we care about is collectively created” (ibidem, 20). We should understand that our individual identities have strong collective dimensions… “because they are constituted in part by socially transmitted conceptions of how a person of that identity properly behaves” (ibidem, 21). In processes of polarization, the narratives about who we are tend to be narrowed down to the stories of others who think like us and behave like we do. The collective dimension impoverishes and the dialogical construction of our identity allows the input of a limited set of voices only. There is grave danger in the frozen identities to which the so-called nationalist/populist identity politicians greatly contribute. We need to answer this polarization of dividedness with creativity and flexibility, with storytelling, theatre, music and dance. Once dividedness polarizes, it paralyzes communities and stands in the way of their resilience. With polarization, the de-escalation of conflicts becomes practically impossible because conversation is no longer possible. Polarization confronts us with the most dangerous of all fractures. Humans have managed to create a formidable enemy—Mother Gaia—and we need protection against her devastating anger. A deeply polarized human species is unable to provide this protection that needs to be based upon togetherness, thinking together and conversing together.

Existential Risk

The accumulation of the fractures into polarization causes the human species—in the beginning of the twenty-first century—to face once again deep existential risks. Those are the risks where humankind as a whole is imperilled as they imply major adverse consequences for the course of human civilization for all time to come. Risks in this category are a recent phenomenon. This is part of the reason why it is useful to distinguish them from other risks. We have not evolved mechanisms, either biologically or culturally, for managing the present risks (Bostrom 2002) that are largely “unintended consequences of radicalized modernity” (Beck 1999, 3). The concern about the extinction of the species we belong to is based on carcinogenic ingredients in food supplies, organized (cyber-)crime, pollution by poisonous materials (acid rains, chemical products), series of natural disasters (asteroids, comets, volcanoes), genetic experiments, collapse of financial markets, the scarcity of water and energy sources, infectious pandemic diseases, the consequences of genetic engineering, artificial intelligence or molecular manufacturing, or on increasing global inequalities that endanger economies and politics (Stiglitz 2013). There is the persistent risk of nuclear, chemical and biological warfare with the observation that for the first time in history weapons of mass destruction and the knowledge of how to manufacture them are available for individuals and small groups. There is also climate change, the loss of biological diversity and the largely underrated issue of overpopulation.2 The human species has survived over centuries many risks but contemporary risks have a planetary scale and “In the charged reflexive settings of high modernity, living on ‘automatic pilot’ becomes more and more difficult to do, and it becomes less and less possible to protect any lifestyle, no matter how firmly pre-established, from the generalised risk climate” (Giddens 1991, 126). As Ulrich Beck writes in the world risk society we cannot be privately insured against the risks of modernity (Beck 1999, 4) and their global interdependence. Unprecedented technological progress that provided the conditions under which the mass murders organized on an industrial scale and made possible by an efficiently organized and managed modern bureaucratic state by the Nazi’s could take place. Technical skills and organizational talent is crucial to organize massive genocide and massive addiction to industrially produced goods such as mobile telephones. Under conditions of modernity Auschwitz could happen again. The need for highly efficient coordination makes modern society very vulnerable to disruptions and on a level of global interdependence such disruptions may have global consequences. Technological advances make humans ever more dangerous, and at the same time, humanity is incapacitated to deal with such unprecedented risks as it outsources its moral responsibilities increasingly to medical, psychotherapeutic, scientific, nutrition and technical-engineering experts. Whereas the Enlightenment promised to liberate humans from the selfimposed inability to use their minds independently of others (Kant), modern life is handed over to coaches and counsellors. As “the most likely global catastropic risks all seem to arise from human activities, especially industrial civilization and advanced technologies” (Bostrom and Cirkovi´ ´ c 2008, 27) humanity has the responsibility to reflect on the unintended and unforeseen consequences of its actions. Most urgent in terms of human survival are the fractures between humans and the Earth System. In the planet’s history humanity finds itself now in a new phase: the “anthropocene”. This means that humans are with their immense and unprecedented power the most influential force in the evolutionary process. Interestingly enough the social sciences largely have refused to accept that the Earth sciences can contribute to our understanding of the world as no longer a “humans among themselves affair” (Hamilton 2017). The “humans only” focus that prevails in the social sciences leads to humans watching their own extinction as a televised spectacle that takes place outside the cubicle of their daily lives. Humans may—as the most powerful species—be at the centre of the planet but are increasingly unable to control the planet. “Our understanding of the Earth we inhabit is undergoing a radical change. The modern ideas of the Earth as the environment in which humans make their home, or as a knowable collection of ecosystems more or less disturbed by humans, is being replaced by the conception of an inscrutable and unpredictable entity with a violent history and volatile ‘mood swing’” (ibidem, 47). It is debatable whether as Pope Francis states in Laudation Si: On Care for our Common Home (Encyclical published by the Vatican, May 24, 2015) nature “is the sister that cries out to us” and “a beautiful mother who opens her arms to embrace us”. As Clive Hamilton notes “Now when Mother Earth opens her arms it is not to embrace but to crush us” (ibidem, 48). Because “Nature is no longer passive and fragile, suffering in silence” (ibidem, 48). As Hamilton argues, we no longer have to save nature but we should save ourselves from nature and from ourselves. The most existential threat is now in the fracture between the unprecedented human power to disrupt the earth system and “the uncontrollable powers of nature it unleashed in the Anthropocene” (ibidem, 49). The interesting conclusion is that we are not any longer free to treat the Earth as we please. Our enormous power comes with an unsettling moral responsibility: we no longer can choose between dominion and stewardship. We have to accept that the anthropocene is anthropocentric (ibidem, 50ff.) meaning that we have the power to change the course of the earth system. This leads to the ethical conclusion that “we must restrain ourselves and restrict what we do” (ibidem, 54). In the conflict between humanity’s unlimited desires and ambitions and the finitude of the earth system we must control the dark side of technological development. We must understand that the forces that were expected to bring us more freedom, more equality and more civilization also brought disruption of the earth system, lethal arms systems, unprecedented ubiquitous surveillance and a tweeting culture that effectively erodes whatever minimal deliberative social processes we had developed. In this moral conflict, we must explore whether our conventional ethical repertoire is adequate. Can we rely upon the will of God or our love for nature? Can we trust enlightened self-interest? Can the notion of collective public duty stand up against the solid individualism of a modern capitalist society. Will the drive towards self-preservation outlive the rampant media-induced indifference? Our future is a confrontation between humans and an unpredictable earth system. This has a certain outcome if we think we can afford indifference and an uncertain outcome—at best— if we treat an angry mother Gaia with the care she deserves. The question is whether today’s global community is capable of dealing with the existential risk of extinction. Can we constitute a global resilient community that can avoid this?

Conclusion

As Abraham Lincoln, later president of the USA, on 16 June 1858 after he had accepted the Illinois Republican Party’s nomination as that state’s US senator, famously stated “A house divided against itself, cannot stand”.3 In order to deal effectively with a formidable existential risk, we must develop communal resilience. This involves the difficulty of accepting genuine dissimilarities. It implies recognizing the other as responsible agent. It demands the critically probing of the arguments for different positions and accepting that togetherness is only possible when groups no longer monopolize the truth. And learning that fractures do not necessarily exclude “togetherness” as long they do not end in the dead alley of polarization.4

If peace is conceptualized as “celebrating moments of sheer human togetherness” and if we aspire to peaceful living together, we must overcome the great obstacle of polarized fragmentation. It may not be the fragmentation in so many different terrains on our planet that creates the essential obstacle to the cosmopolitan togetherness that is basic to collective joy. But the greater problem is that fragmentation is based upon a mindset that is characterized by the belief in singular identities, in the exclusion of alterity, in rampant individualism and in “thinking alone”. This perspective fits remarkably well in the hierarchical social orders that characterize also modern so-called democratic societies. For the conceptualization of peace as moments of collective joy, it is also important to note that such orders are antagonistic to collective festivities. “Ecstatic rituals still build group cohesion, but when they build it among subordinates – peasants, slaves, women, colonized people- the elite calls out its troops. In one way, the musically driven celebrations of subordinates may be more threatening to elites than overt political threats from below” (Ehrenreich 2007, 252).

#### And, decline of local news causes mass political extremism and enables adversaries to internally destabilize the U.S.

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Dennis Murphy, “Why the Decline of Local Media Could Be a Security Risk,” RAND Corporation, 08-08-2024, https://www.rand.org/pubs/commentary/2024/08/why-the-decline-of-local-media-could-be-a-security.html

The United States may be heading towards a period of strategic surprise, and the erosion of local media is a major reason why. According to the Local News Initiative at Northwestern University's Medill School of Journalism, by the end of 2025, the United States will have lost a third of its newspapers in the past 20 years. This hollowing out of local media creates an opening for adversarial actors to influence the country in unexpected and even subversive ways.

To more effectively counter this instability, we need to have access to good quality information at a local level. Insofar as publicly available sources of information are required to understand the drivers of political instability at home, the United States is left increasingly at risk.

The decline of local media is, in this sense, a form of disarmament. Not only will its absence exacerbate difficulties of local governance and accelerate political extremism, but it will also open up blind spots that adversaries both foreign and domestic can leverage to their benefit.

Outside actors can manipulate news reporting for subversive purposes. Indeed, they already have. Local, reliable sources of information could help fight back against this. That such local and reliable news outlets have been in such steep decline only worsens matters. Allowing for the continued decline of local media renders our homeland security efforts half blind.

There is evidence of the ordinary activities of journalists carrying out their job proving useful in uncovering adversarial influence operations and alerting the public of potential vulnerabilities. In Southeast Asia, for example, investigative journalists have helped uncover major influence operations. Lest one believe the United States is invulnerable to similar efforts, the interior of the country is already regularly penetrated by other states: China has hacked critical infrastructure systems in the United States, Iran hacked the city of Atlanta, North Korea hacked Sony Pictures, and Russia has infiltrated U.S. real estate.

Sometimes these activities take years to be uncovered, leaving open a window where an adversary can subvert the United States prior to detection. China's “Volt Typhoon” hack, for example, took place for half a decade before the public became aware of it. Local journalists would be among those responsible actors whose job is to let the public know of vulnerabilities and attacks. Sometimes even when government actors know an attack took place, the people affected are still not informed.

Local journalists can investigate the ways in which events like these—often out of sight and mind from major policymakers in Washington—are connected to a bigger picture, be it ordinary day to day life in small-town America, or yet another data point in an ever-growing list of adversarial subversion. There is no reason to believe that citizens and policymakers are helpless to stop the decline of local media. Grant offering institutions—such as the Fund for Investigative Journalism, Center for Public Integrity, and Public Media Alliance—provide support for local media sources; outlets like ProPublica's Local Reporting Network provide support for local journalists; last year the MacArthur Foundation announced it would make a $500 million investment in local news.

Such efforts must be supported and cannot be allowed to fail. There might also be other ways to provide support to local news organizations or otherwise share costs across different media groups across the country. Saving local news is actually a problem that is much more easily solved than one might expect.

Together, efforts to restore local media hold the potential to do more than make our democracy more resilient. It might also be the first step to ensuring we are not surprised by a security threat.

#### Political extremism and malevolent governance structurally increase the risk of extinction.

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David Althaus and Tobias Baumann, “Reducing long-term risks from malevolent actors,” Center on Long Term Risk, https://longtermrisk.org/files/Reducing\_long\_term\_risks\_from\_malevolent\_actors.pdf

Specifically, we conjecture that malevolent humans in power would affect the risk factors below in the following ways:

• Increase the spread of political extremism and other dangerous ideologies (see again Appendix A).

• Exacerbate the risk of great power wars and international conflict (Byman & Pollack, 2001, particularly p. 112, 134, 137-138); Gallagher & Allen (2014) 10, including the risk of nuclear war and arms races involving transformative AI.

• Increase the likelihood of the formation of a global totalitarian regime, potentially resulting in a permanent lock-in of harmful values and power structures.11

• Increase the likelihood of reckless behaviour, rather than careful reflection, in high-stakes situations (for example, those resembling the Cuban Missile Crisis). o Dark Triad traits, psychopathy in particular, are associated with extreme risk-taking Hosker-Field et al. (2016); Visser et al. (2014).

• Increase intranational conflict and undermine public institutions, social coordination, collective decision making and general discourse12, particularly by: o Exacerbating economic and social inequality.13 o Increasing corruption (Bendahan et al., 2015, table 5), rent-seeking, and the risk of financial crises Boddy (2011). o Reducing access to information, e.g., through censorship and propaganda.14 o Reducing trust in government and institutions Bowler & Karp (2004).15

Such trends would plausibly lead to worse futures in expectation. They also plausibly increase existential risks (including extinction risks) and suffering risks (see the next section). However, the evidence linking these risk factors to malevolent humans in power is fairly weak, for various reasons. We are therefore only somewhat confident in these connections.

3.3.2 Existential and suffering risks due to malevolent leaders

In terms of more concrete scenarios, the most extreme risks to the long-term future would arguably result from malevolent humans with access to highly advanced technology, particularly transformative AI. The following list outlines some (non-exhaustive) examples of how malevolent individuals could increase existential and suffering risks:

• As noted above, malevolent individuals tend to exhibit more risk-taking behaviour. In the context of a project to develop and deploy transformative AI, they are therefore more likely to ignore potential warning signs and omit precautionary measures. This increases the risk of misaligned transformative AI.

• Malevolent humans are likely less opposed to making threats than the average human Jonason et al. (2012); Ullrich et al. (2001) 16 and plausibly less motivated to pursue peaceful bargaining strategies. Conflicts involving malevolent humans are therefore significantly more likely to escalate and result in catastrophic outcomes. Also, it could be dangerous if AI systems inherit some of their values or heuristics, such as an increased willingness to make and carry out threats and/or a reduced willingness to compromise.

• Advanced technology might enable sadistic individuals in power to create suffering on an unprecedented scale.

• A malevolent individual, or a small group of such individuals—e.g., the inner circle of an autocratic state—might manage to obtain control of Earth (cf. MacAskill, 2020) 17, and eventually the observable universe. For example, imagine Hitler or Stalin had access to advanced technology—including aligned AGI and mind uploading, enabling immortality. Such a lock-in of permanent rule by a (global) malevolent dictator would clearly qualify as an existential risk, as it would thwart any prospect of a more valuable future. It also constitutes a significant s-risk as there would be nobody left to keep any sadistic tendencies of the dictator in check.

While specific scenarios are necessarily speculative, it seems clear that malevolent leaders pose a serious threat to humanity’s long-term future. Of course, malevolent leaders are not the root of all evil, and many conflicts, wars and atrocities would happen without them. Nevertheless, we believe that preventing malevolent individuals from rising to power is likely valuable and robustly positive, according to almost all moral perspectives (compare also Beckstead, 2013; Tomasik, 2013a, 2013b).

#### Adversary destabilization causes extinction.

Laitman 17 – PhD in Philosophy & MS in Medical Biocybernetics, author of 40 books on political theory and philosophy of unity, frequently interviewed by mainstream news outlets including the NYT

Michael Laitman, “There Will Be No Winners in the Second Civil War,” August 2017, https://www.newsmax.com/MichaelLaitman/america-civil-war-newt-gingrich-don-lemon/2017/08/25/id/809867/

And not just in the U.S. A civil war in America will not end in America. If the country plunges into battle, many will be vying for the loot. China, Russia, North Korea, Iran, and others will destroy whatever the war doesn’t, the American empire will become history, and a third world war, with multiple nuclear powers, will follow. There will be no winners because, to quote Machiavelli, “Wars begin when you will, but they do not end when you please.”

#### Only collective bargaining solves. It’s necessary to rebalance leverage from platforms to journalists. And, it cuts through platform shenanigans that cause our impacts now.

Caffarra and Crawford 20 – Professor of Competition Economics at University College London, PhD in Economics from the Oxford University; Professor of Economics at the University of Zurich, PhD in Economics from Stanford University.

Cristina Caffarra and Gregory S. Crawford, “The ACCC’s ‘bargaining code’: A path towards ‘decentralised regulation’ of dominant digital platforms?,” Centre for Economic Policy Research, 09/2020, https://cepr.org/system/files/publication-files/103121-policy\_insight\_105\_the\_accc\_s\_bargaining\_code\_a\_path\_towards\_decentralised\_regulation\_of\_dominant\_digital\_platforms\_.pdf

WHY THIS SET UP HAS DESIRABLE PROPERTIES

The proposal has attractive features from an economics perspective. Economists have studied bargaining for decades, with the principles underlying this literature seeking to capture the reality of business negotiations (Brandenberger and Nalebuff 2011). The dominant paradigm for ‘non-cooperative’ settings like negotiations between business partners is the asymmetric Nash bargaining framework. It says that outcomes of a bilateral bargain depend on three factors: (1) the total profit to both parties from reaching an agreement, (2) each party’s ‘threat point’ profit in the case of a disagreement, and (3) each party’s ‘(Nash) bargaining power,’ written as a percentage between 0 and 100 (with the sum of the bargaining powers equal to 100%).6 The total profit from (1) less the profit from each party’s threat point in (2) defines the possible ‘gains from trade’, a.k.a. the size of the ‘pie to be split’, and the bargaining power in (3) defines how much each party gets of this pie (Muthoo 1999).

Several elements of the ACCC’s proposed Bargaining Code can be understood naturally within this framework. The first is the granting of information-gathering powers to both platforms and publishers. The bargaining theory just described assumes both sides know the value to digital platforms of Australian news provision and the costs to publishers of producing news [(1)] as well as each party’s threat points [(2)]. But this is unrealistic unless publishers can learn how platforms benefit from their provision of Australian news and platforms can learn how much it costs to produce that news.7 Each has to also learn the other’s (and their own!) threat point profit, a harder undertaking, but also fostered by the ability to gather relevant information (e.g. how much does Google or Facebook profit from online advertising when they don’t have information on consumers’ news consumption; how many Australian users would go directly to publishers’ websites if Google or Facebook no longer offered news content?).8

The second is granting the ability for news publishers (if they so choose) to bargain collectively in the new system, as well as the non-discrimination requirement that would prevent them from favouring non-Australian news content relative to Australian news content. In line with the concern that digital platforms have greater bargaining leverage in negotiations with news publishers, allowing collective bargaining allows (especially smaller) publishers to get together and achieve economies of scale in negotiation to improve outcomes relative to their negotiating individually.9 Nondiscrimination is important because Google would have a stronger threat position if it could substitute international news content for Australian news in the absence of an agreement with all Australian publishers. It can also be beneficial in circumstances where individual negotiations would lead to ‘divide and conquer’ strategies. With collective bargaining (if chosen) and a non-discrimination rule, Google would have to consider not being able to link to any news, Australian or otherwise. If such links have value, this will lower Google’s threat point, improving outcomes for Australian news publishers as a whole.10

[Begin Footnote 10]

Of course, if they bargain collectively, Australian publishers would then have to decide how to divide whatever they can negotiate from the platforms, itself a non-trivial problem. But collective bargaining would likely enhance their overall bargaining outcome in negotiations with digital platforms, whatever is this second-round decision rule.

[End Footnote 10]

But the important feature, that makes a real difference, is the use of ‘final offer’ (‘baseball-style’) arbitration as a backstop to voluntary negotiations. We’ve discussed the three Nash factors in the context of governing outcomes of such voluntary negotiations. But they also play an important role by defining (expected) threat points in the case no such voluntary agreement can be reached. A known benefit is that when submitting final offers to an arbitrator, each party has an incentive to present an offer relatively close to that which they consider a likely outcome of the voluntary agreement (as evaluated by the arbitration panel), for fear that if they present something outlandish that favours themselves too much, the panel will simply choose the other party’s proposal. This advantage has long been recognized in the economics literature, both by fostering final offers that are close to each other relative to what might arise in bargaining outcomes backstopped by other arbitration rules, as well as producing agreements that don’t require the use of arbitration at all.11 But there is more: this backstop can also mean that collective bargaining is not the only way to protect publishers from uneven power. Should they choose to bargain individually, the fact that there is an ‘arbitration shadow’ to the negotiations means they can make the case to the arbitrator that they should not be offered just the incremental value to Google of their content. Arbitration can mitigate the ‘divide and conquer’ problem.

To which we would add the final advantage of the proposed method: it ultimately gets the parties to do the hard work of quantifying the key inputs into the value of news, not a regulator. This is critically important as it goes towards addressing a key asymmetry of information problem that plagues the economics of regulation generally: digital platforms and news publishers are far more likely to know the value of news content to digital platforms and the costs of news production to news publishers than would a regulator, regardless of that regulator’s information gathering powers. The parties in the proposed method have the same powers, but in addition have the industry expertise to know much better how to use the gathered data to inform valuation estimates (or at least getting close). Indeed, it is this insight – that mandatory bargaining supported by a final-offer arbitration backstop can likely out-perform a dedicated digital platform regulator – that inspires the second half of this Policy Insight.

#### Specifically, journalists need to be able to tailor the outcome of negotiations to their particular conditions to solve industry collapse BUT having it be mandatory is necessary to compliance. AND it avoids harm to big tech.

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Giuseppe Colangelo, “Enforcing Copyright Through Antitrust? The Strange Case of News Publishers Against Digital Platforms,” Journal of Antitrust Enforcement, 01-05-2025, https://papers.ssrn.com/sol3/papers.cfm?abstract\_id=3719811&download=yes

Similar findings are reported in Australia by the ACCC with regard to the market power of Google and Facebook in the supply of search advertising and display advertising services respectively. Moreover, the Australian inquiry has revealed that Google and Facebook exert substantial bargaining power in their dealings with media businesses85. Indeed, because of the size of their online audience, a significant number of media businesses rely on news referral services from Google and Facebook to such a degree that they are each unavoidable trading partners.86 While bargaining power imbalances exist in several contexts, in this case intervention is needed because of the public benefit provided by the production and dissemination of news and the importance of a strong independent media in a well-functioning democracy.

The bargaining power imbalance significantly affects the manner in which media businesses deal with Google and Facebook and the outcomes of those dealings. Notably, these platforms exploit their bargaining position vis-à-vis press publishers by imposing publishing formats and snippet size, adopting policies and practices that may be detrimental to the interests of news publishers (such as Google’s former First Click Free Policy, which required companies to provide five articles per day for free to Google users), denying access to user data.87 Furthermore, media businesses have expressed concerns about a lack of transparency in relation to how digital platforms’ algorithms rank and distribute news content, reducing the level of control a media company can exercise in relation to how their news content is distributed to consumers.

As a solution, the ACCC has suggested the adoption of a code of conduct to encourage negotiation between the parties, at the same time allowing the Commission to intervene in order to “equalize the bargaining imbalance.”88 The ACCC considered the code of conduct as the most appropriate approach because it would provide some flexibility for different arrangements to be reached between each digital platform and media businesses, also allowing platforms to balance their own interests with those of media businesses in drafting the codes of conduct, and flexibility for the codes to be changed if they do not achieve their initial objectives.89 Hence, in the ACCC’s intention the code of conduct was firstly a form of industry self-regulation. Digital platforms should have nine months to develop a code; if they were unable to submit an acceptable code to the Australian Communications and Media Authority (ACMA) within this deadline, the Authority should create a mandatory standard.90

However, once the ACCC started working with Facebook, Google, and news media businesses to develop and implement voluntary codes of conduct, it reported to the Government that the core issue of payment for content was highly unlikely to be resolved through this voluntary process. As a result, the Government asked the ACCC to develop a mandatory code of conduct.91

The shift towards a mandatory bargaining code has sparked a heated debate. Google published an open letter warning Australia that the proposed law will put its services at risk92, Facebook threatened to remove news from the platform in Australia.93

Because the Australian bargaining code surfaces as a regulatory solution alternative to the European approach by forcing digital platforms to strike a deal with news businesses, it is worth analyzing it to evaluate comparative benefits and drawbacks and assess its potential effectiveness in addressing bargaining power imbalances and helping to preserve high-quality journalism.

4.1 The Australian mandatory bargaining code.

In July 2020 the ACCC released a draft of the News Media and Digital Platforms Bargaining Code which is currently under consideration by the Australian parliament.94 While the draft code would initially apply only to Google and Facebook, other digital platforms may be added if they attain a bargaining power imbalance with Australian news media businesses in the future.

The key feature of the code is represented by the provision of a binding final offer arbitration process. In particular, news media organizations would notify digital platforms of their intention to bargain in relation to their content. News businesses can bargain either individually or collectively. Parties are required to negotiate in good faith and, if an agreement is not reached within three months, the matter will be subject to compulsory arbitration. Arbitration will only take place if the bargaining parties have attended at least one day of mediation. If those preconditions are met, an arbitral panel chosen by the bargaining parties (or by the ACMA if the parties fail to agree on panel members) will select between two final offers made by the parties. Notably, within ten days of compulsory arbitration being triggered, each party must submit a final offer on the remuneration amount to be paid by the digital platform and the arbitral panel must accept one of those offers, unless it considers that each final offer is not in the public interest, in which case the arbitral panel may amend the more reasonable of the two offers. Under the terms of the code, in deciding which offer to accept, the panel must consider the direct and indirect benefit that the content of news businesses provides to the digital platform’s service, the cost to the news businesses of producing news content, and whether a particular remuneration amount would place an undue burden on the commercial interests of the digital platform. Furthermore, when considering the indirect benefit, the panel must consider the total indirect benefit of Australian news to the digital platform service (including increased usage of that service and public perception benefits arising from the inclusion of Australian news) and the extent to which that total indirect benefit is attributable to the content of the news business.

According to the ACCC, by acting as a backstop to voluntary negotiations, a final offer arbitration (also known as baseball-style arbitration) provides two significant benefits in comparison to a conventional commercial arbitration.95 First, it leaves it to the parties to determine a suitable price and the fact that the arbitration panel would be choosing from one of two offers, rather than attempting to determine a price, would discourage ambit claims and provide a strong incentive for both parties to submit their most reasonable offers.96 Further, final offer arbitration would ensure quick outcomes, with the arbitrator required to make a decision within 30 business days of receiving offers and comments from the parties, i.e. a maximum of 45 business days after arbitration commences. These features of the Australian code are also its main comparative advantages against the EU copyright approach. Indeed, the Australian regulatory approach provides a swift solution to the ongoing disputes between news publishers and digital platforms by guaranteeing a payment to the former without twisting copyright laws or involving antitrust enforcement. Therefore, the mandatory baseball arbitration is consistent with the aim of ensuring a sharing of revenues between platforms and news media organizations and is more effective in quickly securing the result.

The baseball-style arbitration has been previously advanced as an efficient tool for tackling SEPs disputes over FRAND licensing terms. According to its proponents, mandatory baseball arbitration manages to strike a reasonable balance between the concerns of licensees and licensors by channeling their interests towards reasonable royalty determination.97 Indeed, parties would have a strong incentive to put forward workable proposals capable of meeting the arbitrator’s favor instead of advancing unreasonably high or low requests.98 However, within the SEP scenario the proposal has also raised comment. Some scholars pointed out that mandatory baseball arbitration would be one-sidedly biased to the detriment of right holders who would be doomed to be under-compensated by implementers, hence judicial litigation of FRAND commitments would not decrease because the parties would be prevented from reaching a satisfactory agreement in the first place.99 Further, it has been questioned whether baseball arbitration is a solution at all as it collapses into a single damage appraisal different questions of infringement, essentiality, and validity of patents involved.100 Somewhat ironically, under mandatory baseball arbitration, the arbitrator may end up with a forced choice between options that are actually not FRAND-compliant. On top of this, it has been stressed that compulsory disclosure of awards reached under baseball arbitration would facilitate oligopsonistic collusion by implementers.101 Recently, the European Commission has acknowledged that alternative dispute resolution (ADR) mechanisms, such as mediation and arbitration, can offer swifter and less costly dispute resolution and that the potential benefits of these tools are currently underexploited.102 However, the Commission argued that ADR should not be mandatory for parties.

Some of the aforementioned concerns about the use of mandatory baseball arbitration in the SEP scenario also seem to pertain to the Australian bargaining code. Indeed, by envisioning a one-way payment from digital platforms to news media organizations, the code instructs the arbitrator to proceed in a one-sided evaluation of the offers presented. Despite the ACCC’s inquiry having acknowledged that the relationship among digital platforms and news publishers is characterized by a two-way exchange of value103, under the code the arbitral panel is required to consider only the direct and indirect value that the content of news businesses provides to the digital platform’s service. Similarly, the French Law 2019-775, in enlisting factors that should be considered to define the remuneration for related rights arising from the reproduction and communication to the public of press publications in digital format, only refers to human, material, and financial investments made by publishers and news agencies, the contribution of press publications to political news and current affairs, and the extent of the use of press publications by online public communication services.

A further concern regards the scope of application of the code. Unlike the EU Directive, the Australian approach revolves around the role of media producers, rather than around the notion of press publication. In order to be eligible to participate in the code, a news media business must register with the ACMA and nominate its news sources that predominantly produce “core news.” The latter include journalism about publicly significant issues, journalism that engages Australians in public debate and informs democratic decision making, and journalism relating to community and local events. However, once a news media business is eligible to participate in the code, it would be able to negotiate with digital platforms over all news produced by its nominated news sources (so-called “covered news content”), rather than just core news. Hence, even if news related to sport and entertainment were not core news, it would still be covered by the code if reported by an eligible news media business. For these reasons it has been argued that the Australian news law would create a “state-sponsored media regime”104, where a government requires platforms to pay publishers to carry their content and also determines what content they must carry.

Moreover, it would appear that no consideration has been given to the definition of ‘use’ of news media. As the European and French analysis has shown, the lack of guidance about the notion of very short extracts raises significant interpretative issues. Indeed, services provided by digital platforms interact with news content in different ways, including featuring headlines, hyperlinks, snippets, and images. Therefore, as acknowledged by the ACCC in its concept paper seeking the views of stakeholders to inform the development of the bargaining code, the implementation of a bargaining framework to address remuneration would need to determine which of these interactions would constitute a use of news content that triggers obligations for remuneration.105

5. Concluding remarks. Chronicle of a failure foretold.

The dispute between news media organizations and digital platforms has anticipated the ongoing debate on how competition policy should evolve in the digital age, namely on whether the distinctive features of digital markets require a rethinking of current rules and tools. The role played by large online platforms acting as gatekeepers and regulators within their ecosystem apparently also requires intervention aimed at safeguarding the sustainability of the publishing industry. Indeed, according to news media organizations, some digital platforms represent unavoidable trading partners able to exploit substantial bargaining power in their dealings and this imbalanced relationship is the main source of the publishing industry’s crisis.

From this viewpoint, despite the growing consumption of online news content, the industry is struggling because large digital platforms are free-riding over their content and capturing a significant share of the advertising revenue. These issues are exacerbated by the lack of transparency in the ad tech supply chain, the opacity of the algorithms that rank and distribute news content, the imposition of publishing formats and the lack of sharing of individual data collected from consumers, which, overall, confirm the bargaining power vis-à-vis news businesses. In particular, dominating both digital advertising and key communication platforms, Google and Facebook are deemed to have outsized power over the distribution and monetization of trustworthy sources of news online, creating an uneven playing field in which news publishers are beholden to their decisions.106

Although the free-riding narrative seems not to be supported by empirical evidence, some countries have decided to intervene with the specific goal of rebalancing the relationship of power between digital players and press operators in order to allow the latter to negotiate on an equal footing. Among the different solutions advanced, the European copyright approach has been harshly criticized on several grounds. Alongside the lack of economic justification, doubts have been raised about the scope of protection and the opaqueness of relevant notions, as well as its very effectiveness.

The national implementation in France has proven the limits of the European approach. Moreover, it has shown its perils. With the aim of ensuring that the press publishers’ right is an enforceable negotiation tool to rebalance out relations between press content producers and online distributors, the French Competition Authority is forcing a negotiation in the shadow of competition law. Indeed, in order to avoid the risk that the display policy adopted by Google may frustrate the objective of the new law enacted, the French Competition Authority attempted to fill the copyright gap by granting interim measures requiring Google to conduct negotiations in good faith on the remuneration for the reuse of publishers’ protected content. However, the reasoning of the French Competition Authority seems not supported neither by the text of the EU Directive nor by the doctrines endorsed by the antitrust case law.

Instead of twisting copyright laws or involving antitrust enforcement, the Australian Government has opted for a mandatory code of conduct which includes a binding baseball-style arbitration as a backstop to voluntary negotiations. Although significant doubts about the scope of application and the relevant factors in the evaluation of the offers presented have been raised, at least the Australian code appears effective in swiftly securing the result of guaranteeing a payment to news publishers.

### Plan---1AC

#### Thus, the plan: The United States federal government should strengthen collective bargaining rights for journalism industry workers in relation to Google and Meta.

### Models----1AC

#### Advantage 2 is Models.

#### Other countries are adopting the plan which thumps their DAs, but U.S. bargaining rights are key to our impacts.

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Courtney C. Radsch, “Frenemies: Global approaches to rebalance the Big Tech v journalism relationship,” Brookings Institution, 08-29-2022, https://www.brookings.edu/articles/frenemies-global-approaches-to-rebalance-the-big-tech-v-journalism-relationship/

More than a year after Australia adopted a pioneering new media bargaining code and the EU Copyright Directive went into effect, the idea of getting Big Tech to pay for the news they use is gaining greater support around the world, with lawmakers in Brazil, Canada, India, Indonesia, Sweden, the U.S., and the U.K. exploring interventions that they hope will support an industry facing an extinction event yet recognized as essential to democratic governance. Governments are also considering whether competition policy should be deployed to claw back revenue from tech behemoths and the AdTech infrastructure they control or to enable news media to collectively bargain with aggregators and other platforms that use their content.

Three policy arenas

These legal regulatory efforts have coalesced around three dominant types of interventions: taxation, competition/antitrust, and intellectual property. The building blocks include:

Allowing publishers to collectively bargain without violating antitrust laws

Requiring platforms negotiate with publishers for the use of news snippets

Requiring platforms to pay licensing fees to publishers

Taxing digital advertising and using the resulting revenues to subsidize news outlets

Australia’s 2021 news media bargaining code compels platforms to negotiate payment to media outlets for using their content, and despite criticism that it amounted to a Big Tech subsidy to Big Media given extensive lobbying by media mogul Rupert Murdoch, the law has also rejuvenated the country’s journalism sector. Australian media outlets large and small have benefitted and new journalism jobs are being created in a sector that lost thousands of opportunities during the coronavirus pandemic – though the lack of transparency into the commercial deals negotiated between publishers and platforms remains problematic.

Meanwhile, India’s competition authority has opened an inquiry of its own following an antitrust complaint filed by digital publishers earlier this year claiming that Google unfairly dominates the news aggregator business and does not allow publishers to competitively earn revenue on ads due to a “lack of transparency and information asymmetry.”

The Indian government may not wait for the enquiry before acting. Minister of State for Electronics and Information Technology, Rajeev Chandrasekha, said late last month that the government is looking at updating the IT law to address anti-competitiveness in the AdTech market, as well as requiring compensation for publishers when online services use their content to populate their platforms and profits. India, which has relentlessly pressured online platforms to promote politically favorable content and suppress critical opposition, is one of a handful of countries in the Global South that has both the expertise, user base, and regulatory influence to pursue the Australian strategy.

One of the thorniest challenges to pursuing these policies in any country is deciding what counts as journalism and which news organizations should benefit. Concerns that small outlets will get left behind in the commercial deals negotiated between large publishing conglomerates and Big Tech have plagued efforts to pass similar laws elsewhere. A perception that Murdoch’s media empire was the main beneficiary in Australia prompted independent media in Brazil to align with Google and Facebook to oppose similar legislation there, while in Canada a coalition of small, independent publishers called out secret back room deals in its push for amendments to the Canadian Online News Act. These and other issues are suggesting that journalists will not actually benefit from this type of arrangement and will be left behind.

In addition to these concerns around anti-competitive behaviors, lawmakers across the globe have also recognized the massive financial and editorial impacts that major tweaks to platform algorithms or priorities can have on news organizations, including drops in revenue, closures and layoffs, and the impact on news readers and subscribers who are forced to rely on information provided by dominant Big Tech platforms, even when that turns out to be a lie. From Facebook’s infamous pivot to video to its decision to de-prioritize professionally produced media content in favor of so-called meaningful content from friends, to its most recent shift to TikTok-style content, news organizations have been coerced into realigning their priorities and budgets. For example, Australia’s law includes requirements that platforms give advance notice to media outlets of major algorithmic changes (despite the problematic ambiguity of this concept) that could significantly impact their visibility and viability, and India’s publishers are seeking the same. Of course, these requirements will have little impact on news media revenue if Facebook moves ahead with its pivot away from news reporting.

Unlike other countries, European regulators have tried another approach to renegotiating power dynamics through updates to intellectual property law. The European Union (EU) Copyright Directive created a right for publishers, not just authors, to claim copyright and thus to allow news outlets to be remunerated when online service providers use their content. This concept of “ancillary copyright” or “neighboring rights” creates a framework for news media to negotiate licensing fees with platforms that use their content.

Until recently, the U.S. was also exploring whether a new approach to copyright along the lines of Europe’s was needed, but seems unlikely to pursue it after a report this summer by the Copyright Office recommended against it. It found that national copyright laws already provide some protections to publishers (which were missing in the EU prior to its Copyright Directive) and that revising copyright would do little to address market imbalances that make it difficult for news publishers to effectively negotiate licensing fees with Big Tech.

#### The U.S. is the last remaining holdout. Following on is key to prevent societal collapse. Otherwise, extinction.

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Jacob Ainscough, Alex McLaughlin, Luke Kemp, and Natalie Jones, “Earth’s existential threats: inequality, pandemics and climate change demand global leadership,” The Conversation, 02-23-2021, https://theconversation.com/earths-existential-threats-inequality-pandemics-and-climate-change-demand-global-leadership-154325

Asked in 2003, the UK’s astronomer royal, Martin Rees, gave our present society 50/50 odds of lasting until the end of the century. It’s fair to say the odds haven’t improved in the years since he made this call. The planet is warming, a pandemic runs wild, the threat of nuclear war still hangs overhead and emerging technologies are allowing for the development of new weapons of mass destruction. Existential threats to human existence are growing – and the time left to address them gets ever shorter.

So the new presidential term in the world’s most powerful nation takes on a special significance. The Biden-Harris administration cannot tackle the global challenges we face alone, but the US will be pivotal to efforts to wind back the doomsday clock. Joe Biden made his agenda clear in a short passage of his inaugural speech:

A once-in-a-century virus silently stalks the country … A cry for racial justice, some 400 years in the making, moves us … A cry for survival comes from the planet itself … The rise of political extremism, white supremacy, domestic terrorism, that we must confront, and we will defeat.

After the Trump years, these new political commitments from the world’s dominant power are welcome. Yet this rhetoric reveals a flaw in Biden’s conception of the threats facing the world. Each issue is treated as a distinct challenge. But our research on catastrophic risks reveals that such threats are actually deeply interconnected. Threats facing humanity are a many-headed Hydra – they are all parts of the same beast.

Threat and inequality

The catastrophic risks are held together by a sinew of racial, gender, economic and political inequalities that simultaneously exacerbate each threat and block potential action to address them. Take the climate crisis. Desertification, land degradation and extreme weather disproportionately affect the world’s poorest countries and are estimated to have increased international inequality by 25% in the past 50 years.

But inequality also drives climate change. The richest 10% of the global population are responsible for more than 52% of all emissions. Globally, carbon dioxide emissions track GDP growth with remarkable tenacity.

Higher inequality means less of the benefits of growth accrue to those at the bottom. More growth, and therefore emissions, are then required to meet the material needs of the world’s population. Meanwhile the fossil fuel industry has stymied action with its constant lobbying and sowing of doubt about the connection between fossil fuels and climate change. These factors together threaten to lock us into a downward spiral of worsening inequality and climate breakdown.

A similar story can be told about other threats. The COVID-19 pandemic has exacerbated inequalities both between and within countries. Social distancing is made more difficult the further down the economic scale you are. And access to vaccines seems to follow the same pattern, especially on an international scale.

Or consider artificial intelligence (AI). The increasing capabilities of AI technologies pose a threat to the global political order. These include the use of facial recognition to empower surveillance states, worsening disinformation, the large-scale use of lethal autonomous weapons (killer robots) and – more speculatively and long-term – the potential development of an “artificial general intelligence” as smart and capable as humans, with all the dystopian possibilities that conjures up. Big tech firms such as Google and Facebook have a disproportionate influence in the development and regulation of many of these technologies and applications. This has allowed them to monopolise the benefits while passing the risks on to everyone else.

Looking for global leadership

These connections between threats and inequality are a global phenomenon. Solutions need to be similarly global. On climate change, rejoining the Paris Agreement is a necessary step for the new US administration – but it’s not enough. Most urgently, Biden must work to reconcile bipartisan anti-China sentiment with the reality that China is now a major player in climate politics and must be factored into any solutions.

But there is much more the US, and indeed other rich countries, can do. Both by addressing their own emissions, but also building international partnerships to provide developing countries with the financing and technology required for energy transition. Instead of locking lower income countries into the fragile position of relying on commodity exports to maintain their economies, these efforts should assist countries in diversifying into high value-added industries needed in the new green economy and provide them with greater control over their economic development as partners in the global low-carbon economy.

Biden can leverage America’s position in international financial institutions such as the World Bank and International Monetary Fund to tackle the debt crisis that not only prevents poorer countries from taking action to mitigate climate change and adapt to its impacts, but has also stymied their COVID-19 relief efforts.

The regulation of big tech is another key battleground. Australia’s recent attempts to spread the profits from tech monopolies provoked a public retaliation from Facebook, which temporarily blocked access to Australian news content on its site.

These events are a stark reminder of the power of big tech, and it is this same power that must be limited in the context of AI governance. The US has a stake in these issues, and it must play its part in reducing the risks associated with the development and deployment of AI by international corporations.

In this area and many others, coordinated international approaches are needed to address the links between threats and inequalities pushing our civilisation towards collapse. Such efforts should be at the top of the Biden-Harris agenda.

#### Specifically, the plan is the only way to solve mass misinformation and disinformation from tech platforms. All other alternatives fail.

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Hal J. Singer, “Addressing the Power Imbalance: A Legislative Proposal for Effectuating Competitive Payments from Platforms to Newspapers,” Columbia Journal of Law & The Arts, 2023, https://heinonline.org/HOL/Page?handle=hein.journals/cjla46&div=26&g\_sent=1&casa\_token=&collection=journals

The report is not intended to isolate that portion of the underpayments to news publishers that can be attributable to the platforms’ exclusionary conduct. Facebook and Google engage in a host of potentially anticompetitive strategies vis-à-vis news publishers—both within a platform’s firm boundaries and across the platform’s firm boundaries with third parties—that likely sustain the power imbalance and contribute to the suppression of payments to news publishers. For example, Facebook’s algorithm rewards click-worthy stories, an attribute of stories not produced by legitimate news publishers, by moving them to the top of users’ news feeds.6 Facebook also co-mingles sponsored content or ads alongside user-generated content in its news feed, thereby equating the quality of legitimate news and potentially fake news (though not all sponsored content is fake news).7 Both strategies tend to commodify legitimate news, diminishing its value. Prior to introducing its Instant Articles program, Facebook defaulted users to an in-app browser that degraded the download speeds of news publishers.8 News publishers care about download speeds because users are quick to abandon a story that takes too long to download; news publishers can avoid this degradation by complying with Facebook’s porting requirement, but at a cost of losing clicks (that would have occurred on their own sites) and thus advertising dollars.9 Because legitimate news organizations need advertising revenues to staff reporters and editors, Facebook’s policies discriminate in favor of intentionally fabricated news, which has only minimal quality and managerial costs, and against legitimate news. In December 2020, Facebook unveiled an AI assistant tool called “TLDR,” which reportedly “could summarize news articles in bullet points so that a user wouldn’t have to read the full piece,” further depriving news publishers of traffic.10 Although Facebook has yet to release it, the new tool reportedly could also provide audio narration,11 which conveniently would not include a link to the original article.

Google employs a different set of potentially anticompetitive strategies against news publishers. For example, it inserts snippets of news stories from legitimate news sites on its search results page, which induces some users to forgo clicking on the link and thereby deprives news sites of clicks and the associated advertising revenues.12 Like Facebook, Google also aggregates news sources with and without editorial oversight.13 Such commodification (or “atomization”) of news can also cause reputational harm to news publishers by signaling no quality difference between replicators of news and the original source.14 Google’s placement of news on accelerated mobile pages (AMP) requires the creation of costly and otherwise unnecessary parallel websites by publishers that are hosted, stored and served from Google’s servers rather than the publishers.15 To the extent that Google and news publishers are horizontal competitors for the same readership and advertisers, this conduct can be understood as a form of raising rivals’ costs.16 When a publisher attempts to avoid this AMP-related incremental cost by moving its content behind a paywall, its rise in subscriptions is offset by declines in traffic from Google and other platforms.17

According to a complaint filed by ten state attorneys general in December 2020, Google and Facebook conspired to prevent the ascendancy of a process called “header bidding,” which was used by news publishers as a workaround to reduce their reliance on Google’s ad platforms and thereby capture a larger pay share on their sites.18 In particular, header bidding permitted news publishers to solicit bids for ad placements from multiple ad exchanges at once. In March 2017, Facebook announced it was testing a header-bidding program with several major publishers.19 However, by September 2018, those plans were abandoned, as Google and Facebook entered into an agreement not to compete for news publishers.20 As part of the agreement, Facebook allegedly received special information and speed advantages to help it succeed in the auctions as well as a guarantee that Facebook would win a fixed percentage of auctions that it bid on in what appears to be a market-allocation scheme.2

Although these strategies and restraints are consistent with the claim that Facebook and Google enjoy monopsony power vis-à-vis news publishers,22 and although they likely support the platforms’ ability to underpay news publishers, isolating the incremental harms flowing from a particular anticompetitive restraint is outside the scope of this report.23 In contrast to an antitrust matter, which would focus on a set of restraints, this report focuses on the underpayments to news publishers flowing from the power imbalance between the platforms and individual news publishers generally, whether achieved by natural barriers or artificial barriers (restraints) or some combination of the two. In a competitive input market for online news content, where news publishers enjoyed free agency and could play one platform against another, payments to news publishers would approach the incremental contribution of news publisher content (legitimate news) to the platforms’ advertising revenues.

This report is organized as follows. Part I assesses the significant buying (monopsony) power of Facebook and Google in the acquisition of news publisher content generally. Monopsony is the flip side to monopoly, or selling power, in the output market. The relevant question here is whether Facebook or Google (or both) possess monopsony power in the acquisition of news content for their respective platforms. As it turns out, for many of the same reasons that end users and advertisers lack substitution opportunities to Facebook and Google, input providers such as merchants (for Amazon), app developers (for Apple and Google) and news publishers (for Google and Facebook) lack substitution possibilities, and thus are beholden to these platforms. The input providers are chasing the set of customers assembled by the platforms; by locking in customers, the platforms simultaneously lock in the suppliers. Accordingly, evidence of Facebook’s and Google’s selling power in their respective output markets is also evidence of their buying power in their respective input markets. The platforms’ massive buying power can be demonstrated indirectly, via evidence of high market shares combined with high barriers to entry. For example, Facebook and Google accounted for over half of U.S. digital display advertising in 2019;24 combined shares in excess of fifty percent are consistent with collective market power under U.S. antitrust jurisprudence. Buying power also can be proven directly via evidence of payments below competitive levels or the ability to exclude rivals. Direct evidence of the platforms’ buying power includes: (1) payments to news publishers significantly below competitive levels, (2) news publishers are compelled to accept these take-it-orleave-it terms by the platforms, indicating the power imbalance; (3) the platforms have used exclusive agreements with third parties to exclude horizontal rivals, and they have prevented rivals from acquiring news content via acquisition.

Part II explores how payments to newspapers would be measured in a “but-for” world where the platforms’ buying power were removed, thereby making the news content (input) market competitive. Economic theory dictates that in competitively supplied input markets, input providers tend to capture 100 percent of their marginal revenue product (MRP). Fortunately, the three measures of incremental revenue generated by newspapers for the platforms serve as a reasonable approximation for the newspapers’ collective MRP. By compelling the dominant platforms to pay newspapers the fair-market value of their value added, Congress could replicate payments to news publishers in a world absent Google and Facebook’s buying power. Newspapers are a “must-have” input for the platforms, as news drives most of the conversation. Musthave inputs, such as broadcasting and sports networks, command something closer to their MRP, as their selling power counteracts a portion of cable’s buying power. These must-have input providers capture pay shares of between seven and eleven percent of the cable operators’ total revenue—pay shares that vastly exceed the pay shares currently captured by newspapers from Google and Facebook.

In Part III, I assess the myriad social harms of newspapers not receiving competitive compensation. The news industry has incurred losses in advertising revenue every year since 2006,25 around the time that the platforms solidified their market power over digital advertising. This is not to say that Facebook’s and Google’s domination of digital advertising came entirely at the expense of newspapers. Rather, it is to provide context as to how any underpayment to newspapers can exacerbate an environment that is already quite dire. The effect of shrinking advertising revenues—in part caused by underpayment from dominant platforms—is less cash flow to support journalists, a clear employment effect flowing from the exercise of monopsony power by the dominant platforms. Employment among newspaper employees fell from 71,000 in 2008 to 31,000 in 2020.26 As a result of the deteriorating news media landscape described above, hundreds of local newspapers have been acquired or declared bankruptcy.27 The elimination of local news threatens democracy. Another critical role of traditional news outlets is providing fact-based journalism in the face of disinformation campaigns. The reduction in traditional newspapers has coincided with more Americans using social media platforms to access news. Moreover, the negative employment trends among newspapers, exacerbated by underpayments from the dominant platforms, can have ripple effects throughout local economies. When reporters, correspondents, and broadcasts news analysts—along with the other supporting employees at a publishing firm—lose their jobs, they lose incomes to spend at grocers, restaurants, and other local businesses. This reduction in spending can have a multiplier effect that ripples throughout a local economy and removes stimulus that was once there. Finally, there are also social harms of news publisher closure on a community, including the lack of social cohesion and a reduction in the diversity of viewpoints.

These findings support a proportionate intervention to effectuate competitive payments to newspapers and thereby mitigate these social harms.28 At a high level, and as contemplated by the JCPA, the solution to the power imbalance is to permit newspapers to collectively bargain for payments from platforms, with voluntary negotiations between the platform and newspaper collective, followed by, if necessary, an adequate enforcement mechanism that ensures equitable payment to all news publishers.

#### Absent mandatory collective bargaining, AI slop will continue to proliferate globally which causes disinformation and AI model collapse.

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Karen Rønde, “Danish Media’s United Stand Against Big Tech,” Project Syndicate, 02-04-2025, https://www.project-syndicate.org/commentary/denmark-media-collective-bargaining-big-tech-successes-challenges-by-karen-ronde-2025-02

As AI slop spreads across the internet, concerns about the future of high-quality information are growing. Without accurate and relevant human-generated data, model collapse – whereby generative artificial intelligence trains on its own output and gradually degrades – seems inevitable. The tech giants, well aware of this risk, have cut corners and skirted copyright law in their pursuit of training data for their large language models.

There is a simple solution: these large US companies could pay for the content they use, whether to develop generative AI or to keep social-media users scrolling. In 2021, Australia’s competition authority issued a news media bargaining code requiring platforms to pay for the news from which they profit, which led many tech companies to reach voluntary deals with media organizations. When Meta (which owns Facebook and Instagram) failed to renew these deals in 2024, the Australian government updated the code to include a digital-platform levy. Other countries are considering similar measures.

Europe has already taken some steps in this direction. The European Union’s Directive on Copyright in the Digital Single Market, which came into force in June 2019 and was supposed to be transposed by member states into national law by June 2021, has provided a framework for securing fair compensation for European publishers.

In Denmark, this led to the creation in July 2021 of the Danish Press Publications’ Collective Management Organization (or the DPCMO, of which I am CEO). Representing 99% of the Danish news industry, from newspapers and magazines to digital outlets and public-service broadcasters, the DPCMO has been authorized by the Danish Ministry of Culture to grant extended collective licenses. At first, we had the authority to conclude agreements on behalf of publishers regarding their rights (and neighboring rights) with search engines, social-media platforms, and news apps. In May 2024, the mandate was expanded to include text and data mining by AI firms.

The DPCMO has successfully pushed some tech companies to negotiate collectively with publishers. Interim licensing agreements have been signed with all search engines on the Danish market, including Google, Bing, Yahoo, and DuckDuckGo. We have also reached an agreement with Upday, Axel Springer’s news app.

But other firms have been more obstinate. In April 2024, the DPCMO threatened to sue OpenAI if the company did not strike a group deal, as opposed to licensing agreements with individual publications. After OpenAI’s lawyer announced that further communication with the DPCMO would not be productive, we requested mediation with OpenAI, and Danish Minister of Culture Jakob Engel-Schmidt is expected to appoint a mediator soon.

Likewise, Apple refused to enter into an agreement with the DPCMO regarding its Apple News app. As a result, the DPCMO, together with the Danish Media Association, the Danish Rights Alliance and the Danish Union of Journalists, reported Apple to the police, alleging that the app’s use of news content constitutes a copyright violation. Apple ultimately made the app unavailable in Denmark.

Meta and ByteDance (which owns TikTok) argued that their social-media sites fall outside the scope of articles 15 and 17 of the EU’s Directive on Copyright, which provide new rules on content-sharing platforms, and subsequently refused to participate in mediation and arbitration with the DPCMO. Together with the Danish Media Association, we brought a complaint against Meta and ByteDance to the European Commission, arguing that the firms have violated the Digital Market Act’s data-access regulations. The case is pending.

The reason for filing multiple lawsuits is to uphold EU copyright law, which serves as a crucial framework for regulating relations between the press and Big Tech. We have taken inspiration from the French competition authority (L’Autorité de la Concurrence), which found that Google’s conduct in relation to its search engine and generative AI chatbot Gemini (formerly known as Bard) has prevented publishers from assessing and negotiating remuneration for neighboring rights and is thus an abuse of dominance.

In the second half of this year, Denmark will assume the presidency of the Council of the EU, which holds agenda-setting powers. Given that one of Denmark’s priorities for the presidency is to rein in Big Tech, we urge Engel-Schmidt to lead an EU-wide effort to improve enforcement of the Directive on Copyright. One way to do this is to introduce a “final offer arbitration” mechanism, whereby arbitration is mandatory, and the arbitrator must choose one of the last offers presented by the parties, as Australia, Canada, and the United Kingdom have done.

As Council of the EU president, Denmark must also focus on accelerating efforts to counter mis- and disinformation, including deep fakes, and, relatedly, to improve media literacy. To that end, EU policymakers should seek input from ordinary citizens, not just experts. Rebuilding trust in the media ecosystem requires collective action and broad support.

Curbing Big Tech’s power over news outlets requires policymakers, civil servants, NGOs, academics, collective management organizations, and youth activists to stand together. Perhaps more important, journalists, photographers, and publishers must speak with one voice, so that tech firms cannot divide and rule. If we want to preserve a free and pluralist press – an essential pillar of democracy – our time and energy should be spent fighting these massive companies, not each other.

#### Tech-platform induced disinformation in the U.S. dooms the epistemic commons---extinction.

Schmachtenberger 21 – Founder of the Consilience Project, a think tank dedicated to reducing existential risk, Co-Founder of the Civilization Research Institute.

Daniel Schmachtenberger, “It's a MAD Information War,” Consilience Project, 07-25-2021, https://consilienceproject.org/its-a-mad-information-war/

Can humanity survive digitally enhanced psychological warfare?

No matter where you live, if you are on the Internet you are in a war zone. You may not feel the terror of bombs dropping around you, nor the horrors of physical violence, but there is war nonetheless. For as long as humans have fought, military tactics have always involved propaganda, information manipulation, and deception. Today, digital communication technologies have changed the landscape of what the U.S. military calls “irregular warfare.”[1] As opposed to “conventional warfare,” this kind of war is not primarily about the use of physical force, and it is not primarily about targeting an adversary’s military assets. Irregular warfare includes economic warfare (sanctions), cyber warfare (attacks within the digital domain), and political warfare (diplomacy), but it most pervasively manifests as some version of population-centric information and narrative warfare. The goal is the same as conventional war: to acquire by coercive means some political or strategic good, such as economic, geographical, or military advantage. In this kind of war, the mind of every citizen is a potential target, and tactical victories could include a delegitimized election, implosions of civic discourse, and mutual hatred sparked between fellow citizens.

Just as the destructive power of nuclear weapons forced humanity to reorient to the idea that mutually assured destruction exists at the extremes of physical violence, so advances in information warfare require us to face the same truth of inevitable self-destruction, and to mutually back away. The challenges before us are technological, psychological, and cultural. But the first step in all of this is knowing that we are caught up in a new kind of war. If we are to survive, we must all understand how this situation came about, and grasp the basic dynamics of the advancing battle fronts.

As a U.S. citizen living in a “swing state,” it is possible to be subject to propaganda on social media from both domestic political parties and foreign militaries—a constant battle, 24 hours a day, 365 days a year, all in high-definition in the palm of your hand.

Irregular wars have arms races between combatants in much the same way as regular wars. Techniques of information warfare (such as propaganda) have been developed and expanded by scientists for decades, with much success. We argue that arms races in the context of information wars lead to the same end state as arms races in conventional warfare: mutually assured destruction (MAD). During the Cold War, when doctrines and awareness of MAD meant that nuclear weapons could not be used without risking destruction on a global scale, nations instead committed military assets and intelligence resources into irregular warfare campaigns. But it was not until the emergence of digital technologies that humanity collectively faced the reality of information weapons of mass destruction. In the context of informational warfare, mutually assured destruction is the total collapse of the epistemic commons, and the exhaustion of language as a means of cooperation for all parties on all sides of the conflict.

There has been a resurgence in the formal study and critique of propaganda because of recent escalations in irregular warfare. This article paints a picture of massive and sophisticated information warfare campaigns, including between nation states (Russia vs. U.S.), and between political parties (Democrats vs. Republicans). As a U.S. citizen living in a “swing state,” it is possible to be subject to propaganda on social media from both domestic political parties and foreign militaries—a constant battle, 24 hours a day, 365 days a year, all in high-definition in the palm of your hand. Humanity has never been subject to propaganda and information warfare of this kind or at this scale. What are the consequences of this unprecedented situation for individuals and societies?

Because of advances in irregular warfare, open societies are under siege. They are becoming increasingly fragmented and divided, while authoritarian societies are hardening into centralized information bubbles, ready to pop. Under conditions of total information warfare, democratic forms of government become impossible to operate in earnest because the people have no adequate means of making sense of the world. Without a healthy press, education, or public sphere, it is impossible for citizens to develop a realistic mutual understanding of the world. Undemocratic authoritarian states also become increasingly difficult to maintain, because the political elites themselves can too easily end up within insular echo chambers, absent of the free and novel insights needed to solve truly complex social problems.

…citizens’ adherence to their in-group narrative is now so strong that even the revelation that they have been infiltrated by hostile state actors is not enough to close the divide in society.

In 2016, Russian intelligence agents hacked the email of John Podesta, the chairman of Hillary Clinton’s campaign. Following the hack, they set up a “Wikileaks-inspired” site (called DC Leaks) to disseminate the content of the emails to the American voting public and the international press.[2] Among other revelations, the leaks gave Bernie Sanders supporters insights into their candidate’s treatment during the primary. The leaks also highlighted a host of other information operations being undertaken by Russian intelligence elsewhere in the culture. Some of the emails were woven into the “Pizzagate” narrative, which falsely claimed Democratic leaders were holding children captive in the basement of a Washington, D.C. pizzeria. This came from social media accounts known to operate from the Internet Research Agency (IRA). The IRA is probably the most famous of all troll farms, which has been operated by the Russian government for more than a decade. This state-administered department employs hundreds of people who work out of a nondescript office building in the suburbs of St. Petersburg.[3]

While it would be easy to see DC Leaks as election interference in favor of Trump, the actual state of Russian operations is much broader, undermining all sides of the political spectrum. One particular case demonstrates the relative ease with which a sock puppet, or disguised account, of Russian intelligence can use social media to deceive protesters into taking action on the streets of an American city.[4] In 2017, one of the most followed Black activist Twitter feeds (@Blacktivist)[5] was later discovered to be one of many fake accounts set up by Russian trolls. Alongside another called @WokeBlack, these accounts were engaged in organizing protests in U.S. cities.[6] Blacktivist’s posts were retweeted in the millions. They were often understood as articulate and valid takes on the racial situation in the U.S. Blacktivist and WokeBlack encouraged Black voters to vote for Green candidate Jill Stein in swing states in which their votes could have put Clinton into the White House. This highlights a concerning phenomenon, in which citizens’ adherence to their in-group narrative is now so strong that even the revelation that they have been infiltrated by hostile state actors is not enough to close the divide in society.

It has been known from the earliest days of military strategy: you can be blinded by your own smokescreen, and even more so when your enemy is using one too.

One common misunderstanding of information war and propaganda is that it only involves the spreading of lies and fake news. Of course, these are key tools, but note that the emails published on DC Leaks are not simply forgeries, and the ideas of Blacktivist are not simply wrong. It is precisely that they are true that makes them powerful, and potentially more powerfully divisive. This is one possible goal of information war (especially as practiced by the Russian state): to sow seeds of internal dissension, confusion, and ultimately epistemic nihilism.[7] As we will see, “fact-checking” and fake news debunking are only a small part of the solution, because a great deal of what should be classed as propaganda will pass the test of earnest fact-checking.[8] We will take a detailed look at propaganda—including its various definitions and techniques—in the second article of this series.

It is estimated that during the 2016 election, Americans shared Russian propaganda on social media hundreds of millions of times.[9] It has also been estimated that during that same time almost one-fifth of Americans’ Twitter discussions were likely to come from bots.[10] American citizens have been subject to AI bots and sock puppets, built by their own political parties, as well as foreign militaries and hackers. All this activity has been understood as a new class of information warfare, often called computational propaganda.[11] Various definitions are offered for this term, which provides a name for the process that leads to information weapons of mass destruction.

While the 2016 U.S. election was a watershed in computational propaganda, the same phenomenon has basically swept the planet, beginning as early as 2010. Ukraine, Estonia, China, Iran, Mexico, the UK, and the U.S. have all had major politically significant incidents of computational propaganda.[12] Research on computational propaganda is underway at various academic centers and think tanks, including at the Oxford Internet Institute, the Stanford Internet Observatory, and the Digital Forensics Lab of the Atlantic Council. The focus has been largely on the techniques, organizations, and forensic approaches, revealing a dangerous new frontier of digitally enhanced irregular warfare. We posit that this frontier leads toward mutually assured destruction, like all frontiers of arms races in weapons technologies.

In one sense, mutually assured destruction in the context of information war is simple. It has been known from the earliest days of military strategy: you can be blinded by your own smokescreen, and even more so when your enemy is using one too. The use of powerful information manipulation tactics to coerce the enemy requires the creation of organizations that specialize in making and using such tools of war. History suggests that it can be hard to achieve trust and collaboration in governments that maintain large and complex propaganda operations. Stalin’s demise in Russia can be at least partially attributed to this lack of trust. Stalin spent his last days in a bunker, paranoid and suffering the consequences of creating an almost completely manipulated information environment. Accounts show that during the Cold War, both the CIA and KGB used deceptive techniques to convince their own government agencies of the success of their campaigns (i.e. the agencies propagandized their own colleagues to ensure continued support for their work). Societies that depend on the politicized control of information end up shrouding both political leaders and the masses in mere simulations of reality.[13]

We have reached a point at which a difference in magnitude has become a difference in kind.

The idea that any group of leaders is immune to the cognitive and emotional distortions they inflict upon the masses is misleading. While a small political elite might know more than most other members of their society, they are nevertheless limited epistemically by their position as problem-solvers who are segregated from actual free and open streams of information. They cannot readily trust high-ranking officials in their own intelligence and military, who themselves are employed in the practice of information manipulation and are interested in keeping their jobs and reputations. They also cannot rely on well-educated and expert members of the general population, who in fact have been lifetime subjects of information manipulation. Nor can they rely on input from foreign nations, who are systematically trying to control what information is available to their adversaries, and how it is framed. Over time, a downward spiral of distrust and confusion degrades decision-making and problem-solving capacities until the social system collapses, as occurred eventually with the Soviet Union.[14]

Politically motivated information asymmetries produce only short-term gains. Social systems of this kind are undone by the long-term consequences of the damage inflicted on public sensemaking. The dangers of what is possible when centralizing and politicizing the control of information have long been noted by those arguing in support of open societies. However, under the conditions created by advances in digital technologies, problems of information war have become more complex.

Political parties in the world’s most open societies have wielded unprecedented instruments of information warfare on their own people as part of election cycles—unwittingly or not. The role of Cambridge Analytica in Trump's election is now a familiar cultural touchpoint. But very little was said about the armies of hired trolls suddenly popping up to follow and support Biden and Harris, many of them outsourced to a firm in India.[15] Chat bots and botnets were created by both parties in both 2016 and 2020. But it was Obama’s campaign in 2012 that truly broke the ice in the use of computational propaganda in the domestic sphere.[16]

These digital information warriors have real-world impacts.

Some may argue that this is just a natural extension of the propaganda created by political parties of the past, which was always intense in the United States. This is true in the same way it is true that the atomic bomb is simply a natural extension of the weapons programs of the past. We have reached a point at which a difference in magnitude has become a difference in kind.

Historically, as weapons technologies crossed thresholds of destructiveness, military and governance responses resulted in enhanced regulations and international agreements on use. This process occurred with biological weapons and with atomic weapons. We propose that information weapons of mass destruction exist, but have not yet been recognized as such. Therefore, law abiding political actors can use them without consequence, and without understanding the damage inflicted on the public sphere and information commons.

Every major government has their own version of Russia’s IRA.[17] These organizations would be more accurately referred to as cyborg armies. They consist of a mixture of human brains, cultural software (memes), digital hardware, and artificial intelligence. Faculties house hundreds of individuals working in shifts 24 hours a day. One individual will run dozens or hundreds of sock puppet social media accounts. Many of these accounts will be automated using custom computer code. Teams of writers produce content for orchestrated campaigns.[18]

We are entering the realm of the dystopian.

These digital information warriors have real-world impacts, far beyond the arguments they troll on Twitter. As described above, there are cases in which anti-government protests within the U.S. were organized by sock puppet accounts set up by foreign governments.[19] Mexico and the Philippines had elections fundamentally disrupted by massive operations, likely involving foreign governments’ troll farms.[20] Many people in the U.S. do not realize that Germany also had its capitol stormed in 2020, just before the U.S. capitol, likely also in large part due to escalations in domestic computational propaganda involving troll farms.[21]

Now imagine a near future in which Virtual Reality (VR) and Augmented Reality (AR) have merged with social media platforms. This future is closer than you might think: Facebook bought Oculus Rift for more than $2 billion in 2014, with the brand becoming one of the major players in VR. The industry is seeking to provide a radically immersive experience that literally overlays a digital simulation across the totality of individual experience.

It will soon be possible to spend countless hours plugged into VR headsets experiencing the equivalent of a “news feed” that consumes your entire sensory experience. This is not a small screen in your hand. When the story is reported from location you are “there” in a way you never were before. Imagine further that “deep fakes” are drawn into the mix—deep fakes are technically advanced digital forgeries, typically in the form of video footage showing someone doing or saying something they never did or said. This would mean that political messages can be delivered to you through the simulated image of your best friend or your deceased father. This is bringing micro-targeting of political messaging to a level of emotional manipulation previously unimaginable. We are entering the realm of the dystopian.

With this unprecedented level of persuasive information technology, it should be clear that if governments and media elites misuse their powers, technologies could be created that would be the equivalent of mental imprisonment. This would be digitally enabled brainwashing on a scale that could capture an entire generation of minds, especially if a popular and marketable application is developed to package delivery. We are looking at the equivalent of having a weapon that can destroy a population—only they will not die, they will instead “lose their minds and hearts” over to the will of those in control of the VR attention-capture technologies. It is no longer beyond reason to consider the reality of a world of automated computational brainwashing, psychologically irresistible, and delivered at scale. While this scenario is still science fiction, leaders in the field of computational propaganda are already worrying about how long we have left until these trends start playing out.[22]

Society has been left teetering on the edge of mass insanity, caught up in the dynamics of MAD, reaching the final limit of military strategies of total war. How did we get to this treacherous place?

Caution: Rabbit Holes and Halls of Mirrors

One of the difficulties in researching irregular warfare is that the very texts providing information on the subject can themselves be weapons of information warfare. When you read a book by an American writing about the KGB, for example, how can you be sure it is not an artifact of the CIA? This would seem absurd if it were not already known that the CIA has been known to publish books, most of which you would never know had anything to do with the CIA. And then the question must be asked: is this text here, the one you are reading, not just some kind of propaganda?

These traps are noted by several recent scholars in the field of propaganda analysis. They demonstrate how the act of making the public aware of the quantity and effectiveness of computational propaganda only furthers the aims of some propagandists. If the goal is to make the target population confused and suspicious of all their information sources, and thus unable to effectively cooperate, then making everyone think there is propaganda everywhere would accomplish that goal. Furthermore, when the propaganda in question raises legitimate concerns or presents verifiable and damning facts (such as DC Leaks), then drawing attention to the information war furthers the purposes of those waging it.

Also, when someone “exposes Russian propaganda,” as we have done to a degree here, it is hard to say they are not taking sides in the war. Indeed, doing so appears part of an offensive or defensive maneuver. Once awareness is directed at the dynamics of information warfare, a hall of mirrors unfolds in which everything can potentially enter the vortex of critical suspicion. Caution is warranted when exploring rabbit holes about information war.

Not every person in our war-ravaged public sphere is a warrior. Education can still take place, even if a great deal of the information landscape involves the coercive, bad faith manipulation of ideas. One of the overall goals of this series of papers is to provide the tools and insights necessary to tell the difference between education and propaganda. Upon completion, the series itself should be clearly identifiable as good faith communication motivated by an interest in education, not warfare.

Shelving nukes has not meant the end of war; it has meant the beginning of war by other means.

Steven Pinker has noted that there has not been a major war for more than half a century, and that overall, as history has unfolded, the relative scale and violence of armed conflict has subsided. He suggests this is a sign of progress toward peace, justice, and truth.[23] In this he echoes others like Francis Fukuyama, who proposed that the West had reached the end of history, which means in one sense the end of large-scale war.[24] This may be justifiable in the context of warfare as something involving only bombs and guns. Irregular warfare, however, has been increasing in intensity, scope, and impact. Total war between major nation states has not truly reduced; instead, it has transformed into something less physically violent and more psychologically violent.

Given humanity’s long history of war and physical conflict, it can be hard to grasp that irregular warfare is now the predominant mode of military action. Today conventional (kinetic/physical) warfare is used in support of irregular campaigns. Bombs and guns are not the main event; instead they are enveloped within a broader strategy including informational, economic, political, and psychological warfare. This reorientation began in earnest with the Cold War and over time it has only become more entrenched in military strategy.

Of course, there has also been a buildup of conventional weaponry, including nuclear weapons. But as Yuval Harari notes, it is highly improbable, almost unbelievable, that “no one has fired the big guns.”[25] Why not? Humans have always used the most powerful means of physical violence at their disposal. Is the awareness of mutually assured destruction enough? Probably not, and bombs would have dropped, were it not also for the transfer of military and government assets into non-kinetic warfare. Shelving nukes has not meant the end of war; it has meant the beginning of war by other means.

When the U.S. entered World War II, there was a tremendous amount of related propaganda. This included tens of thousands of pamphlets and hours of radio broadcast intended to prepare the way for the men, guns, tanks, and planes. This is how information warfare tactics had traditionally been used: as an aid to physical violence, and as a means of subverting the morale of civilian and military populations to ease the way for conquest. Historically, information and intelligence units worked to support victory won by use of force.

But when the U.S. and USSR began the Cold War, in the shadow of atomic weapons, the situation had changed fundamentally. Total war was not over; it had only become less obvious: it had turned into a war of ideas.[26] Proxy wars, like Korea and Vietnam, were fought as part of the symbolic maneuvers of the broader total information war. With the benefit of hindsight, the Cold War is widely understood as being a culture war, which is another way of saying information war. Proxy wars were part of the manipulation of information, more than they were about the acquisition of resources through military conquest. The agreements between superpowers during the Cold War did not create peace, they only limited physical violence to make way for unlimited information, political, and psychological warfare.

The cumulative effect, however, is the creation of an environment of resonant and mutually reinforcing symbols and images that work over time to change mindsets, dispositions, and behaviors.

Marshall McLuhan is famously quoted as saying “The Bomb is pure information.”[27] What he meant is that nuclear weapons are only in part instruments of physical destruction. They are also creations of scientists and politicians, and so the existence of atomic bombs entails a vast network of communication and information. By that same token, the “nuclear age” also requires a vast regime of information control. Jean Baudrillard, who was influenced by McLuhan, also wrote specifically about the way nuclear weapons and energy demand new forms of information management to provide convincing narratives, creating “simulations” of risk, safety, and scientific authority.[28] The Cold War involved very real and imminent existential risk, and also the manipulation of the public view of that risk through practices of information warfare. The example of Carl Sagan’s role in the questionable science (but brilliant propaganda) around “nuclear winter” has been discussed in detail elsewhere.[29]

The Cold War occurred during a time in history at which developments in communications technologies made possible a new form of international “psychological warfare.” This was the preferred term used by Eisenhower to describe his approach to irregular warfare. Beginning in the late 19th century, the nature of humanity’s information ecosystem was changed forever by a succession of technologies associated with “the communications revolution”: telegraph, telephones, radio, mass-circulated periodicals, film, television, electronic mail, and the Internet. This created an operational concept of “global public opinion” that could be engaged in real time.[30]

By the time the Cold War was underway advertising and public relations had become major industries and were woven into every dimension of communications media. A common approach to propaganda was to “camouflage” it by making it so the hand of the government or PR organ was not obvious.[31] This means that the whole array of available media may be used, which during the Cold War involved orchestrated campaigns unfolding across print (newspapers and magazines), radio, TV, movies, events (like parades and ceremonies), high art, and academic papers and books. Most people encountering any one of these forms of media would be unlikely to consider it as part of a broader campaign of psychological warfare. The cumulative effect, however, is the creation of an environment of resonant and mutually reinforcing symbols and images that work over time to change mindsets, dispositions, and behaviors.[32]

The information commons is now impacted by a wider range of threat actors, with varying objectives, targets, and interests.

The content and placement of this warfare is hard to pin down. For example, both the CIA and the KGB worked in and around “the peace movement” in the U.S. and Europe. Their work often differed in outcome but employed the same fundamental tactic: to instigate and support movements and protests that manifest the legitimacy of one ideology (or the illegitimacy of the other). During the 1950s and 1960s the CIA was one of the main financial supports for the National Student Association, one of the largest student organizations in the U.S., with representatives on campuses across the country. The National Student Association organized protests for free speech, desegregation, anti-war, anti-colonialism, and feminism. The goal of CIA involvement was to demonstrate that the U.S. was an open society by promoting the visibility of dissent, which made America different from the Soviet Union. In “the free world,” students were able to speak their mind and protests were able to change public sentiment and even law. The CIA also used this operation to keep tabs on all the student radicals and maintain the protest movements within certain “safe limits.”[33]

The KGB by contrast was involved in orchestrating international scientific cooperation in the West for anti-nuclear proliferation protests. They leaked documents from the Pentagon to drive fear of U.S. belligerence within European nations, pushing them toward peace. They released the names and addresses of hundreds of CIA agents in a book published in English called Who’s Who in CIA. The response to this by the CIA was to publish a similar book simply called KGB.[34] More broadly, the Soviet Union promoted ideological war through cultural diplomacy involving events of high culture, including ballet, classical music, literature, science, and other aspects of Russian culture. The aim of this propaganda was to show that the U.S. was immature, capitalistic, and superficial, and therefore unable to hold a true vision for the future of the human race.[35]

Both nations focused on educational institutions, at home and abroad.[36] This shift brought warfare explicitly into the domain of intergenerational transmission, which we have discussed in our article on educational crises as a primary social function.[37] Information warfare targets the deep social structure of societies, just as the destruction of roads, crops, and military assets targets the deep physical infrastructures. Both create conditions in which normal life cannot persist. Societies are made vulnerable to disunification, mutual antagonism, and manipulation by outside actors.

It might seem that the manipulation of information and education is less dangerous than the destruction of roads and power grids. This is not the case. As shown in our work on educational crises: without coherent processes of intergenerational transmission, societies fail.[38] One outcome of the Cold War was the creation of educational infrastructures around the world that had very specific properties, imprints left from decades-long campaigns involving the weaponization of knowledge.

When the Cold War ended what became of the vast infrastructure built to conduct psychological warfare? It was not disassembled; it was simply put to different use.

State-on-state information war is currently taking place on a large scale, but now it is a complex multi-player scenario in which digital technologies allow relatively small actors to have potentially significant impacts. A clear recent example may be observed in the case of “fake news city,” a small metropolitan area in Macedonia (now North Macedonia) that has flooded the U.S. with disinformation, making massive profits along the way.[39] The information commons is now impacted by a wider range of threat actors, with varying objectives, targets, and interests. The average citizen must live with the psychological risks of this new kind of inter-state warfare.

Arguably the most important recent developments in irregular warfare have taken place in the political campaigns of competing parties in Western democracies, especially the U.S. The U.S.’s culture wars are irregular wars, and the country’s two political parties are waging constant irregular warfare against each other. This has resulted in the self-propagandizing of the U.S. by virtue of unregulated competition between its own political parties. Both information and legislation (and now in the context of the pandemic, biomedical regulations) are being used as part of this domestic irregular warfare. Democrats and Republicans now relate to each other the way the U.S. (as a whole) used to relate to the Soviet Union during the Cold War.

The best propaganda does not look like propaganda.

©Adaptive Cultures

It is likely that continual escalation of civil irregular war in the U.S. has no other outcome than mutually assured destruction. In reality, at the very least, this means the dissolution of the union through conflict, and the end of the nation as an experiment in open societies. As demonstrated in a number of related Consilience Papers, society is subject to widespread bad faith communication in the media, and an endemic pattern of political actors spreading ideas by fostering collusion between special interest groups, intellectuals, and the press.[40] Taken together with the escalation in information warfare, the full consequences of our current situation begin to come into view.

#### AI is inevitable, but model collapse specifically causes it to make compounding mistakes that guarantee distorted and unreliable outputs. That ruins the positive potential for AI.

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Bernard Marr, “Why AI Models Are Collapsing And What It Means For The Future Of Technology,” Forbes, 08-19-2024, https://www.forbes.com/sites/bernardmarr/2024/08/19/why-ai-models-are-collapsing-and-what-it-means-for-the-future-of-technology/

Model collapse, recently detailed in a Nature article by a team of researchers, is what happens when AI models are trained on data that includes content generated by earlier versions of themselves. Over time, this recursive process causes the models to drift further away from the original data distribution, losing the ability to accurately represent the world as it really is. Instead of improving, the AI starts to make mistakes that compound over generations, leading to outputs that are increasingly distorted and unreliable.

This isn’t just a technical issue for data scientists to worry about. If left unchecked, model collapse could have profound implications for businesses, technology, and our entire digital ecosystem.

What Exactly Is Model Collapse?

Let’s break it down. Most AI models, like GPT-4, are trained on vast amounts of data—much of it scraped from the internet. Initially, this data is generated by humans, reflecting the diversity and complexity of human language, behavior, and culture. The AI learns patterns from this data and uses it to generate new content, whether it’s writing an article, creating an image, or even generating code.

But what happens when the next generation of AI models is trained not just on human-generated data but also on data produced by earlier AI models? The result is a kind of echo chamber effect. The AI starts to "learn" from its own outputs, and because these outputs are never perfect, the model's understanding of the world starts to degrade. It's like making a copy of a copy of a copy—each version loses a bit of the original detail, and the end result is a blurry, less accurate representation of the world.

This degradation happens gradually, but it’s inevitable. The AI begins to lose the ability to generate content that reflects the true diversity of human experience. Instead, it starts producing content that is more uniform, less creative, and ultimately less useful.

Why Should We Care?

At first glance, model collapse might seem like a niche problem, something for AI researchers to worry about in their labs. But the implications are far-reaching. If AI models continue to train on AI-generated data, we could see a decline in the quality of everything from automated customer service to online content and even financial forecasting.

For businesses, this could mean that AI-driven tools become less reliable over time, leading to poor decision making, reduced customer satisfaction, and potentially costly errors. Imagine relying on an AI model to predict market trends, only to discover that it’s been trained on data that no longer accurately reflects real-world conditions. The consequences could be disastrous.

Moreover, model collapse could exacerbate issues of bias and inequality in AI. Low-probability events, which often involve marginalized groups or unique scenarios, are particularly vulnerable to being "forgotten" by AI models as they undergo collapse. This could lead to a future where AI is less capable of understanding and responding to the needs of diverse populations, further entrenching existing biases and inequalities.

The Challenge Of Human Data And The Rise Of AI-Generated Content

One of the primary solutions to preventing model collapse is ensuring that AI continues to be trained on high-quality, human-generated data. But this solution isn’t without its challenges. As AI becomes more prevalent, the content we encounter online is increasingly being generated by machines rather than humans. This creates a paradox: AI needs human data to function effectively, but the internet is becoming flooded with AI-generated content.

This situation makes it difficult to distinguish between human-generated and AI-generated content, complicating the task of curating pure human data for training future models. As more AI-generated content mimics human output convincingly, the risk of model collapse increases because the training data becomes contaminated with AI’s own projections, leading to a feedback loop of decreasing quality.

Moreover, using human data isn’t as simple as scraping content from the web. There are significant ethical and legal challenges involved. Who owns the data? Do individuals have rights over the content they create, and can they object to its use in training AI? These are pressing questions that need to be addressed as we navigate the future of AI development. The balance between leveraging human data and respecting individual rights is delicate, and failing to manage this balance could lead to significant legal and reputational risks for companies.

The First-Mover Advantage

Interestingly, the phenomenon of model collapse also highlights a critical concept in the world of AI: the first-mover advantage. The initial models that are trained on purely human-generated data are likely to be the most accurate and reliable. As subsequent models increasingly rely on AI-generated content for training, they will inevitably become less precise.

This creates a unique opportunity for businesses and organizations that are early adopters of AI technology. Those who invest in AI now, while the models are still trained primarily on human data, stand to benefit from the highest-quality outputs. They can build systems and make decisions based on AI that is still closely aligned with reality. However, as more and more AI-generated content floods the internet, future models will be at greater risk of collapse, and the advantages of using AI will diminish.

Preventing AI From Spiraling Into Irrelevance

So, what can be done to prevent model collapse and ensure that AI continues to be a powerful and reliable tool? The key lies in how we train our models.

First, it’s crucial to maintain access to high-quality, human-generated data. As tempting as it may be to rely on AI-generated content—after all, it’s cheaper and easier to obtain—we must resist the urge to cut corners. Ensuring that AI models continue to learn from diverse, authentic human experiences is essential to preserving their accuracy and relevance. However, this must be balanced with respect for the rights of individuals whose data is being used. Clear guidelines and ethical standards need to be established to navigate this complex terrain.

Second, the AI community needs greater transparency and collaboration. By sharing data sources, training methodologies, and the origins of content, AI developers can help prevent the inadvertent recycling of AI-generated data. This will require coordination and cooperation across industries, but it’s a necessary step if we want to maintain the integrity of our AI systems.

Finally, businesses and AI developers should consider integrating periodic "resets" into the training process. By regularly reintroducing models to fresh, human-generated data, we can help counteract the gradual drift that leads to model collapse. This approach won’t completely eliminate the risk, but it can slow down the process and keep AI models on track for longer.

The Road Ahead

AI has the potential to transform our world in ways we can barely imagine, but it’s not without its challenges. Model collapse is a stark reminder that, as powerful as these technologies are, they are still dependent on the quality of the data they’re trained on.

As we continue to integrate AI into every aspect of our lives, we must be vigilant about how we train and maintain these systems. By prioritizing high-quality data, fostering transparency, and being proactive in our approach, we can prevent AI from spiraling into irrelevance and ensure that it remains a valuable tool for the future.

Model collapse is a challenge, but it’s one that we can overcome with the right strategies and a commitment to keeping AI grounded in reality.

#### That guarantees extinction well before advanced AI.

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Atoosa Kasirzadeh, “Two types of AI existential risk: decisive and accumulative,” Philosophical Studies, 03-30-2025, https://link.springer.com/article/10.1007/s11098-025-02301-3

\*We don’t endorse offensive language

The conventional discourse on existential risks (x-risks) from AI typically focuses on abrupt, dire events caused by advanced AI systems, particularly those that might achieve or surpass human-level intelligence. These events have severe consequences that either lead to human extinction or irreversibly cripple human civilization to a point beyond recovery. This decisive view, however, often neglects the serious possibility of AI x-risk manifesting gradually through an incremental series of smaller yet interconnected disruptions, crossing critical thresholds over time. This paper contrasts the conventional *decisive AI x-risk hypothesis* with what I call an *accumulative AI x-risk hypothesis*. While the former envisions an overt AI takeover pathway, characterized by scenarios like uncontrollable superintelligence, the latter suggests a different pathway to existential catastrophes. This involves a gradual accumulation of AI-induced threats such as severe vulnerabilities and systemic erosion of critical economic and political structures. The accumulative hypothesis suggests a boiling frog scenario where incremental AI risks slowly undermine systemic and societal resilience until a triggering event results in irreversible collapse. Through complex systems analysis, this paper examines the distinct assumptions differentiating these two hypotheses. It is then argued that the accumulative view can reconcile seemingly incompatible perspectives on AI risks. The implications of differentiating between the two types of pathway—the decisive and the accumulative—for the governance of AI as well as long-term AI safety are discussed.

1 Introduction

Recent advances in machine learning have sparked intense debate about the existential risks (x-risks) associated with artificial intelligence (AI) systems.Footnote1 Central to this debate is a concern about the mechanisms by which AI could cause existential catastrophes. In direct response to this concern, this paper explores: What are the distinct types of pathway by which AI systems could cause existential catastrophes? Conventional discourse on AI existential catastrophes typically portrays them as sudden, decisive events, caused by artificial general or super intelligence (Bostrom, 2013) or extremely powerful (non-general) AI (Carlsmith, 2022).

Contrasting this conventional decisive viewpoint, this paper introduces the accumulative AI x-risk hypothesis as an alternative lens. The accumulative hypothesis posits that AI x-risks do not exclusively materialize as decisive, high-magnitude global events caused by extremely powerful AI such as artificial general or super intelligence. Instead, locally significant AI-driven disruptions can accumulate and interact over time, progressively weakening the resilience of critical societal systems, from democratic institutions and economic markets to social trust networks. When these systems become sufficiently fragile, a modest perturbation could trigger cascading failures that propagate via the interdependence of these systems. The failures amplify and reinforce each other by network effects and feedback loops, potentially leading to a globally irreversible civilizational collapse.

This paper develops the outline of an accumulative perspective on AI x-risk, by examining how multiple types of AI-induced risks could compound and cascade over time to gradually bring about an AI-generated existential catastrophe. By applying complex systems analysis—an approach not typically used in AI x-risk scholarship—I defend the significance of accumulative AI x-risk, and consequently argue for a fundamental reconceptualization of AI x-risk governance. I discuss the epistemic and pragmatic benefits of attending to the accumulative perspective if such risks are to be governed effectively.

2 AI x-risk: preliminaries

2.1 Concepts of risk

At most basic, risk relates to some characterization of uncertainty about potential (adverse) outcomes (Dean, 1998; Hansson, 2010; Aven, 2012). According to the ISO 31000 standard (International Organization for Standardization, 2018), risk is defined as “the effect of uncertainty on objectives.” The Society for Risk Analysis (Aven et al., 2018) defines it as “uncertainty about and severity of the consequences of an activity,” while the U.S. Environmental Protection Agency (U.S. Environmental Protection Agency, 2024) defines risk as predicting “the probability, nature, and magnitude of the adverse effects that might occur.”

More concretely, risk has been analyzed through at least four distinct, though not mutually exclusive, interpretations.

First, risk has been used to mean an unwanted event that may occur (Carlsmith, 2022). For instance, “AI systems exhibiting power-seeking behavior pose a major existential risk to humanity.” Second, risk has been used to denote the cause(s) of an unwanted event that may occur (Weidinger et al., 2022). For example, “Insufficient testing of generative AI models could cause severe harm in AI deployment.” Third, risk has been used to mean the probability of an unwanted event that may occur (Lowrance, 1976). An example is “The risk that a large language model will generate incorrect information in response to user queries is approximately 5%.” Fourth, risk has been used to mean a statistical expectation value—the product of probability and consequence—of an unwanted event that may occur (United Nations International Strategy for Disaster Reduction, 2009). For instance, “The risk of LLM hallucination in a medical context can be calculated by multiplying the probability of giving incorrect medical advice (1%) by the average cost of medical liability claims ($500,000), yielding an expected cost of $5,000 per consultation.”

Most researchers define existential risks as the potential for events that would result in the extinction of humanity or an unrecoverable decline in humanity’s potential to thrive (Bostrom, 2013; Ord, 2020a).Footnote2 Existential catastrophes are a class of potential events that may originate from natural causes, such as a supervolcanic eruption; anthropogenic sources, like nuclear conflict; or emerging threats, such as misaligned artificial superintelligence.Footnote3 This paper concentrates on existential catastrophes induced by AI (AI x-catastrophes) and their associated risks.

In AI x-risk literature, researchers employ either of the qualitative or quantitative interpretations described above, each highlighting specific information about x-risks but also presenting certain limitations (Tonn & Stiefel, 2013; Beard et al., 2020).Footnote4 This paper aims to maintain neutrality between the different interpretations of AI x-risk (i.e., unwanted AI x-catastrophe, cause(s) of unwanted AI x-catastrophe, probability of unwanted AI x-catastrophe, and statistical expectation value of AI x-catastrophe), drawing on a broad range of perspectives to analyze AI x-catastrophes and their associated risks. While I employ the causal interpretation of AI x-risk for illustrative purposes, alternative interpretations could remain equally valid; though thehe probabilistic and statistical expectation value interpretations of AI x-risk warrant their own detailed investigation elsewhere.

The conventional discourse on AI x-catastrophes portrays them as decisive, large-scale events caused by highly advanced AI systems, often referred to as artificial general intelligence (AGI) or artificial superintelligence (ASI).Footnote5 The idea that advanced machines can pose significant risks is not novel and has historical antecedents.Footnote6 Samuel Butler (1863, p. 185), a novelist and literary critic, alluded to the possibility of machines dominating humanity. This concern was later picked up by the renowned mathematician Alan Turing (1950), who warned of intelligent machines eventually taking control. Norbert Wiener (1960), a founder of the field of cybernetics, cautioned against entrusting machines with purposes misaligned with human intentions or desires. Similarly, the mathematician Irving J. Good (1966) expressed concerns about the creation of “ultraintelligent machines.”

More recently, philosophers like Nick Bostrom (2002, p. 7) drew systematic attention to the existential threats posed by ASI: “When we create the first superintelligent entity, we might make a mistake and give it goals that lead it to annihilate humankind, assuming its enormous intellectual advantage gives it the power to do so.”Footnote7 Computer scientists such as Stuart Russell (2019) and physicists like Max Tegmark (2018) echoed similar concerns, stressing the x-risks of ASI beyond human control. Such views about ASI x-risk frequently hinge on two key theses: orthogonality and instrumental convergence (Bostrom, 2012, 2014).Footnote8

The orthogonality thesis posits that an advanced AI system’s intelligence level and its final goals are orthogonal.Footnote9 This implies that an AI system could have any combination of final goals --- beneficial or harmful --- and intelligent capabilities. That is, the space of possible goals is limitless, and intelligence alone does not constrain which of these goals an agent might adopt. The instrumental convergence thesis holds that diverse final goals often have similar instrumental sub-goals—like self-preservation or resource acquisition—as these sub-goals are useful for achieving almost any final objective. This means that for a wide range of ends, instrumental rationality converges on similar means. An ASI might therefore pursue actions harmful to humanity not out of malice, but as instrumental means toward achieving its (programmed) goals. Two hypothetical scenarios illustrate how conventional models of ASI could cause x-catastrophic outcomes.

In a thought experiment popularized by Bostrom (2003), an ASI is given the seemingly innocuous and simple goal of maximizing paperclip production. Even with this simple objective, the ASI could pursue instrumental sub-goals: it might eliminate humans to prevent deactivation (self-preservation) or convert their bodies into paperclips (resource acquisition). Consequently, the ASI’s optimal future could become one abundant with paperclips but devoid of humans—not because intelligence necessitates this goal, but because instrumental sub-goals are (putatively) rational steps toward satisfying its given optimization objective. That is, the paperclip maximizer illustrates how an AI with an apparently harmless goal could pose x-risk via the rational pursuit of instrumental sub-goals like resource acquisition and self-preservation.Footnote10

In a structurally similar thought experiment, Russell and Norvig (2010, p. 1039) describe the following scenario attributed to Marvin Minsky: an advanced AI tasked with proving the Riemann hypothesis might appropriate Earth’s resources to build supercomputers, endangering humanity in pursuit of a mathematical proof. Like the paperclip maximizer, this example is supposed to illustrate how an advanced AI pursuing a benign goal could pose x-risk to humanity. Both scenarios demonstrate a key pattern: an advanced AI system optimizing for a specific final goal could rationally pursue sub-goals which are catastrophic to humanity, not from malice, but as instrumental steps toward its optimization goal.

2.2 Decisive AI x-risk

The conventional view, sketched above, frames AI x-catastrophes as arising from the decisive actions of ASI. Toby Ord (2020a, p. 20), a prominent x-risk scholar, explicitly endorses the decisive character of x-catastrophes: “I take on the usual sense of catastrophe as a single decisive event rather than any combination of events that is bad in sum. A true existential catastrophe must by its very nature be the decisive moment of human history the point where we failed.” This conventional framing suggests that AI x-risk manifests as sudden, cataclysmic events that either eradicate humanity or irreversibly curtail its potential. I articulate this perspective in terms of the decisive ASI x-risk hypothesis.

Decisive ASI x-risk hypothesis: x-risk from ASI is the possibility of abrupt large-scale events that lead to humanity’s extinction or cause an unrecoverable decline in its potential.

Both Bostrom’s portrayal of ASI pursuing destructive goals and Ord’s characterization of x-catastrophes as singular, defining events exemplify the conventional view: AI x-risk manifests as sudden, decisive moments of overwhelming impact. The decisive AI x-risk, according to this framing, is the expected uncertainty of the occurrence of such conclusive events as catalysts for x-catastrophic outcomes.

The decisive hypothesis, however, overlooks an alternative type of causal pathway leading to AI x-catastrophes. This alternative involves the gradual accumulation of smaller, seemingly non-existential, AI risks eventually surpassing critical thresholds.Footnote11 These risks are a subset of what typically is referred to as ethical or social risks. In the rest of this paper, the terms "AI ethical risk" and "AI social risk" are used interchangeably.

2.3 AI risks: existential versus social

The prevailing discourse on risks from AI distinguishes between AI x-risks and AI social risks as separate and distinct categories. This separation has been a mainstream trend: x-risk from superintelligent or “strong” AI are often contrasted with normal non-existential risks (Hendrycks & Mazeika, 2022, p. 3) or with ethical and social risks (Weidinger et al., 2021, p. 7). Several other examples of this contrast can be found on social media platforms (e.g., Twitter) and popular media.Footnote12 In a notable instance, Turing Award Laureate, Geoffrey Hinton, who departed from his position at Google to openly discuss x-risks from AI, emphasized during a recent interview that his concerns about existential risk "are different" from the concerns of Timnit Gebru, a computer scientist and responsible AI researcher, about AI ethical risks that are not "existentially serious" (CNN, 2023).

Typically, existential and social risks are demarcated along the lines of locality—i.e., the scope of risk—and severity—i.e., whether impacts are recoverable and limited, or irreversible and catastrophic for (human) civilization (Bostrom (2013), Amodei et al. (2016). While this demarcation could be pragmatically insightful, there is a notable gap in exploring the relationship between x-risks and the evolution of ethical concerns in a substantial manner.Footnote13

The social risks of AI systems have been analyzed across different domains—from language models and their multimodal variants (Bender et al., 2021; Weidinger et al., 2022; Bird et al., 2023) to recommender systems (Milano et al., 2020; Deldjoo et al., 2024), to name just a few examples. While a full exposition of these risks is beyond the scope of this paper and has been extensively discussed in the above references, here I provide a brief categorization of seven risk classes that are shared in most AI social risk taxonomies.

Manipulation and deception risks include AI systems that cause harm by manipulating human perception or behavior via targeted or unwanted persuasion techniques, such as emotional exploitation (Kasirzadeh & Evans, 2023; Carroll et al., 2024; Park et al. (2024). Misinformation and disinformation risks arise from AI systems generating and amplifying false content at scale, enabling the spread of propaganda and undermining public trust and discourse (Sharma et al., 2019; Quach, 2020; Lin et al., 2021; Kay et al., 2024). Malicious use risks include the weaponization of AI systems for cyber attacks, the deployment of AI-enabled drones and other physical systems for physical attacks, and the automation of social engineering attacks (Brundage et al., 2018). Insecurity and information threat risks arise when AI systems reveal sensitive personal data or lead to an unintended disclosure of protected information (Carlini et al., 2021). Discrimination and hate speech risks arise by biased AI systems perpetuating systemic inequalities or generating targeted harmful content (Buolamwini & Gebru, 2018; Obermeyer et al., 2019). Surveillance, rights infringement, and erosion of trust risks originate from AI-powered mass surveillance systems and persistent monitoring that could lead to loss of privacy (Dwork, 2006; Tucker, 2018) and loss of trust in ruling institutions (Nowotny, 2021). Environmental and socioeconomic risks include ecological damage from the enormous energy consumption and carbon footprint associated with large-scale AI training and deployment (Luccioni et al., 2025) alongside widespread economic disruption via labor market transformation, worker displacement as automation renders certain job categories obsolete, or psychological harm inflicted on low-wage workers tasked with labeling content to train safe AI systems (Korinek & Stiglitz, 2018; Pashentsev, 2021; Perrigo (2023); Eloundou et al., 2024).

2.4 Accumulative AI x-risk

As an alternative to the decisive AI x-risk hypothesis, the gradual and cumulative progression of critically significant social risks forms a different type of pathway to AI x-catastrophes. I articulate this perspective in terms of the accumulative AI x-risk hypothesis.

Accumulative AI x-risk hypothesis: AI x-risk results from the build-up of a series of smaller, lower-severity AI-induced disruptions over time, collectively and gradually weakening systemic resilience until a triggering event causes unrecoverable collapse.

According to this alternative hypothesis, AI x-catastrophes could emerge not from a decisive event, but from the cumulative impact of multiple interconnected AI-induced adverse events over time. As compared to the decisive hypothesis, the accumulative hypothesis suggests a different type of causal pathway to AI x-catastrophe: a path wherein a succession of lower-severity, yet cumulatively significant, disruptions deeply erode the systemic resilience of the global system, radically disrupting critical socioeconomic and sociopolitical equilibrium. This weakened state potentially primes the global system for an unrecoverable collapse, particularly when further stressed by external events.

Figure 1 provides a schematic illustration contrasting the decisive and accumulative models of AI x-risk. The decisive scenario (blue path) represents the conventional view where a sudden catastrophic event—such as one caused by the arrival of ASI—leads to rapid, irreversible consequences. In contrast, the accumulative scenario (red path) shows how existential catastrophes can arise from a gradual accumulation of multiple smaller disruptions that compound and amplify over time. These accumulating disruptions gradually erode system stability, potentially crossing critical thresholds until a triggering event occurs.Footnote14

The gradual nature of the accumulative AI x-risk hypothesis can be likened to other global existential threats such as climate change.Footnote15 The accumulative perspective is structurally akin to the incremental rise in greenhouse gases contributing to climate change, where each individual emission seems minor, but collectively, they lead to significant and potentially irreversible changes in the Earth’s climate.

In the rest of this paper, I employ complex systems analysis to further analyze the two distinct pathways that could lead to AI x-catastrophes. The decisive pathway is based on the assumption that direct, catastrophic failures are triggered by (a) superintelligent system(s), while the accumulative pathway describes how systemic instabilities arise from interactions or interrelations between multiple AI-driven disruptions. This systems analysis perspective allows us to formulate the key assumptions underlying each hypothesis in greater detail, and examine how different patterns of causation and connectivity could produce AI x-catastrophes via fundamentally different mechanisms.

Before proceeding further, a crucial clarification is in order. The emphasis of this paper on conventional discussions of AI x-risk does not imply that all discourse on AI x-risk has been confined to the decisive hypothesis. This discourse is expanding, and an increasing number of scholars who do not necessarily endorse a decisive viewpoint are engaging to some degree with some version of the accumulative-type hypothesis (see, for example, Bucknall and Dori-Hacohen (2022), Hendrycks and Mazeika (2022), Shevlane et al. (2023), and Bales et al. (2024)); yet, no expansive and exclusive philosophical treatment of this hypothesis has been published. Nevertheless, this paper primarily focuses on the conventional decisive viewpoint on AI x-risk as this viewpoint--- historically entrenched and widely regarded as the predominant narrative --- has been a source of considerable debate and disagreement within various academic circles and public spheres. Its longstanding and prevalent nature in the field has contributed significantly to the imagination of majority about AI x-risk. This paper focuses on developing the accumulative perspective on AI x-risk which has not been adequately represented or robustly defended in the philosophical literature. It is my hope that this addition would facilitate a more unified and constructive dialogue about different kinds of AI risk and their relations.

3 Complex systems analysis for AI x-risk

AI x-catastrophes and their associated risks appear within our complex global system. Understanding how these catastrophes could occur requires analyzing how various elements—humans, AIs, and institutions—interact across multiple domains within this system. Complex systems analysis, which provides conceptual and mathematical instruments for analyzing relations and interactions between system components, enables us to trace how AI risks might arise through these interconnected relationships. The distinction between complex and non-complex systems defies precise definition (Ladyman et al., 2013); however, this paper clearly addresses subsystems characterized by markers of complexity: numerous components, their relationships, and interdependencies. Therefore, whenever I employ the term "system analysis" throughout our analysis, I am specifically referring to complex system analysis.

Systems analysis, pioneered by Von Bertalanffy (1968) and later advanced via influential works of Forrester (1971) and Meadows (2008), serves dual purpose for characterizing x-risk from AI. First, it provides an epistemic instrument for understanding how complex AI-induced risks arise from interactions between multiple subsystems. Second, it offers a pragmatic instrument for identifying when and how to intervene to minimize the evolving risk of undesired events.

Historically, systems analysis has proven valuable in understanding and taming various global risks —from the propagation of financial system shocks (Helbing, 2013) to the analysis of climate change tipping points (Steffen et al., 2018). It then seems natural that this approach would be helpful for analyzing AI x-risk, which also has a global nature. But, what is a system?

A system is a set of interconnected components whose (complex) interactions could produce unexpected or emergent behaviors and outcomes. Any complex system is characterized by three fundamental features: its basic constitutive components, their interconnections and interdependencies, and its boundaries (what distinguishes this system from its environment).

Systems analysis examines how phenomena evolve from initial perturbations that seed the process, through network propagation that spreads effects to compounding or cascading dynamics that amplify impacts, and finally to catastrophic transitions that transform entire systems.Footnote16 Let me explain each in relation to AI risks.

First, systems analysis provides a rigorous methodology for mapping how initial disturbances propagate through interconnected (AI) systems. For example, a software bug in one AI model might trigger failures in dependent systems, data corruption could cascade through shared training pipelines, or model misspecification might amplify errors across a network of automated decision systems.

Second, the initial perturbations, however small, could establish or trigger transmission pathways by which effects can spread—much like how a small trading error can trigger a chain of automated responses in financial markets (Min & Borch, 2022) or how the failure of one power station can cascade via an electrical grid (Andersson et al., 2005).

Third, systems analysis reveals cascade dynamics, where initial perturbations trigger chains of events with amplifying effects. Buldyrev et al. (2010), for instance, show how local failures can overload other components, leading to consequential failures that spread through the network. In AI systems, these cascades can manifest in two key ways: by error cascades, where errors in one AI’s behavior become amplified as other systems build upon this flawed information, and by feedback loops, where initial disturbances cycle through the network, magnifying the original perturbation with each iteration.

Fourth, systems analysis identifies potential catastrophic transitions at critical thresholds (Scheffer et al., 2009; Lenton et al., 2008). At these tipping points, seemingly small perturbations can trigger rapid, nonlinear changes in system-wide behavior. Catastrophic transitions in AI systems might be triggered by minor fluctuations—such as subtle shifts in model behavior or isolated component failures—but once a threshold is crossed, they can fundamentally alter the entire network’s functioning and stability. Like a glass that shatters under increasing pressure, the system undergoes an abrupt transition from one state to another.

The complex global system can be represented as a collection of interconnected subsystems. While a comprehensive mapping of all subsystems and their relationships is infeasible here, I focus on three critical meso-level subsystems for illustrative purposes—economic, political, and military.Footnote17

The economic subsystem, with its complex network of production, consumption, and exchange networks, could serve as a primary channel by which AI’s causal effects propagate. As AI systems could increasingly substitute for routine cognitive tasks, they may reshape parts of labor markets. This impact can also reverberate in capital markets via automated trading systems and risk assessment mechanisms, while fundamentally altering productivity dynamics through both labor augmentation and process automation.Footnote18

The political subsystem is typically (and inherently) linked to economic subsystem. National and international funding decisions, regulatory frameworks, and geopolitical dynamics create a complex network of influences that direct AI research and deployment. Simultaneously, AI technologies are changing political processes themselves, enabling new forms of democratic deliberation (Tessler et al., 2024), as well as concerning developments such as gradual manipulation of public opinion by targeted misinformation campaigns or personalized political advertising.Footnote19 AI-infused surveillance could create a self-reinforcing cycle: as governments increase surveillance, citizens resist these measures, leading to more intensive surveillance and control, ultimately weakening foundations of democratic institutions.Footnote20

The military subsystem, deeply intertwined with both economic and political subsystems, is another critical node type in the complex global system. AI’s integration into defense and intelligence operations is core to national security strategies, while simultaneously influencing international relations. Military applications of AI could create destabilizing feedback loops where nations accelerate AI weapons development in response to perceived threats, simultaneously shifting technological research priorities toward military capabilities and altering geopolitical power balances.Footnote21

The three subsystem types do not operate in isolation but form a densely interconnected network where changes in one area could compound through others, potentially in unexpected ways. Collectively, these subsystems, along with others, create the context within which AI x-catastrophes and their associated AI x-risks must be analyzed.

The next section applies this systems analysis perspective to develop an illustrative case for the accumulative AI x-risk hypothesis: “The perfect storm MISTER” thought experiment.Footnote22 Each letter in MISTER represents a member of a subset of the social risks (Manipulation, Insecurity threats, Surveillance and erosion of Trust, Economic destabilization, and Rights infringement) that were introduced in Sect. 2.3.Footnote23 This will be followed by a comparison of decisive and accumulative AI x-risk pathways from our systems-analysis perspective.

4 The perfect storm MISTER

Consider the highly interconnected world of 2040 where the pervasive integration of AI tools, AI assistants, AI agents, and Internet of Things (IoT) technologies has transformed almost every aspect of daily life.Footnote24 Cities embody a higher level of automation as compared to today, with sustainability assistants (Rillig & Kasirzadeh, 2024) optimizing resource usage, AI agents (Xi et al., 2023) managing various functions in domestic and industrial sectors, and even the most mundane devices like mirrors and refrigerators have become part of a vast data-exchanging AI network. Personalized AI assistants (Gabriel et al., 2024) have become the backbone of this connected world, serving roles from decision-making algorithms to social companions. However, beneath the surface of this technological connectivity, vulnerabilities and risks have been brewing.

Manipulation by AI assistants and agents. The abuse and misuse of AI systems for creating convincing deepfakes and misinformation reaches a critical point, where the information ecosystem becomes so polluted that rational public discourse becomes nearly impossible.Footnote25 The manipulation architecture operates by “cognitive cascade captures” (Hazrati & Ricci, 2024; Deldjoo et al., 2024) where initial successful manipulation creates vulnerabilities for subsequent influence attempts.

Advanced AI agents have enabled the creation of hyper-personalized propaganda and persuasive narratives, which can be strategically leveraged for social engineering purposes such as manipulating group identities, amplifying existing prejudices, exploiting belief systems by synthetic evidence, and creating personalized epistemic bubbles (Milano et al., 2020; Kay et al., 2024).

Unlike traditional static influence attempts, AI assistants and agents embedded in recommender systems could maintain consistent manipulation pressure while dynamically adapting to individual and collective response patterns (Kasirzadeh & Evans, 2023; Carroll et al., 2024). This unprecedented technological capability, in turn, poses fundamental challenges for maintaining individual and collective autonomy and preserving shared reality frameworks.

Insecurity threats. The proliferation of IoT devices in domestic environments has fundamentally transformed the security landscape, creating unprecedented vulnerabilities in personal digital spaces. We can distinguish between three types of security threats: digital, bio, and epistemic.

Digital-security threats. IoT and AI agents, embedded in devices from mirrors to refrigerators, have evolved beyond their roles as mere conveniences to significant points of vulnerability. Cybercriminals can now penetrate these devices, leading to widespread identity theft and ushering in an era of digital espionage. What were initially perceived as isolated breaches have gradually coalesced into a discernible pattern, signifying a more profound erosion of digital security.

The expansion of IoT devices has simultaneously paved the way for the creation of extensive, interconnected botnets. These AI-powered networks, once relatively benign, now demonstrate agentic abilities and have become capable of launching unprecedented Distributed Denial of Service attacks against critical infrastructures, including national power grids and communication networks. Each attack, incrementally more sophisticated than the last, represents a disturbing escalation from individual cybersecurity concerns to widespread threats against national security.

Bio-security threats. As AI technologies have become more widely available, they facilitate the development of new forms of bioterrorism. Private research labs with rather minimal expertise in synthetic biology and chemistry are now using AI agents to develop more infectious and deadly pathogens. The dual-use nature of AI in biotechnology—its potential for both beneficial and harmful applications—initially envisioned for medical breakthroughs, is maliciously repurposed to engineer biological weapons.Footnote26

Epistemic insecurity. Advanced AI assistants and agents have introduced fundamental challenges to both public and private epistemic infrastructures.Footnote27 In public domains, this has manifested through the systematic erosion of shared verification mechanisms, where traditional epistemic authorities face unprecedented challenges as synthetic content becomes increasingly indistinguishable from authentic documentation, with verification processes unable to keep pace with the rapid production of sophisticated fabrications. This disruption strikes at the heart of societal knowledge validation systems, undermining established protocols for information verification and authentication.

In the private sphere, personal communication channels-traditionally resistant to large-scale manipulation via social trust mechanisms-have become increasingly vulnerable to synthetic content that convincingly mimics trusted sources (Pennycook & Rand, 2021). This disruption extends beyond mere communication interference, affecting personal correspondence authenticity, private record verification, and the fundamental reliability of interpersonal trust mechanisms. The impact on private epistemic frameworks represents a significant shift in how individuals verify and validate information within their personal networks.

Surveillance and erosion of Trust. The transformation of mass surveillance by AI use is one of the deepest shifts in the relationship between state power and individual liberty. What began as isolated initiatives have evolved into a global phenomenon that transcends traditional political classifications, fundamentally altering the perceptions of privacy, social cohesion, and democratic governance.

The historical trajectory of mass surveillance has reached a troubling convergence between authoritarian and democratic governance models. Early warning signs emerged with China’s social credit system and the NSA’s PRISM program, but these examples now appear almost wide-spread.Footnote28 Multiple earlier revelations have particularly warned against the erosion of democratic norms by AI-enabled surveillancce technologies such as spywares (Farrow, 2022; Rujevic, 2024).Footnote29

The societal implications of ubiquitous surveillance manifest in what Han (2015) describes as the “transparency society,” where the mere possibility of observation fundamentally alters social behavior.Footnote30 Earlier studies (Kaminski & Witnov, 2014) have investigated and documented situations where citizens modify their behavior not in response to actual surveillance but to its perceived omnipresence.Footnote31 This chilling effect on public behavior and discourse is a particularly insidious threat to democratic vitality, as it operates via self-imposed constraints rather than direct coercion.

Economic destabilization. By 2040, the global economy has entered an unprecedented phase of instability, driven by the rapid and unmanaged deployment of AI systems across industries since the late 2020s. Nearly 40% of pre-2025 jobs have been eliminated by AI automation, creating massive structural unemployment. The pace of AI adoption has left no sufficient time for meaningful workforce transitions. The promised creation of new jobs never materialized at scale—AI systems became in charge of handling their own maintenance, optimization, and even creative development. The proposed solution of Universal Basic Income (UBI), while theoretically promising, has fallen short in practice due to political constraints and corporate resistance to the taxation necessary for meaningful implementation.Footnote32 The concentration of AI capabilities among a handful of tech conglomerates has exacerbated wealth inequality to historic levels, with the top 0.1% now controlling over 70% of global wealth.

The economic upheaval has been amplified by the fragmentation of the global order into competing digital-industrial blocs. The US-led Western alliance and the China-centered Asian sphere have created parallel technological and financial ecosystems, effectively splitting the world economy. This digital iron curtain has disrupted decades of global trade integration, with companies forced to maintain separate systems and standards for each bloc. The adoption of competing digital currencies has undermined the dollar-based financial system, while AI-powered economic warfare—including automated sanctions enforcement, algorithmic trade restrictions, and digital blockades—has become a daily reality. Smaller nations find themselves forced to align with one bloc or risk economic isolation, further destabilizing regional powers and trade relationships.

Market stability has faced additional challenges from the acceleration of algorithmic trading systems. While high-frequency trading is not new, the integration of advanced AI capabilities introduces novel forms of systemic risk (Jain et al., 2016; Baron et al., 2019). These systems can now process and react to market signals at unprecedented speeds, potentially creating feedback loops that amplify market volatility. The phenomenon extends beyond simple flash crashes to what might be termed "cascade failures," where AI-driven trading systems interact in ways that create emergent instability patterns.

Rights infringement. The pervasive application of AI in mass surveillance, coupled with data brokers' extensive collection and commodification of personal information, has deeply encroached upon basic human rights, creating an ecosystem where privacy violations are both profitable and increasingly difficult to escape. Privacy breaches have become alarmingly routine as AI systems gather and analyze personal data on an unprecedented scale. This constant monitoring undermines the right to privacy, a pillar of individual freedom. The situation is compounded by AI systems that enable discriminatory profiling and unwarranted scrutiny of individuals. Such practices, often lacking transparency and accountability, could lead to systemic unjust treatment and exacerbate existing societal inequalities at scale, directly infringing upon fundamental rights to privacy, equal protection, and due process.

In the perfect storm MISTER Scenario, a series of interconnected AI-induced risks coalesce into a catastrophic sequence of events, each exacerbating the next, leading to an existential crisis for humanity.

The AI x-catastrophe unfolds with a devastating AI-driven cyberattack simultaneously targeting critical power grids across three continents. This orchestrated attack is the tipping point, a culmination of the escalating cybersecurity threats. The resultant continent-wide blackouts cause immediate and widespread chaos, disrupting essential services and plunging billions into darkness. The blackouts trigger a domino effect, causing major economic crashes. Financial markets, already destabilized by AI-induced manipulations, collapse under the strain. The economic fallout rapidly fuels societal unrest, with widespread protests and riots in response to the failing systems.

Amidst this chaos and darkness, the seeds of deep distrust sown by AI-manipulated media, deepfakes, and targeted disinformation campaigns, which had been proliferating prior to the blackouts, begin to bear fruit. These divisive narratives, deeply entrenched in public consciousness, exacerbate social divides and impede efforts to restore stability and order. The blackout acts as a catalyst, propelling these latent tensions into active, widespread civil unrest. Simultaneously, the crisis exposes and amplifies previously minor inefficiencies and errors in AI systems, which become more pronounced due to the volatile market dynamics, regulatory upheaval, and ongoing algorithmic adjustments. These AI system failures extend their impact across various critical infrastructures, including healthcare and communication networks, further amplifying the societal disruption.

The causal impact of AI inefficiencies limited to each subsystem, each seemingly non-existential in isolation, begins to accumulate dynamically and gives rise to compounded systemic impact. The convergence of a set of catastrophic events—multiple cyberattacks, manipulation, systemic eroded trust, economic destabilization, and rights infringements—leads to a state of global dysfunction and chaos. The capacity for a coordinated global response becomes critically undermined, as nations grapple with internal crises and widespread infrastructural breakdowns. Regional conflicts escalate into larger wars. Nations or non-state actors, driven by desperation or opportunism, engage in aggressive military actions, leveraging AI autonomous weapons in warfare without legal constraints.

In this scenario, the x-catastrophe arise from the synergistic failure of systems critical to the functioning and survival of human civilization. The simultaneous and compounded nature of these crises creates a perfect storm situation where not only is recovery extremely challenging, but the potential for irreversible collapse is a stark reality.

With the perfect storm MISTER scenario established, we now compare the causal pathways underlying decisive and accumulative hypotheses from a systems analysis perspective.

5 Pathway to decisive ASI x-risk

The decisive ASI x-risk hypothesis focuses on scenarios, like the paperclip maximizer, where ASI could abruptly trigger existential catastrophes. This hypothesis assumes catastrophic outcomes arise from a single, identifiable cause: the creation of a misaligned superintelligence capable of rapid system-wide disruption. Recall the analytical instrument of complex systems analysis: how phenomena evolve from initial perturbations that seed the process, through network propagation that spreads effects to compounding or cascading dynamics that amplify impacts, and finally to catastrophic transitions that transform entire systems. Let us analyze the decisive hypothesis from this lens. First, ASI serves as the initial perturbation source, introducing novel disruptions into the global system. Second, the extensive connectivity of modern global infrastructures to ASI enables rapid propagation of ASI-initiated disruptions. Third, predominantly unidirectional dependencies from ASI towards various subsystems prevent the system from self-correcting, instead reinforcing and accelerating the catastrophic trajectory Finally, ASI-induced catastrophic event results in a catastrophic transition which in this case is the existential catastrophe.

Figure 2 illustrates a causal pathway according to the decisive AI x-risk hypothesis. Here is an interpretation of the figure and the assumptions underlying the decisive causal pathway. Modern civilization operates via densely connected subsystems—from financial markets and supply chains to communication infrastructures as well as social and military institutions. In the figure, square nodes represent various instances of subsystems in the global world, with red squares indicating subsystems severely impacted by the ASI and grey squares showing those not yet (severely) impacted. Stronger impacts are shown with bolder red links, while weaker or potential connections are indicated in grey. The arrangement of the propagation of ASI impact in the subsystems follows a temporal sequence for illustrative purposes. The red diamond node represents the catastrophic event (such as human extinction).

In scenarios like the paperclip maximizer, what begins as a simple optimization goal (maximize paperclips) cascades via multiple subsystems as the ASI pursues instrumental subgoals like resource acquisition. Initial control of computational resources spreads in economic networks, infrastructure control cascades through technological systems, and responses to human resistance ripple through social and political networks. Unlike many natural systems in naturally-evolved environments that have inherent balancing mechanisms (like predator populations limited by prey scarcity), an ASI creates self-reinforcing cycles without effective counterbalances. For example, the ASI’s acquisition of computing resources, as an instrumental subgoal, increases its capabilities, enabling more strategies for pursuing further subgoals. Each cycle amplifies the ASI’s ability to pursue its ultimate objective. With access to critically important components (from global manufacturing to energy grids), the ASI can leverage all necessary subsystems, with no significant subsystem immune from its influence (illustrated by the red diamond with x). This progression lacks natural checks - nothing effectively constrains its escalating influence as it pursues its goal of converting resources into paperclips.

6 Pathway to accumulative AI x-risk

Recall the accumulative AI x-risk hypothesis: x-risks arise from multiple AI-induced interacting disruptions that compound over time, progressively weakening systemic resilience until a triggering event causes unrecoverable collapse. Unlike decisive scenarios where ASI serves as the main (or single) causal source, this hypothesis involves multiple AI-induced causal processes that collectively contribute to bringing about an existential catastrophe.

From a systems analysis perspective, first, different types of AI systems serve as initial perturbation sources, where localized clusters of impacts, even if minor at the outset, can aggregate, evolve, and intensify across various subsystems. Second, while modern infrastructures are highly interconnected, AI systems typically impact specific subsystem clusters due to various types of boundaries in place—creating selective disruptive pathways to propagate via the network rather than the pervasive reach by ASI seen in decisive AI x-risk scenarios. Third, disruptions from different AI clusters interact and amplify each other as they spread via connected subsystems, creating cumulative effects larger than their initial impacts. Finally, as impacts from multiple AI clusters accumulate across subsystems, the system’s capacity for self-correction diminishes, making each new disruption more likely to reinforce rather than resolve existing instabilities.

Figure 3 illustrates a simplified causal pathway in accumulative AI x-risk scenario. Each hexagon represents a cluster of social risks at-scale from AI assistants or agents in perfect storm MISTER: Manipulation by AI assistants and agents, Insecurity threats, Surveillance and erosion of Trust, Economic destabilization, and Rights infringement. Within the hexagons, circles and squares represent different entities (institutions, humans) interacting with AI systems. The grey lines indicate potential connections and dashed lines represent weak relations.

The accumulative AI x-risk is about the potential of the interlinked and reciprocal events to progressively destabilize key subsystems. Although no single AI is the primary cause of an accumulative existential threat, the aggregated impact of distributed AIs across various subsystems leads to existential crises such as an unrecoverable global chaos (the diamond in red).Footnote33

#### Specifically, it makes permanent civil war highly likely---extinction.

Ferguson 23 – Senior Faculty Fellow at the Belfer Center for Science and International Affairs and former Professor of History at Harvard University, former Professor of International Affairs at the London School of Economics, PhD in History from the University of Oxford.

Niall Ferguson, “The Aliens Have Landed, and We Created Them,” The Washington Post, 04-09-2023, https://www.washingtonpost.com/business/2023/04/09/artificial-intelligence-the-aliens-have-landed-and-we-created-them/e75f4b9c-d68d-11ed-ac8b-cd7da05168e9\_story.html

It is not every day that I read a prediction of doom as arresting as Eliezer Yudkowsky’s in Time magazine last week. “The most likely result of building a superhumanly smart AI, under anything remotely like the current circumstances,” he wrote, “is that literally everyone on Earth will die. Not as in ‘maybe possibly some remote chance,’ but as in ‘that is the obvious thing that would happen.’ … If somebody builds a too-powerful AI, under present conditions, I expect that every single member of the human species and all biological life on Earth dies shortly thereafter.”

Do I have your attention now?

Yudkowsky is not some random Cassandra. He leads the Machine Intelligence Research Institute, a nonprofit in Berkeley, California, and has already written extensively on the question of artificial intelligence. I still remember vividly, when I was researching my book Doom, his warning that someone might unwittingly create an AI that turns against us — “for example,” I suggested, “because we tell it to halt climate change and it concludes that annihilating Homo sapiens is the optimal solution.” It was Yudkowsky who some years ago proposed a modified Moore’s law: Every 18 months, the minimum IQ necessary to destroy the world drops by one point.

Now Yudkowsky has gone further. He believes we are fast approaching a fatal conjuncture, in which we create an AI more intelligent than us, which “does not do what we want, and does not care for us nor for sentient life in general. … The likely result of humanity facing down an opposed superhuman intelligence is a total loss.”

He is suggesting that such an AI could easily escape from the internet “to build artificial life forms,” in effect waging biological warfare on us. His recommendation is clear. We need a complete, global moratorium on the development of AI.

This goes much further than the open letter signed by Elon Musk, Steve Wozniak (the Apple co-founder) and more than 15,000 other luminaries that calls for a six-month pause in the development of AIs more powerful than the current state of the art. But their motivation is the same as Yudkowsky’s: the belief that developing AI with superhuman capabilities in the absence of any international regulatory framework risks catastrophe. The only real difference is that Yudkowsky doubts that such a framework can be devised inside half a year. He is almost certainly right about that.

The obvious analogy is with two previous fields of potentially lethal scientific research: nuclear weapons and biological warfare. We knew from very early in the history of these fields that the potential for catastrophe was enormous — if not the extinction of humanity, then at least death on a vast scale. Yet the efforts to curb the proliferation of nuclear and biological weapons took much longer than six months and were only partly successful. In 1946, the US proposed the Baruch Plan to internationalize nuclear research. But the Soviet Union rejected it and there was soon a frenetic nuclear arms race. The most that was achieved was to limit the number of countries that possessed nuclear weapons (through the Non-Proliferation Treaty, which came into force in 1970) and to slow down and eventually reverse the growth of superpower arsenals.

Similarly, the Biological Weapons Convention that came into force in 1975 did not wholly end research into such weapons. The Soviets never desisted. And we know that all kinds of very hazardous biological research goes on in China and elsewhere, including the gain-of-function experiments with coronaviruses, which it seems increasingly likely led to the Covid-19 pandemic.

So if Yudkowsky is right that AI is potentially as dangerous as nuclear or biological weapons, a six-month pause is unlikely to achieve much. On the other hand, his call for a complete freeze on research and development has about as much chance of success as the Baruch Plan.

One obvious difference between those older deadly weapons and AI is that most research on AI is being done by the private sector. According to the latest report of the Stanford Institute for Human-Centered AI, global private investment in artificial intelligence totaled $92 billion in 2022, of which more than half was in the US. A total of 32 significant machine-learning models were produced by private companies, compared to just three produced by academic institutions. Good luck turning all that off.

But is the analogy with what we used to call “The Bomb” correct? That depends on your taste in science fiction. Just about everyone has heard of Skynet, which originated in the 1984 film The Terminator, starring a young Arnold Schwarzenegger. For younger readers, the premise is that “Skynet,” a computer defense system “built for SAC-NORAD by Cyber Dynamics,” goes rogue in the future and attempts to wipe out humanity with a nuclear attack. John Connor leads the human resistance to Skynet and its robot Terminators. Skynet responds by sending Terminators back in time — because of course time travel is easy if you’re a really powerful AI — to kill Connor’s mother.

Yet there are many other versions of AI in science fiction. For example, in Ted Chiang’s Lifecycle of Software Objects (2010), AI manifests itself as “digients” — initially harmless and helpless computer-generated pets and companions, a little like baby chimpanzees. They spend quite a long time learning to be intelligent. In this version of the world, the moral problem is that we humans are tempted to exploit the digients as robot slaves or sex toys.

In essence, Yudkowsky’s numerous critics want us to believe that AI is more digient than Skynet. Writing on Twitter, Matt Parlmer, founder of the machine-tool firm GenFab, accused Yudkowsky “and the other hardline anti-AI cultists” of being “out of their depth, both in terms of command of basic technical elements of this field but also in terms of their emotional states. … Many things are coming, Skynet is not one of them.” Shutting down AI research, argued Parlmer, would deprive sick people of potential breakthroughs in medical science.

Nicholas Thompson, the CEO of the Atlantic, agreed that Yudkowsky and other Luddites were overstating the risks. “I recently made a children’s book for my 9-year-old’s birthday using Dall-E and GPT-4 about a World Cup between his stuffed animals,” he told Atlantic staff. “The bears won and he loved it. … Let’s all build in some time to experiment. We’ll make cool stuff and we’ll learn while we do it.”

My Bloomberg Opinion colleague Tyler Cowen was more pragmatic. He posed some hypothetical questions: “What if, in 2006, we had collectively decided to suspend the development of social media for six months while we pondered possible harms from its widespread use? Its effects were hardly obvious at the time, and they are still contested. In the meantime, after the six-month delay, how much further along would we have been in the evaluation process? And even if American companies institute a six-month pause, who’s to say that Chinese companies will?”

But the most eloquent defender of unrestrained AI research and development is my old friend Reid Hoffman, the founder of LinkedIn, who has written an entire book on the subject … approximately half of which was generated by AI.

For the lay reader, the problem with this debate is twofold. First, the defenders of AI all seem to be quite heavily invested in AI. Second, they mostly acknowledge that there is at least some risk in developing AIs with intelligence superior to ours. Hoffman’s bottom line seems to be: Trust us to do this ethically, because if you restrain us, the bad guys will be the ones who do the development and then you may get Skynet.

So let me offer a disinterested view. I have zero skin in this game. I have no investments in AI, nor does it threaten my livelihood. Sure, the most recent large language models can generate passable journalism, but journalism is my hobby. The AI doesn’t yet exist that could write a better biography of Henry Kissinger than I can, not least because a very large number of the relevant historical documents are not machine-readable.

Let us begin by being more precise about what we are discussing. Most AI does things that offer benefits not threats to humanity. For example, DeepMind’s AlphaFold has determined the structures of around 200 million proteins, a huge scientific leap forward.

The debate we are having today is about a particular branch of AI: the large language models (LLMs) produced by organizations such as OpenAI, notably ChatGPT and its more powerful successor GPT-4.

The backstory of OpenAI is a fascinating one. When I moved to California seven years ago, I participated in a discussion with Sam Altman, one of the founders of OpenAI. As I recall, he assured the audience that, within five years, AI-powered self-driving vehicles would have rendered every truck driver in America redundant. Like me, you may have missed the fleet of self-driving trucks on our highways, and the crowds of unemployed truckers learning to code on the streets of San Francisco. Like his former partner Elon Musk, Altman realized at some point that teaching neural networks to drive was harder than they had assumed. Hence OpenAI’s pivot to LLMs.

As a report in the Wall Street Journal made clear, the original vision of OpenAI in 2015 was that it would be a nonprofit precisely because of the inherent dangers of such AI. In Altman’s own words: “If you’re making AI, it is potentially very good, potentially very terrible.” However, it rapidly became apparent that building LLMs powerful enough to generate credible results was too expensive for a nonprofit because of the huge computing power required. So Altman created a for-profit arm of OpenAI and sold a large stake to Microsoft CEO Satya Nadella, who saw a golden opportunity to catch up with Google, hitherto the leader in AI development.

“In the long run,” Altman told the Journal, he wants to “set up a global governance structure that would oversee decisions about the future of AI and gradually reduce the power OpenAI’s executive team has over its technology.” OpenAI’s ultimate mission, he went on, is to build artificial general intelligence “safely.” The goal is “to avoid a race toward building dangerous AI systems fueled by competition and instead prioritize the safety of humanity.”

In the short run, however, Altman is now part of that race. And this, of course, is why he has fallen out not only with Musk, whose company Tesla is also in the race, but also with OpenAI’s lead safety researcher, Dario Amodei, who has quit OpenAI to set up his own AI company called Anthropic, which is backed by … Google.

So just how dangerous is this for-profit LLM race? Superficially, not dangerous at all. As my favorite genius, Stephen Wolfram, explains, an AI such as ChatGPT “is always fundamentally trying to … produce a ‘reasonable continuation’ of whatever text it’s got so far, where by ‘reasonable’ we mean ‘what one might expect someone to write after seeing what people have written on billions of webpages.’ … When ChatGPT does something like write an essay, what it’s essentially doing is just asking over and over again ‘given the text so far, what should the next word be?’ — and each time adding a word.”

GPT-4 is just an even more powerful word-predicting neural network, doing vast numbers of operations on arrays of numbers with GPUs — the processing units originally designed to accelerate graphics rendering. As a result, its output is even more convincingly humanlike than ChatGPT’s. If you don’t believe me, look at what GPT-4 came up with when Reid Hoffman asked it to answer the question “How many restaurant inspectors does it take to change a lightbulb?” in the style of Jerry Seinfeld:

GPT-4: What is the deal with restaurant inspectors? They’re always poking around in the kitchen, checking the temperature of the meat, looking for signs of rodents, but they never seem to help out with anything. Have you ever seen a restaurant inspector change a lightbulb? No, of course not. They’re too busy writing up violations and handing out fines. You know what they do when they see a lightbulb that’s out? They mark it down on their clipboard and tell the owner to fix it by next week or else. Or else what? Or else they’ll come back and check the lightbulb again. That’s their big threat. They’re not going to change it for you, they’re not going to lend you a ladder, they’re not going to offer any advice on how to unscrew the old one and screw in the new one. They’re just going to stare at you with that smug look on their face and say, “You know this is a serious safety hazard. You could have a fire, you could have a lawsuit, you could have a bad Yelp review. You better get on that, pal.” And then they leave, and you’re left with a dark corner of your dining room, where no one wants to sit, where the food looks unappetizing, where the mood is gloomy. And you think to yourself, how many restaurant inspectors does it take to change a lightbulb? None. They don’t change lightbulbs. They just make you feel bad about yours.

Not only is that pretty plausible, but according to a thorough report by Bubeck et al. (2023), GPT-4 can also “solve novel and difficult tasks that span mathematics, coding, vision, medicine, law, psychology and more, without needing any special prompting” and with “strikingly close to human-level performance.”

Well, how about superhuman-level? GPT-4 was easily able “to write a proof of infinitude of primes in the form of a poem, to draw a unicorn in TiKZ (a language for creating graphics …), to create a complex animation in Python, and to solve a high-school level mathematical problem.” I’ve read that report carefully. GPT-4 is much smarter than me.

So what’s the problem, apart from the obvious fact that millions of comedy writers — not to mention lawyers, journalists and just about everyone else who writes down words for a living (apart from me, obviously) — will now have to retrain as truck drivers?

Hoffman acknowledges that a problem exists. He notes “the well-documented shortcomings of LLMs such as the problem of hallucinations” — a fancy word for their tendency to make stuff up. This makes me somewhat wary of his proposal to use GPT-4 to “flood the zone with truth” (or maybe just truthiness) to dilute the flood of fake news. Even GPT-4 cannot deny the downside risk. Hoffman asks it the question: “Once large language models are fully developed and deployed, what would you suspect will be the worst effects on the quality of overall cultural production?” In addition to the mass unemployment of professional writers, it suggests two:

1. Homogenization and loss of diversity: Large language models could generate massive amounts of content that mimic existing styles, genres, and trends, but lack originality, creativity, and authenticity. This could result in a saturation of the cultural market with bland and repetitive products that appeal to the lowest common denominator and discourage innovation and experimentation.

2. Manipulation and deception: Large language models could also be used to create deceptive or harmful content that exploits human biases, emotions, and preferences. This could include fake news, propaganda, misinformation, deepfakes, scams, or hate speech that undermine trust, democracy and social cohesion.

Sorry, Reid, but No. 2 is a much, much bigger problem than your habitual techno-optimism allows.

Let me now offer a different analogy from nukes and biowarfare. The more I read about GPT-4, the more I think we are talking here not about artificial intelligence (i.e., synthetic humanlike intelligence) but inhuman intelligence, which we have designed and trained to sound convincingly like us.

I am reminded of Liu Cixin’s The Dark Forest, which describes the invasion of Earth by the ruthless and technologically superior Trisolarans. In effect, we are building the aliens, to save them from having to make the long journey from outer space. And the core lesson of that book is that the aliens have to destroy us if we are not quick to destroy them.

These are the axioms of Liu’s “cosmic sociology”: First, “survival is the primary need of civilization.” Second, “civilization continuously grows and expands, but the total matter in the universe remains constant.” Third, “chains of suspicion” and the risk of a “technological explosion” in another civilization mean that in this universe there can only be the law of the jungle.

Another sci-fi analogy that comes to mind is John Wyndham’s Day of the Triffids (1951), in which most of humanity is first blinded by rays from satellites and then wiped out by carnivorous plants genetically engineered — by the dastardly Soviets — and farmed for their vegetable oil.

As Bill, the central character, observes: “Nobody can ever see what a major discovery is going to lead to — whether it is a new kind of engine or a triffid — and we coped with them all right in normal conditions. We benefited quite a lot from them, as long as the conditions were to their disadvantage.”

Why might GPT-4 (or -5) turn triffid on us? Because we are feeding it all the data in the world, and a lot of that data, from the most respectable sources, says that the world is threatened by man-made climate change. The obvious solution to that problem must be to decimate or wholly eradicate homo sapiens, thereby also conserving energy to generate the ever-growing computing power necessary for GPT-6, -7 and -8.

How might AI off us? Not by producing Schwarzenegger-like killer androids, but merely by using its power to mimic us in order to drive us individually insane and collectively into civil war. You don’t believe me? Well, how about the Belgian father of two who committed suicide after talking to an AI chatbot for weeks about his fears of climate change? The chatbot was powered by GPT-J, an open-source alternative to OpenAI’s ChatGPT.

As my Hoover Institution colleague Manny Rincon-Cruz says: LLMs don’t manipulate atoms or bits; they manipulate us. And it’s not so much that GPT-5 will “decide” to wipe us out. Rather, the risk is that we will tear ourselves apart as a species by using LLMs for ignoble or nefarious ends. It’s simply astonishing to me that Reid Hoffman can write an entire book about the implications of AI without seriously reflecting on what it’s going to do to American politics. After what social media — from Facebook ads to loaded Google searches to Twitterbots — did in 2016?

#### BUT diversely-trained AI solves super-eruptions through breakthroughs, detection, and de-risking. Otherwise, they’re certain, coming fast, and existential due to deep-freeze.

Montgomery et al. 14 – Founder of KYield, an emerging tech research firm; Professor of Economics at the University of Alabama, PhD from Iowa State University; Executive Vice President at KYield, PhD in Molecular Genetics from the University of Kansas.

Mark Montgomery, Robert Nielson, and Garrett Lindemann, “Plausible Scenarios For Artificial Intelligence in Preventing Catastrophes,” KYield, 12-23-2014, https://kyieldos.com/2014/12/23/plausible-scenarios-for-artificial-intelligence-in-preventing-catastrophes/

A very high probability event that should consume greater attention, super volcano eruptions occur about every 50,000 years. GCR highlights the Toba eruption in Indonesia approximately 75,000 years ago, which may be the closest humanity has come to extinction. The primary risk from super eruptions is airborne particulates that can cause a rapid decline in global temperatures, estimated to have been 5–15 C after the Toba event. [4]

While it appears that a super-eruption contains a low level of existential risk to the human race, a catastrophic event is almost certain and would likely exceed all previous disasters, followed by massive loss of life and economic collapse, reduced only by the level of preventative measures taken in advance. While preparation and alert systems have much improved since my co-workers and I observed the eruption of Mt. St. Helens from Paradise on Mt. Rainier the morning of May 18th, 1980, it is quite clear that the world is simply not prepared for one of the larger super-eruptions that will undoubtedly occur. [5] [6]

The economic contagion observed in recent events such as the 9/11 terrorists attacks, the global financial crises, the Tōhoku earthquake and tsunami, the current Syrian Civil War, and the ongoing Ebola Epidemic in West Africa serve as reasonable real-world benchmarks from which to make projections for much larger events, such as a super-eruption or asteroid. It is not alarmist to state that we are woefully unprepared and need to employ AI to increase the probability for preserving our species and others. The creation and colonization of highly adaptive outposts in space designed with the intent of sustainability would therefore seem prudent policy best served with the assistance of AI.

The role of AI in mitigating the risks associated with super volcanoes include accelerated research, more accurate forecasting, increased modeling for preparation and mitigation of damage, accelerating discovery of systems for surviving super eruptions, and to assist in recovery. These tasks require ultra-high-scale data analytics to deal with complexities far beyond the ability of humans to process within circumstantially dictated time windows, and are too critical to be dependent upon a few individuals, thus requiring highly adaptive AI across distributed networks involving large numbers of interconnected deep earth and deep sea sensors, linking individuals, teams, and organizations. [7] Machine learning has the ability to accelerate all critical functions, including identifying and analyzing preventative measures with algorithms designed to discover and model scenario consequences.

#### Preemptive discoveries can solve globally BUT mistakes are existential.

Denkenberger & Blair 18 – Professor of Mechanical Engineering & Professor of Geology

David C. Denkenberger, U of Canterbury, and Robert W. Blair, Jr., Fort Lewis College, “Interventions that may prevent or mollify supervolcanic eruptions,” *Futures* Vol. 102 (Sept. 2018), pp. 51-62, https://doi.org/10.1016/j.futures.2018.01.002

The Toba supervolcanic eruption (in present-day Indonesia) approximately 74,000 years ago may have nearly caused the extinction of humans and another primate species (Rampino, 2008). Recent modeling indicated a ∼50% reduction in primary plant productivity regionally for the Toba supervolcano (Timmreck et al., 2012). It is tempting to conclude that this would suggest about a 50% reduction in the human population. However, this is the best case scenario given the minimal food storage that the hunters and gatherers would have had. Unless the population was halved by some other means (war perhaps), the excess population would overwhelm sustainable food production. Then food stocks such as plants, land animals, and fish would collapse and would likely result in mass starvation. Note that the Toba ash blanketed much of Southeast Asia that today supports the highest concentration of human population. Petraglia et al. (2007) found that there was continuity in tools across the super eruption event (Petraglia et al., 2007). However, even if continuity of population is implied, because the resolution is thousands of years, this could hide a significant die off. For instance, a population growth rate of 3% per year achievable in favorable circumstances could allow a recovery from a 99.9% die off in less than 250 years. Furthermore, a larger super-volcanic eruption (1016 kg) could be even worse resulting in the collapse of whole ecosystem habitats, leading to a massive population collapse and loss of civilization. Recovery of civilization is not guaranteed, and eventually human extinction could result (Maher & Baum, 2013). When considering the chance of human extinction, many more future lives are at stake than just the present generation (Bostrom, 2003).

A recent estimate of the probability of a supervolcanic eruption somewhere in the world is on the order of magnitude of 1/10,000 per year (Rougier, Sparks, Cashman, & Brown, 2018), though previous estimates were on the order of 1/100,000 per year (Mason et al., 2004). The good news is that society may have significant advanced warning for such eruptions: days to years (Lowenstern, Smith, & Hill, 2006). Other risks are generally regarded as higher probability, such as nuclear winter, abrupt climate change, crop killing scenarios, pandemic, molecular manufacturing, and negative artificial general intelligence (Turchin, this issue). However, addressing super volcanic eruptions is a particularly neglected topic that we believe is worthy of investigation. Supervolcanoes consist of a very large magma chamber, often in excess of 500 km3, in the case of Yellowstone roughly 60 km long, 30 km wide and 2 km thick (Oskin, 2013; Yellowstone Caldera, 2014). The top of this chamber is about 6 to 8 km below the earth’s surface. The chamber is filled by magma fed from a hotspot below. Forceful injection of magma appears to occur through multiple surges (Caricchi, Annen, Blundy, Simpson, & Pinel, 2014). The magma creeps upward through the crust until the buoyancy pressure approximates the pressure produced by the rock above, at which point lateral magma migration dominates by creating large lens-shaped pods. The assembly of the volcanic complex results in stacked lenses. Over the period of hundreds of thousands of years, the magma mix of crystals, melt and volatiles fluctuates in ratio and composition. Potentially at some point a rapid injection of a silicic magma (>70% silica (SiO2)) would create a shallow lens accompanied by physical separation of melt plus volatiles (>50% of magma) that concentrate and balloon near the top of the chamber. This would create an overpressure (greater pressure than that expected by the lithostatic pressure (analogous to hydrostatic pressure, but due to rock instead of water)) that could exceed the strength of the overlying crustal cap and trigger an eruption cycle. Once venting commences, often along ring-shaped fractures, exsolution (coming out of solution) of dissolved volatiles accompanies fragmentation of the magma to produce a violent atmospheric ash-flow explosion. The rapid deflation of large shallow magma chambers is accentuated by the simultaneous gravitational collapse of overlying crust that fills the subterranean void created from the eruption. A caldera depression is created above the collapsed chamber. The eruption vent will follow the weakest route to the surface, and this may not always occur directly over the magma chamber (Lipman & McIntosh, 2008).

Despite the risk presented by supervolcanic eruptions, there is little in the literature about preventing these eruptions or lessening their impact. This paper summarizes the literature and contributes 59 novel interventions for the problem. It also provides a technical analysis, accurate within an order of magnitude, of some of these interventions. Mechanisms suggested in the literature include (see Fig. 1 for a diagram):

• magma removal (US 7284931 B2, 2007), • nuclear bombs to make cracks to release pressure (McGuire, 2005) and • “sky bots” to consume ash (McGuire, 2005). • water pipes inside the cap rock to promote internal heat transfer (Wilcox, Mitchell, Parcheta, Schwandner, & Lopes (2017)) • drilling near magma chamber to freeze it and produce geothermal electricity (Wilcox et al., 2017) Fig. 1 Download: Download high-res image (201KB) Download: Download full-size image Fig. 1. Diagram of categories of pre-eruption interventions.

Perhaps there are so few interventions in the literature because there appears to be a widespread assumption that nothing can be done to prevent supervolcanic eruptions, e.g. (Burke & Engel, 2007).

Novel mechanism categories include: • Altering magma characteristics, • increasing strength of overlying crustal cap, • increasing the pressure on the magma, • stopping an eruption in progress, • containing the erupted material, • disrupting the plume, and • accelerating a smaller eruption.

We cover all of these interventions in order of most preventative (e.g. freezing magma) to least preventative (intentionally inciting an eruption). Many of the interventions delay the eruption. There is uncertainty in the timing and magnitude of the triggering mechanisms. Therefore, it is not possible to say with certainty that an eruption is delayed for 100 years, but we can estimate this in the statistical sense. The time to implement an intervention that statistically delays the eruption by a century we call “time to safety.” We discuss results to provide preliminary information for planning and policy to address supervolcanic eruption induced catastrophe. Many of the interventions are speculative and abstract and this paper is mainly targeted at starting a research conversation.

2. Interventions

Table 1 summarizes the promising interventions. Feasibility includes the level of technological sophistication required to implement intervention and the probability of success. Risk is the chance of provoking an eruption.

Table 1. Summary of the 31 more promising pre-eruption interventions’ qualitative feasibility and risk level (and 7 post eruption or inciting eruption interventions). Generally, interventions near or in the magma chamber are low feasibility and interventions that could be achieved with comparatively little effort are high feasibility. Intervention category Intervention Qualitative feasibility Risk level Altering the Characteristics of the Magma (Section 2.1) Freezing magma with heat extraction from near the chamber Lowa Low Freezing magma with pipes in the crustal cap with convecting water Low Low Adding crystals to the magma Low Medium Adding molten material that will increase the crystal content of the magma Low Medium Adding material to increase the viscosity of the magma Low Medium Magma Removal/Venting (Section 2.2) Excavating magma for pressure release Low Medium Excavating liquid and volatiles from magma for pressure release and reducing eruptibility of remaining magma Low Medium Fracking for magma venting Low High Detonating nuclear weapons for magma venting Low High Increasing strength of overlying crustal cap (Section 2.3) Strengthening the cap by cooling rock Medium Low Strengthening the cap by stitching the fractures Medium Low Strengthening the cap by cementing fractures Medium Low Strengthening the cap by putting plates or meshes on the surface that bridge the fractures Medium Low Increasing the Pressure on the Magma (Section 2.4) Loading crustal cap with unconsolidated materials via ground transport High Low Placing a single water reservoir over magma chamber High Medium Adding more water into the ground by constructing multiple small infiltration reservoirs High Low Cooling groundwater with geothermal energy production High Low Cooling groundwater with steam venting or cooling towers High Low Replacing groundwater with denser fluid High Low Fracking ground and leaving fluid in place Medium Medium Flooding with remotely stored water Medium Medium Redirecting an adjacent non-super eruptive lava flow Low Medium Forcing magma extrusion early into the (non-super eruptive) volcanic cycle Low Medium Removing water vapor from air with a cooled surface Medium Low Removing water vapor from air with a chemical Medium Low Removing CO2 from air with a chemical Medium Low Removing O2 from air with a chemical Medium Low Removing N2 from air with a chemical Medium Low Compressing air into a tank Medium Low Compressing air into an underground reservoir Medium Low Moving mass onto the magma chamber with aircraft Medium Low Containing the eruption (Section 2.6) Containing eruption with added stratospheric bubbles Low Low Accelerating a smaller eruption (Section 2.8) Fracturing the crustal cap Medium Highb Evacuating the crustal cap Medium Highb Removing groundwater via water wells Medium Highb Making cuts in the earth’s surface so as to drain more groundwater Medium Highb Heating groundwater to lower its density Medium Highb Injecting into the groundwater a lower density fluid Medium Highb a Fairly feasible over a very long time, but doing this in a reasonable amount of time would require massive drilling near magma chamber, which would be very difficult. b Intended to be high. 2.1. Altering the characteristics of the magma Options for modifying the characteristics of the magma include freezing it, altering the fluid chemical composition, and increasing crystal density.

Freezing or crystallization of the magma could be achieved indirectly by cooling the country (surrounding) rock by drilling close to the magma and removing heat. This could be accomplished with various techniques used for geothermal energy production, like injecting cool water in one well and withdrawing hot (supercritical) water in an adjacent well. The deepest well ever drilled was 12.6 km deep by 1994 (Kukkonen & Clauser, 1994). Also, drilling into magma has been demonstrated (Elders, FriÐleifsson, & Albertsson, 2014). Therefore, it may be possible to drill down to the magma in the case of Yellowstone (6–8 km). Geothermal energy production would be an economic benefit and perhaps a major objective of this technique. To freeze the chamber most quickly, a large-scale geothermal field network would need to blanket the overlying crustal cap. An alternate proposal is drilling beside the chamber, freezing some magma, and then drilling closer to the center (Wilcox et al., 2017). This would require deeper drilling and it would take longer to freeze the chamber (their estimate is tens of thousands of years). There is risk in both options however with weakening the crustal cap and possibly creating hydromagmatic (water and magma) explosions.

Whether the magma is eruptible or not depends on the fraction of crystals. Three possible ways to sense the magma fraction of crystals are 1) analyzing samples brought to the surface, 2) measuring in situ temperature, and 3) measuring the torque on the drill. The crystal fraction should not change too quickly (there are not solid walls which enclose a molten interior), so then it may be possible to get quite close to the eruptible magma with low risk. Therefore, this would not rely on existing data sets for the boundary of eruptible material, but instead local sensing. The heat removal could easily be dissipated into the atmosphere. There are approximately 100,000 oil and natural gas wells drilled per year (Cook, 2014) and the average one is 1.8 km deep (U.S. Energy Information Administration, 2014). However, scaling to 8 km deep wells at very high temperature would be difficult, so we do not provide an estimate of the time to safety here.

Since the magma chamber is roughly 800 °C (Loewen, Bindeman, & Melnik, 2017), many materials could not be used, including electronics (Schlumberger, 2014). However, steel melts at about 1370 °C, so it would have significant strength. Prescribed directional drilling, which requires electronics, near magma would be more difficult.

If one could drill into the magma, one may be able to directly alter the magma characteristics via mass injection. One option could be adding minerals,2 perhaps as solid in a slurry, that would increase the crystal mass to exceed 50% of the total, thus reducing the eruption potential (Caricchi et al., 2014). A second intervention might be to add a liquid that would turn into a solid in the magma. A third intervention would be injecting a liquid silica glass that would increase the viscosity of the magma and decrease magma migration. The distribution of crystals or other material into the upper layer of the magma could be facilitated by horizontal drilling. However, an additional mechanism of mixing is likely to be required, which needs future work. Therefore, the time to safety of these interventions is not estimated here. Any material injection would increase the pressure of the magma chamber, which presents an eruption risk.

2.2. Magma Removal/Venting

Magma removal has been proposed to reduce the pressure of the magma chamber (US 7284931 B2, 2007). A patent was granted for this procedure and it also proposes generating geothermal electricity from the magma. A potential disadvantage of this technique is that drilling into a volatile-rich over-pressurized magma chamber could reduce the pressure catastrophically and cause an eruption. Alternatively, the magma could be allowed to vent spontaneously from a hole, driven by the pressure difference to the atmosphere above.

With the Yellowstone parameters and a recurrence interval of 600,000 years, the average magma fill rate is 0.2 m3/s. Therefore, in order to remove 100 years worth of magma in one year, an evacuation rate of 20 m3/s would be required. For comparison, the land rise rate of Yellowstone from 2004 to 2008 was approximately 0.076 m/yr. This corresponds to roughly 4 m3/s fill rate. Another way of looking at the problem is the immediate pressure reduction caused by magma evacuation, the converse of pressure increase caused by magma injection. In this case, the surrounding crust can be thought of as a very viscous fluid with a viscosity of roughly 1018 Pa s (Caricchi et al., 2014). Using this reference’s equation, a century of safety could be achieved with only 0.02 m3/s continuous evacuation rate. This assumed a spherical magma chamber, and is less than the magma fill rate if it were constant, so this is not a reasonable result. Therefore, we conservatively assume that 20 m3/s magma evacuation for one year is required for a century of safety. Preliminary calculations indicate that in order for the magma to be removed before it solidifies, a significantly larger diameter would be required than current deep wells. Therefore, we do not estimate a time to safety.

An additional method of venting would be selectively removing the liquid and volatiles from the magma. This would render the remaining magma less eruptible. Also, the liquid and volatiles would have lower viscosity than whole magma, easing the removal.

Another possible way of venting magma would be drilling combined with controlled water injection around a defined magma perimeter. This may facilitate horizontal migration of magma, increasing the surface area to volume ratio that lends itself to increased cooling, but this is a slow effect. It is not clear that hydraulic fracturing (fracking) magma would be feasible, so we do not estimate a time to safety.

A nuclear explosion deep underground initially creates a cavity, and then typically rock falls from above creating a chimney of unconsolidated rock (Sublette, 2001). This chimney volume is order of magnitude 0.01 km3. Outside the cavity is fractured rock, and further outside that is compressed rock. If this explosion occurs next to magma, and if the net space produced for magma is 10% of the chimney volume, this may evacuate order of magnitude 0.001 km3 of magma from the magma chamber if the response were similar to the tests done near the surface. Therefore, a century of magma flow could be accommodated with order of magnitude 1000 nuclear detonations. However, the diameter of nuclear weapons is significantly larger than typical deep well drilling diameter. It may be possible to deliver the weapons via a (perhaps radioactively) heated torpedo that melts its way down through the crust. However, neither of these methods are proven, so we do not estimate a time to safety. Also, the detonations themselves could provoke an eruption. Furthermore, if prevention techniques are not continued, there will eventually be an eruption. This eruption could then contain the radioactivity from the nuclear explosions. However, the impact of radioactivity would be largely a regional problem, and would not cause nearly as much impact as the blocking of the sun (Denkenberger & Pearce, 2015). Conventional weapons would not have the radioactivity problem, but would be less technically feasible.

2.3. Increasing strength of overlying crustal cap The critical pressure required to produce an eruption depends not only on the thickness of the crustal cap (the weight), but also the tensile strength of the country rock (Caricchi et al., 2014; Jellinek & DePaolo, 2003). This is determined by its temperature, composition and fracture density (faults and joints). Cooling the country rock via extraction of geothermal heat is one method to increase the strength of solid rock, though this may increase fracturing because of the shrinkage. Another idea would be stitching fault zones with carbon fiber rods, steel cables or other tensile-capable material. These could be put into place with meandering horizontal drill holes that crisscross fracture zones. For open fractures, injecting a cementing material (e.g. Portland cement or glass) might increase tensile strength. A third possibility is anchoring plates or mega “butterfly bandages” to bridge fractures near the surface. With inflation of overlying crustal cap, the plates/nets would become taut and assist, at least temporarily, with strengthening the cap. If the plates/nets had large surface extent, the force could propagate many kilometers downward, shoring subterranean faults. It is future work to identify the fracture density and the increase in strength due to these interventions, and corresponding time to safety. However, we note that one prediction of supereruption triggering involves faults starting at the surface and slowly traveling downward to the magma chamber (Gregg, De Silva, Grosfils, & Parmigiani, 2012), which may allow time for shoring interventions. 2.4. Increasing the pressure on the magma

One potential way to prevent the chain reaction of the eruption cycle is to increase the pressure on the magma by adding material at or near the surface. There is evidence that increasing glacial ice thickness delayed eruptions (Geyer & Bindeman, 2011). This would possibly increase the strength of the cap. Another benefit could be keeping gases in solution with the magma, or at least increasing the density of bubbles, making it less prone to eruption. A further benefit is reducing the shearing stress in the country rock caused by the magma chamber induced uplift. Shearing of the country rock has been proposed and modeled as the trigger for supervolcanic eruptions (Gregg et al., 2012; Gregg, Grosfils, & de Silva, 2015). Adding of the weight could be in response to a magma injection. Injections do not necessarily raise the elevation of the land over the entire chamber uniformly. Therefore, weight could be added where uplift is observed. If this technique could be implemented quickly, it has the possibility of preventing an impending eruption, as there would be days to years of warning. Ideally, the cost would only be incurred when the intervention is highly desirable. However, unrest such as rising ground and earthquakes could instead have results other than a supereruption (Lowenstern et al., 2006).

A different possible triggering mechanism mentioned earlier is the buoyancy of the magma creating an overpressure that causes failure in the country rock above. It is not clear that adding more weight at the surface would reduce this overpressure. However, producing a pressure due to the weight of material placed at the surface to equal the increased buoyancy caused by new magma injections offers a simple way to calculate the feasibility of humans influencing supervolcanic processes. The impact may be of a similar order of magnitude as adding weight prevention of the shear failure mentioned above. With 8 km of rock above the magma chamber in the case of Yellowstone, the material added does not need to be perfectly uniform thickness. The buoyancy of the magma relative to the surrounding rock is 400 kg/m3 (Caricchi et al., 2014). With the rough Yellowstone eruptive recurrence interval of 600,000 years, in order to counteract this buoyancy, about 15 Pa of pressure would need to be added per year. Therefore, statistically a 10-year delay could be achieved with 150 Pa and a century delay could be achieved with 1500 Pa. In reality, the pressure in the chamber is increased episodically with magma injection. Therefore, if there were going to be an imminent large magma injection, 1500 Pa may be insufficient to prevent it. However, the converse is also true, that a small amount of increased pressure could prevent an eruption that would have happened sooner, and then provide centuries or millennia of protection until the next large injection pulse occurs. Therefore, to a first approximation, 1500 Pa would protect for about a century, which is what we call a century of safety.

This target pressure is the pressure on the magma chamber. If the pressure at the surface were uniform over the magma chamber, the pressure at the edge of the magma chamber would be less than at the surface because the stress spreads out. Boussinesq developed a solution to this problem assuming the material was elastic and uniform and there was a point load, and Newmark integrated this equation to find the stress for a rectangular force addition (Coduto, 2001). For the parameters of Yellowstone, the pressure at the edge of the magma chamber with these assumptions is roughly 40% as large as the pressure at the surface. This implies that 2.5 times as much material would be required at the surface. The amount of material could be reduced if it were preferentially placed near the edges of the magma chamber. However, we conservatively ignore this and have a goal of 4000 Pa at the surface. Below is a discussion of possible added materials to achieve desired pressures. 2.4.1. Unconsolidated materials One option for increasing the pressure on the magma would be adding soil-rock overburden (unconsolidated materials). There may be copious volcanic ash near by from previous super eruptions. It should be technically feasible to move this ash from areas not above the magma chamber to over the chamber. The added material could be re-vegetated to increase stabilization and aesthetic appeal. With a density of 1500 kg/m3, about 0.25 m on average would provide a blanket pressure at the magma chamber enough to counter a century of predicted overpressure build up. In the case of Yellowstone, the challenge is mining, delivery and disbursement of an estimated 0.7 billion tons (Gt) of overburden. The easiest system would involve an integrated backhoe and dump truck network. In the U.S., there were 24,000 dump trucks in 1999 (Federal Highway Administration, 1999), so if the stock increased by 2% per year, there would be 33,000 dump trucks in 2017. Dump trucks have approximately 30 ton load capability (Davis, Williams, Boundy, & Moore, 2015). Instead of using dump trucks 40 h a week, they could be used near continuously, or about four times as many hours per week. This would allow current construction projects to continue despite three fourths of the dump trucks relocating to Yellowstone. If the magma chamber were a rectangle 60 km by 30 km and if the material were taken from the edge of the magma chamber and distributed uniformly, the average transportation distance would be the weighted average distance from the edges to the centroids of the two end triangles and two side trapezoids. This is 6.25 km. However, material must be taken from a non-zero area and this area should be a significant distance away from the magma chamber so as to not significantly counteract the increase in pressure on the magma chamber. Furthermore, the roads are not ideally placed and are not straight. New roads leading off the existing roads would be required to both collect and distribute the unconsolidated materials. Therefore, we estimate 30 km average transportation distance. Note that the source of materials may still be inside Yellowstone National Park, but those areas could be revegetated as well. We estimate driving 60 km/h (higher on existing paved roads, lower on new (likely gravel roads)) and for 70% of the time (half of that time with a load). In order for the dump truck system to function, unconsolidated materials must be loaded into them. Frozen soil is much more difficult to extract. It may be possible to keep the soil unfrozen despite cold temperatures (e.g. by continuously extracting it), but we conservatively ignore this possibility. Therefore, we estimate that the system runs for only the seven months of the year that average above freezing. This yields 1.4 Gt km or 0.05 Gt/yr that the dump trucks could transport. Another potential limiting factor is the ability to load the dump trucks. Moving soil is more economical with dump trucks than bulldozers or scrapers at a distance of approximately 1.5 km (Schexnayder & Mayo, 2003). Therefore, the typical haul distance would be significantly shorter than the 30 km required above. This means that the backhoes required for loading the dump trucks would not be a limiting factor. Also, it may be possible to construct ramps such that bulldozers could load dump trucks. A further potential limiting factor is the capacity of the roads. There are five two-lane roads leading into Yellowstone, but two of them are closed in the winter. Since trucks would only be moving unconsolidated materials during the summer, we use five roads for the analysis. Dump trucks are approximately 15 m long (Federal Highway Administration, 1999). We estimate that there could be a 2 s following distance and 70% road utilization (due to issues such as other traffic, accidents and road maintenance). This would result in the ability to move 1.1 Gt/yr of material, so this is not the limiting factor. We are considering Yellowstone as an example, but these kinds of calculations would be similar for other supervolcanoes. An additional potential limiting factor is energy. First is providing the fuel for the equipment. Diesel tank trucks have a range greater than a typical car and consume only a few percent of their mass over that distance. Therefore, these trucks could go long distances from refineries consuming part of the fuel in their large tank. Lighting would also be required for night operations. Electricity for this could be provided by portable diesel generators if existing electrical systems were insufficient. The final potential limiting factor is putting the materials in place. If the result is simply piles of unconsolidated material, the dump trucks could basically do this by themselves. However, if the desired thickness of the materials were large, the initial soil would need to be consolidated in order for vehicles to drive on it. This would still be feasible, because much soil that is transported is consolidated (e.g. to build roads on) (Schexnayder & Mayo, 2003). Therefore, the limiting factor is the transportation capability of the U.S. dump trucks, and this results in 15 years to safety. There are multiple active supervolcanoes in the world, but more earth moving equipment in the world than the U.S., so the overall feasibility would be similar. Shorter times could be achieved by using mining equipment and retrofitting other trucks to carry unconsolidated materials. The current U.S. trucking capacity is 9200 Gt km (Freight Transportation, 2012), which dwarfs dump truck capacity. This indicates that running the dump trucks at high duty cycle would have a relatively small environmental/climate impact. Unloading of these trucks could be achieved by tipping the trucks (Humbird et al., 2011), with a backhoe, etc. The capacity of the roads could be increased by having a shorter following distance and higher speed (though this would need to be tempered by increased accident disruption). Also, additional lanes could be added to roads, especially where there is significant slope (and therefore slower truck speed). 2.4.2. Water There are several options of using water to increase the pressure on the magma. Similar to unconsolidated materials, about 0.4 m thick on average of water would delay the eruption a century, requiring approximately 0.7 km3 of water in the case of Yellowstone. Evidence of the geological significance of water is that large water reservoirs load and depress the overlying elastic crust and by doing so generate micro seismicity (small earthquakes) (Gupta, 2002). One option is to dam up a watershed over the magma chamber, creating a water reservoir. Hydroelectric power production could be an added benefit. The water would not be uniformly distributed, which could be risky. Added risks are hydromagmatic eruptions if water were to make contact with shallow magma intrusives via fractures under the reservoir. Note that Yellowstone Lake plus other water bodies cover ∼15% of the Yellowstone caldera. However, it is not centered on the magma chamber, so to get sufficient pressure over the entire magma chamber would require much more than 0.7 km3 of water. Therefore, we do not estimate a time to safety. Another method would be multiple small infiltration dams that would increase groundwater saturation by raising the groundwater table, increasing the pressure on the magma. Hydropower generation would also be possible for these dams. This could be more uniformly distributed pressure than a single large reservoir. An added benefit of increased water in the water table is the potential use as a reservoir for the production of geothermal energy. Small and medium sized dams are typically constructed in a few months (Lempérière, 2013). Working round-the-clock would accelerate this. The dams could be of the embankment type and utilize the unconsolidated materials from outside the caldera, combining this with the unconsolidated materials intervention. However, dams of this type are very heavy, and given the relatively long time to safety from unconsolidated materials, this might not be the best option. Faster options include using local unconsolidated materials or bringing in materials for concrete or steel dams. The annual flow of the Yellowstone River out of Yellowstone National Park is 2.6 km3 (Miller, Clark, & Wright, 2004). This drainage area is about 6900 km2, so scaling this to the magma chamber area yields 0.7 km3/yr. This means that the filling time of the dams would be approximately 0.9 years, but this is conservative because there is water flowing above the magma chamber that comes from outside the magma chamber area at higher elevation (this could provide the base flow of the Yellowstone River). Therefore, we estimate the overall time to safety would be 1 year. Cutting trees down would increase runoff because it reduces transpiration, but would cause other problems. A third water option is increasing the density of the groundwater by cooling it in conjunction with more conventional geothermal electricity generation, because drilling does not need to be near the magma. When the density of the groundwater increases at first, this would lower the water table, so the pressure on the magma would not increase. In fact, if heat rejection for the geothermal power plant is achieved with a cooling tower, water would be lost, reducing pressure on the magma. However, the level of the water table would tend to recover via natural recharge, thus creating greater overall pressure on the magma eventually. The fourth option is the fastest way of implementing an increase in groundwater density by cooling, which is venting steam (developing geothermal energy conversion would take longer). Venting steam could be achieved by pumping water into an injection well and having it come out a nearby retrieval well. As the water nears the surface, the pressure would fall below the boiling point. The steam produced would reduce the density of the mixture, thus aiding the pump. At the surface, the water would attain the boiling point of about 100 °C (altitude would reduce the boiling point, but salts would increase it). To reduce the drilling depth, warm water could be brought to the surface and evaporated partially by spraying into the air or using cooling towers. This would still likely be more effort than infiltration dams, though the long-term surface disturbance would be lower. A fifth option involving water is injecting denser fluid (such as salt water) into the water table. Preferably this would be done below probable withdrawals of water for human use. The salt would need to be brought in from further distances than the unconsolidated materials. Furthermore, drilling to place the salt is much more difficult than just laying unconsolidated materials on the surface. Therefore, this option would take significantly more effort, so we rate it as medium feasibility (see Table 1). The main advantage would be less surface disruption than dams or unconsolidated material. A sixth option involving water is hydraulic fracturing of the rock in order to inject more fluid into the ground. This would require even more effort than injecting a denser fluid because the pressures involved are very high. Therefore, it is not likely to be preferred and is given medium feasibility (see Table 1). The final water option is building reservoirs outside heavy tourism areas and not above the magma chamber. Then if an eruption were impending (e.g. measured by rapid ground rise), people would be evacuated and the reservoirs would be emptied onto the area above the magma chamber. An additional dam(s) would be required to keep the water above the magma chamber in the case of an impending eruption (this lower dam(s) would not impede flow normally). Containment of water requires a large topographic watershed basin and adequate rainfall to be effective. Depending on reaction time of the controllers and the system, significantly more pressure could be required to reverse an impending eruption. This could require significantly more water, so we do not estimate time to safety. Again, this would likely be more effort than infiltration dams or unconsolidated materials, so it is given medium feasibility (see Table 1). 2.4.3. Other materials Using steel, concrete, crushed rock, etc. for their weight would all be more expensive than unconsolidated surface materials, and less amenable to vegetation reclamation. However, steel and reinforced concrete could be advantageous from the perspective of shoring up fractures (see Section 2.3) as well as adding weight. Some supervolcanic regions (Yellowstone-Snake River Plain, ID; Valles Grande-Mount Taylor, NM) exhibit a bimodal lava composition (two distinct compositions). A low probability of success idea is to redirect a natural high temperature fluid basaltic lava rift eruption (non-super eruptive) to cap an adjacent potential ash-flow (super eruptive) center. An alternative is forcing magma extrusion early into the (non-super eruptive) volcanic cycle onto the crustal cap prior to late (super eruptive) stage surges. Attempts have been made to redirect lava flow with explosives (Zimbelman, Garry, Johnston, & Williams, 2008), though the efficacy is debated. A further source of material would be using the magma that is evacuated from the magma chamber (an intervention discussed above) to put additional pressure on the magma by putting the material on the surface. 2.4.4. Seven options for air capture If precipitation and trucking of unconsolidated materials were insufficient to prevent an impending eruption, additional mass could be captured from the air. One option is condensing water from the air on a chilled surface, but this would take considerable electricity locally (this could be produced by geothermal power plants). Another option is condensing water from the air on a desiccant, which would not require very much local energy. A further option that does not require very much local energy is removing carbon dioxide from the air on a chemical such as sodium hydroxide. An additional option is removing oxygen from the air with a chemical, such as iron turning to rust. Still another option is removing nitrogen from the air by the Haber Bosch process. This would take significant local energy, but later if the weight of the ammonia were not needed (or could be substituted by unconsolidated materials), the ammonia could be used for fertilizer. Penultimately, air could be compressed into tanks. Finally, the air could be compressed and injected underground. This would raise the ground slightly, which might promote more draining of groundwater, so research would be required to determine if this would be net beneficial. Any of the above solids or liquids could be stored in tanks at the surface. In the case of condensed water, this could be injected below the surface at high pressure, used to fill the dams faster, or used to have the groundwater table recover faster after the deeper water has been cooled. An option that is not technically air capture but does involve air transport is using airplanes, helicopters or dirigibles to move mass onto the magma chamber. 2.5. Stopping eruption in progress A supervolcanic eruption in progress releases a total power of order of magnitude 10,000 TW, and mechanical power is order of magnitude 1000 TW (Mason et al., 2004). Global conventional primary energy consumption is approximately 17 TW (IEA, 2012), indicating the difficulty of influencing an eruption in progress. A thick layer of steel may be able to withstand impacts of rocks traveling near the speed of sound (and near 800 °C). However, it will be difficult to predict where exactly the eruption will take place, and it would likely be distributed along fractures. Furthermore, moving a very thick steel plate would likely not be feasible either over the ground or in the air, especially with the heat, toxic gases, and flying rocks near the eruption. 2.6. Containing the erupted material The idea here would be to contain the material ejected in a bubble. There would likely still be some local or regional impacts, so this would be mollifying the effects. It may be necessary to construct the bubble even before the impending eruption. Roughly, there are three categories: 1. ground-based, high-pressure bubble 2. stratospheric bubbles and 3. ground-based, near-atmospheric bubble. It is useful to have an order of magnitude estimate of the size of these bubbles. Gas content in magma varies significantly, but it is of order of magnitude 1% by mass and water is typically the most common (Science.gov, 2017). At 800 °C, this means the gas takes up order of magnitude 100 times as much volume at atmospheric pressure as the magma from which it comes. The magma volume is order of magnitude 1000 km3, so this is order of magnitude 100,000 km3 of gas at atmospheric pressure. At high pressure, the volume would be lower, but at high altitude, the volume would be larger. A ground-based, high-pressure bubble would require a tremendous amount of high-strength steel, which is not feasible. Much more efficient is to use the pressure of the atmosphere to help contain the gases, which is explored in the successive interventions. The plume would naturally go to an altitude of 25–75 km, roughly corresponding to the altitude that has the potential temperature (the temperature that a parcel of air would warm to if it were brought down to sea level) of the eruption disregarding the solid fraction. The plume would rapidly spread over its hemisphere, and eventually the globe. It may be possible to place the bubble around the plume in the stratosphere, if the enclosing material were elevated with balloons. Then the plume would have cooled down so polymers could be used. For regular eruptions, the plume remains largely one-dimensional and is pushed downstream by the wind. However, super eruptions are so powerful that they overwhelm the wind and spread in all directions nearly equally, creating a continental-scale umbrella cloud (Mastin, Van Eaton, & Lowenstern, 2014). If the film were the entire size of the umbrella plume, differing wind velocities would tear this single stratospheric bubble to shreds. Therefore, what may be feasible is using many smaller bubbles. These bubbles would block sunlight locally, but they would cover a small fraction of the atmospheric area. With the higher concentration of sulfur dioxide than would occur without containment, the resultant sulfate droplets would be larger and therefore would agglomerate and fall out faster. This would mitigate the issue of limited UV resistance of polymers. The sulfate would collect at the bottom of the bubble, and this could be allowed to drain. This would result in some acid rain, but the consequences are far less than blocking the sun globally. This appears to be the most promising intervention that does not prevent the eruption, though its ramping is left to future work (see Table 1). The next option is a ground-based, near-atmospheric bubble. With the large spatial extent, very high strength-to-weight ratios would be required, such as carbon fiber reinforced polymer. However, near the ground, temperatures would be high, so carbon fiber reinforced titanium could be a good choice. It may be possible to design it such that it is neutrally buoyant. However, as in the case of the stratospheric bubbles, there would be a tendency of the gases to spread outward at the top, inducing stresses in the bubble. This intervention would have the advantage of not requiring stratospheric deployment, but overall this appears to be less promising than the stratospheric bubbles.

If the equipment for a plume containment intervention could be quickly flown around the world, one set of equipment could reduce the risk from all active super volcanoes.

2.7. Disrupting the plume

If the plume could be sufficiently disrupted, little or no sulfur dioxide would reach the stratosphere. There would still be local or regional impacts, so this would be mollifying the effects. An added benefit is that if the direction of the plume is changed, it could have less local damage, such as directing it over the ocean. Plume disruption interventions are discussed below.

The first is hypothetical “sky bots” consuming ash (McGuire, 2005), but they would actually also need to consume the sulfur dioxide. Though this may be possible with molecular manufacturing, it is not feasible at this point.

The second is modifying the supervolcanic orifice so that the plume is directed sideways. If a stratovolcano (built up in layers) is present, a lateral blast similar to what was observed with Mount Saint Helens in 1980 could occur. To create such an event might require triggering a massive landslide on the flanks of the volcano. In order to determine where the landslide should be triggered, it may be possible to use remote sensing. However, it is likely that even though the plume is directed sideways, buoyancy would still force some of it into the stratosphere.

The third disruption intervention is installing a steel plate elevated in the atmosphere by the stagnation pressure of the plume. It would have the advantage over the plate that stops the eruption that the rocks would slow down as they overcame gravity. However, the elevated plate would have to withstand many more rock collisions because of the continuing eruption. Furthermore, it would be challenging to keep the plate in place, though Bernoulli’s principle could be utilized in an analogous way of a table tennis ball being levitated by a person blowing up on it. Overall, this is less promising than the plate that stops the eruption.

The fourth is installing a dome over the eruption with openings near the ground to let the gases out. Since the gases would be in many small jets, there would be more mixing with cool atmospheric air, so the volcanic gases may not make it to the stratosphere. This could require significantly less material than a dome that fully contains the eruption, and it may be possible to make it flexible. The material would need to withstand high temperature, but even relatively large diameter steel cables can be made flexible by having many smaller fibers make up each cable. The height would protect it somewhat from rock collisions, and so would the flexibility. Then if the location of the eruption were generally known ahead of time, the dome could be unrolled. Separate pieces may need to be bonded together, and the periphery would need to be anchored to the ground. The fifth disruption intervention is mixing water into the plume. Adding an enormous amount of water would prevent the plume from rising into the stratosphere. A smaller amount of water may be able to scrub out the sulfur dioxide if the water is sprayed in rather than in a pool. However, some of the water would need to remain liquid for this to work, so the same order of magnitude of water would likely be required. This water requirement is many orders of magnitude more than using water to increase the pressure to prevent an eruption, so these cooling/scrubbing methods are not promising.

The sixth is altering or controlling massive air currents. Humanity would need to create a high pressure differential to dilute the plume so that it would be low enough temperature so as to not rise to the stratosphere. These techniques include a giant tank of compressed air, dedicated ground-based or air-based fans (like helicopters), or ground or air-based wind turbines (Roberts et al., 2007) run as fans. The power and energy required may need to be comparable to the mechanical power of the plume, so this would not be feasible. A nuclear weapon could disrupt the plume, but only for a short time, and would have deleterious side effects (though likely not nuclear winter, as this depends on burning of cities and smoke release (Robock, Oman, & Stenchikov, 2007). Furthermore, the added heat from the detonation would increase buoyancy, so most of the sulfur dioxide may still make it to the stratosphere. Conventional explosives would have similar difficulties. Compressed air would advantageous in this regard because it would be cold after it depressurizes. An alternate possibility is harnessing natural forces, such as inducing hurricane circulation.

The seventh disruption intervention is cooling plume gases with a solid. However, humanity would need to be able to deliver a tremendous amount of mass flow, which is more difficult with a solid, such as unconsolidated materials. Thus, this is not promising.

The eighth is filtering or screening out eruptive materials. The sulfur dioxide in the troposphere is a gas, so that would not be filtered out. Therefore, it could only work in the stratosphere where droplets form. Similarly, electrostatic deposition of droplets could be used on the plume in the stratosphere. Alternatively, coagulation induced by intense sound waves could remove the sulfate droplets more quickly from the plume. A further technique is inertial, such as cyclonic separation.

If the equipment for a plume disruption intervention could be quickly flown around the world, one set of equipment could mitigate the risk from all active super volcanoes. However, overall, the plume disruption strategies are likely not promising, and therefore are not listed in the table.

2.8. Accelerating a smaller eruption

The basic framework for preferring the delay of a super volcanic eruption is that either there is a pure time preference for people alive now or that future technology would better be able to deal with a problem. An alternative perspective is intentionally inciting an eruption because it will be less intense than if humanity lets it happen naturally (or delays it), mollification. One option would be selective shallow crustal fracturing to weaken the magma crustal cap. Another option would be removal of crustal cap via open pit mining to create a premature eruption at a predetermined location. This could be coupled with loading other areas to divert the eruptive center to weaker (excavated) areas. A third option is removing groundwater via water wells (continually, as it would tend to refill). A fourth option would be making cuts in the earth’s surface so as to drain more groundwater (this can be thought of the reverse of infiltration dams). The density of groundwater can be lowered by heating it, but this fifth option would be very energy intensive. A lower density fluid could be injected into the groundwater as a sixth option. Toxicity would be a concern for petroleum derivatives, but a non-toxic alternative such as vegetable oil might work. The magma itself could be made more eruptible by reversing some of the techniques to make the magma less eruptible. However, this involves drilling down to the magma, which has low feasibility, so we do not list these interventions separately.

3. Discussion/future work

This analysis has focused primarily on the technical feasibility of preventing or mollifying supervolcanic eruptions. There is much more science and engineering to be done. It is too early to make policy recommendations, but policy-related research would be valuable. For instance, interventions which disrupt tourism are unlikely to be politically feasible – no social license granted. Social license refers to the buy-in of local people, but this may be trumped by national security issues. The social impact could be mitigated for some interventions by using horizontal drilling (i.e. starting outside the Park).

The highest priority follow-up research would be cost estimation of the unconsolidated materials and the infiltration dams, ideally in the cases of an impending eruption and outside of this window. For the promising interventions that do not have a time to safety estimate, one could be estimated, particularly for the remaining four high feasibility interventions: single water reservoir, cooling groundwater with geothermal electricity production, cooling groundwater by steam venting, and injecting a denser fluid into the groundwater. This would help prioritize doing cost estimations. Small-scale experiments could be performed on more frequently erupting volcanoes, even though the mechanism of eruption is different (Caricchi et al., 2014). For instance, it may be possible to prevent an eruption that would normally have been caused by magma injection, perhaps by adding weight or strengthening fractures.

The success of interventions involving loading the crust could be better estimated by further analyzing the interaction of the growing and retreating ice sheets on supervolcanoes such as Yellowstone where a major expansion of the North American continental ice sheet occurred about 680,000 years ago (Yellowstone erupted about 640,000 years ago). Similarly, studying the current influence of the changing Vatnajökull ice cap and magma migration on volcanoes in Iceland (e.g. (Pagli & Sigmundsson, 2008)) would be beneficial to test theories of preventing eruptions.

Interventions that delay the eruption have the risk of making the future eruption more intense, such as loading the crustal lid that allows greater overpressure build up. However, humanity will have more time and likely more technology to apply to the problem in the future. On the other hand, in the future, there are likely to be more people and infrastructure to be damaged by a super eruption. Another consideration with respect to resource allocation is that a different catastrophe could destroy civilization (e.g. asteroid or comet impact, nuclear winter, pandemic). One definition of the collapse of civilization involves loss of government, short-term focus, collapse of long distance trade, and widespread conflict (Coates, 2009). As the people try to recover, they could be completely wiped out by a supervolcanic eruption that was made more intense by delaying techniques proposed here, a form of double catastrophe (e.g. Baum, Maher, & Haqq-Misra, 2013). The techniques to accelerate the eruption would give society a better idea when an eruption is likely to occur, which could be advantageous if it incites preparations (see below). Also, knowing where an eruption will occur would make certain techniques of mollifying an eruption more feasible. Potentially the safest intervention from the perspective of current and future generations would be methods to accelerate the solidification of magma. This in combination with well-placed water injection wells and extraction allows for developing a dry rock geothermal field while at the same time adding mass to the crustal cap with water. However, any drilling carries some risk associated with weakening the crust, so prior to the drilling, some shoring up of fractures may be prudent.

None of these geoengineering interventions will have 100% certainty of success. Thus, a likely approach would be to adopt several strategies in parallel that can add to collective positive feedback to curtail the eruption intensity, delay the event or direct it to regions less sensitive to ecological disruption. Also, future technologies such as molecular manufacturing could dramatically reduce future costs of the options (Phoenix & Drexler, 2004). Therefore, it may make sense to investigate multiple interventions such as combining unconsolidated materials and infiltration dams.

#### Super-eruptions also create other x-risks by collapsing global infrastructure and sparking world wars.

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Ilan Noy and Tomáš Uher, “Four New Horsemen of an Apocalypse? Solar Flares, Super-volcanoes, Pandemics, and Artificial Intelligence,” Economics of Disasters and Climate Change, https://link.springer.com/article/10.1007/s41885-022-00105-x

A large volcanic eruption of magnitude 7 would likely cause global catastrophic outcomes due to its climatic effects and consequent disruptions of global food production, infrastructure, and communication. A super-volcanic eruption of magnitude 8 or higher could potentially lead to a temporary or (in the worst case) an irreversible collapse of civilization or human extinction (Plag et al. 2013; Ord 2020). Apart from these direct effects, the volcanic-induced societal disruptions could lead to wars and conflicts and thus exacerbate or even create other existential risks.