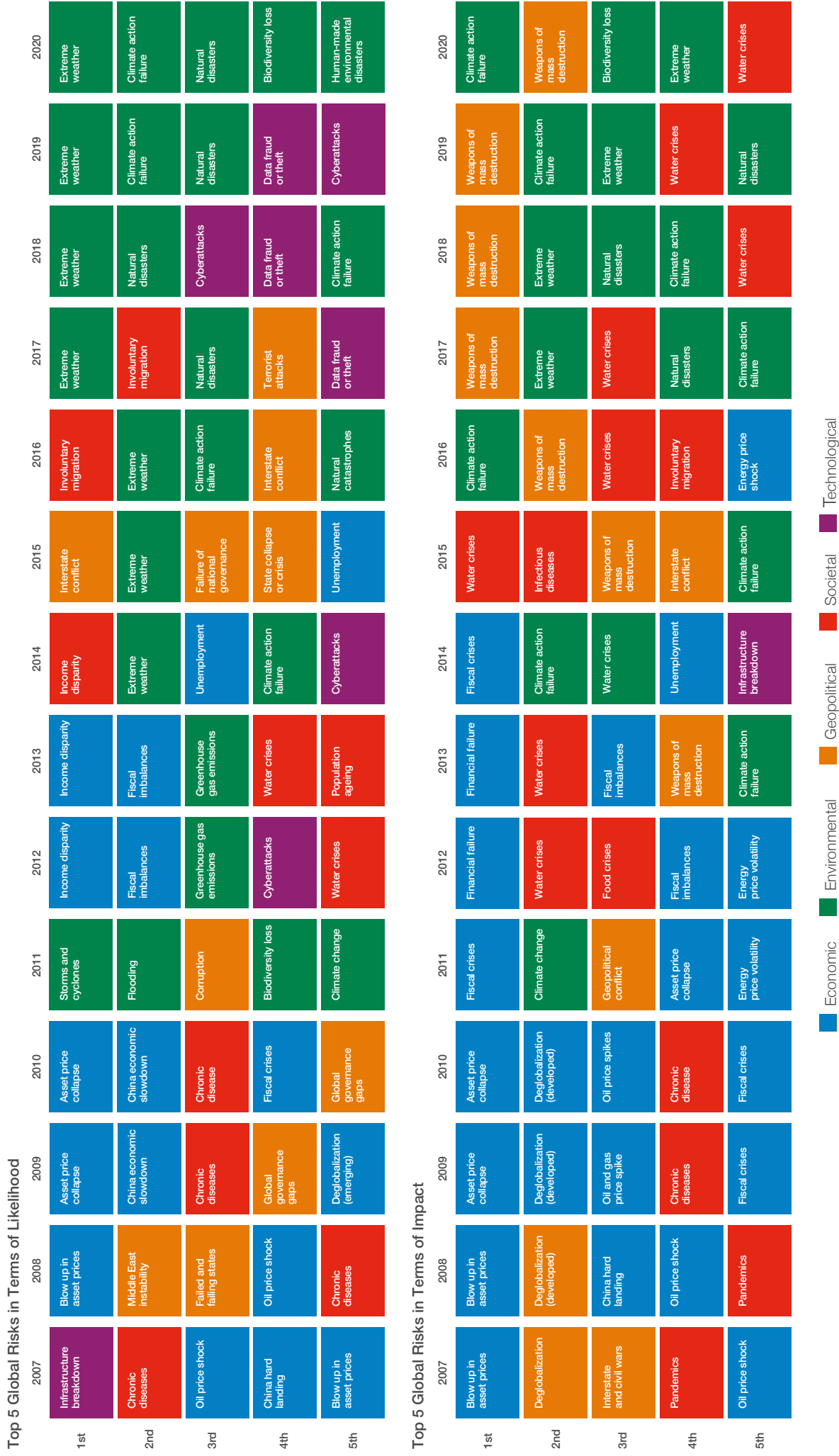


The Global Risks Report 2020

Insight Report | 15th Edition

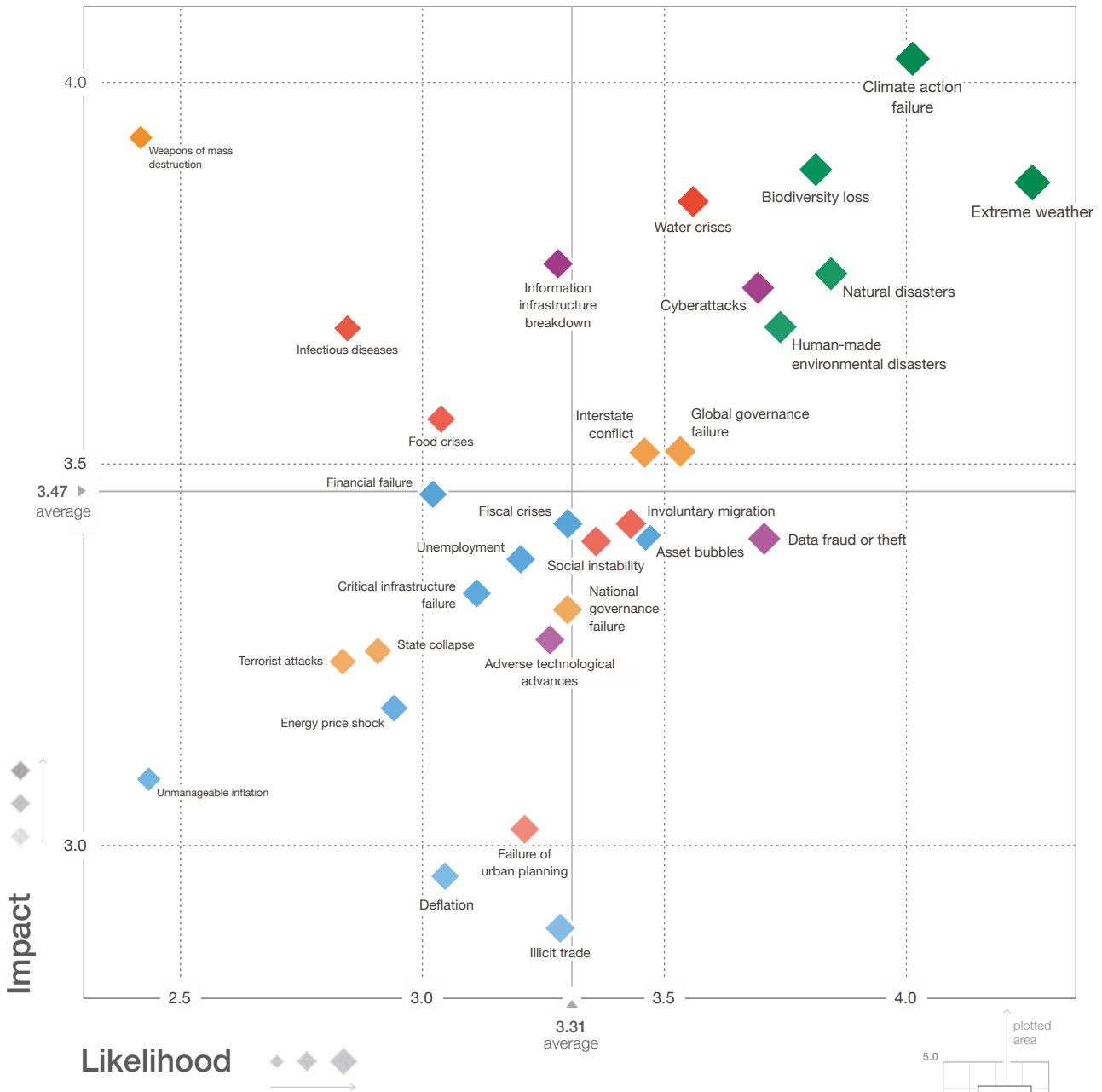
In partnership with Marsh & McLennan and Zurich Insurance Group

Figure 1: The Evolving Risks Landscape, 2007–2020



Source: World Economic Forum 2007-2020, Global Risks Reports.
 Note: Global risks may not be strictly comparable across years, as definitions and the set of global risks have evolved with new issues emerging on the 10-year horizon. For example, cyberattacks, income disparity and unemployment entered the set of global risks in 2012. Some global risks have been reclassified: water crises and income disparity were reclassified as societal risks in the 2015 and 2014 Global Risks Reports, respectively.

Figure II: The Global Risks Landscape 2020



Likelihood

Top 10 risks in terms of Likelihood

- 1 Extreme weather
- 2 Climate action failure
- 3 Natural disasters
- 4 Biodiversity loss
- 5 Human-made environmental disasters
- 6 Data fraud or theft
- 7 Cyberattacks
- 8 Water crises
- 9 Global governance failure
- 10 Asset bubbles

Top 10 risks in terms of Impact

- 1 Climate action failure
- 2 Weapons of mass destruction
- 3 Biodiversity loss
- 4 Extreme weather
- 5 Water crises
- 6 Information infrastructure breakdown
- 7 Natural disasters
- 8 Cyberattacks
- 9 Human-made environmental disasters
- 10 Infectious diseases

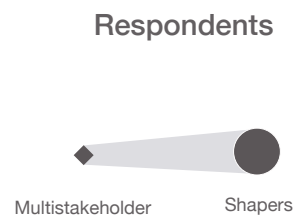
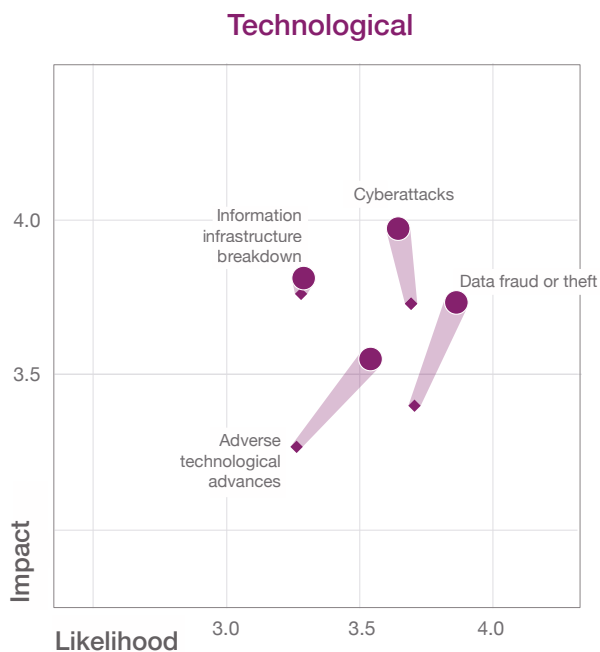
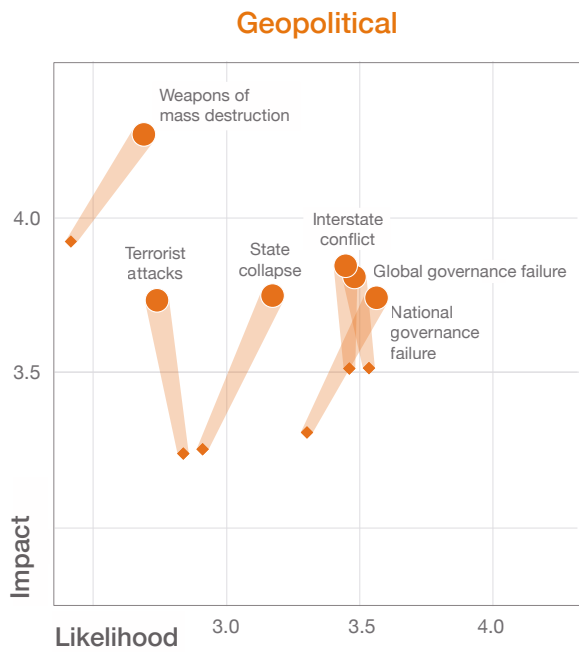
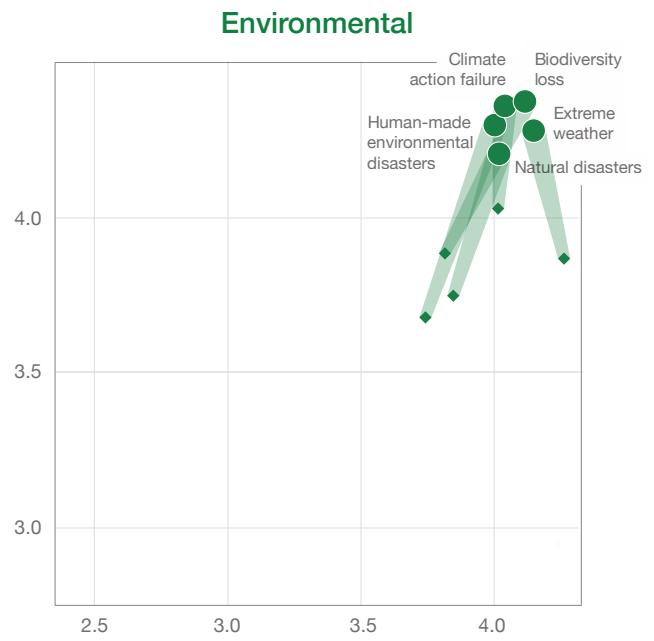
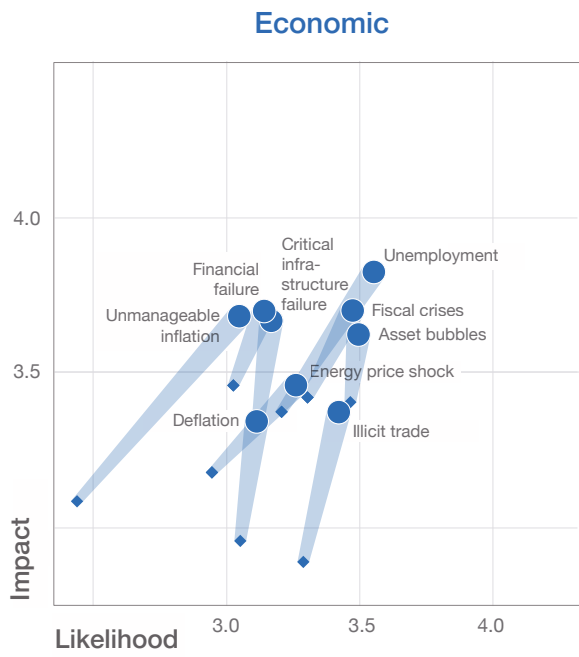
Categories

- ◆ Economic
- ◆ Environmental
- ◆ Geopolitical
- ◆ Societal
- ◆ Technological

Source: World Economic Forum Global Risks Perception Survey 2019–2020.

Note: Survey respondents were asked to assess the likelihood of the individual global risk on a scale of 1 to 5, 1 representing a risk that is very unlikely to happen and 5 a risk that is very likely to occur. They also assessed the impact of each global risk on a scale of 1 to 5, 1 representing a minimal impact and 5 a catastrophic impact. To ensure legibility, the names of the global risks are abbreviated; see Appendix A for the full name and description.

Figure III: The Global Shapers Risk Landscape 2020



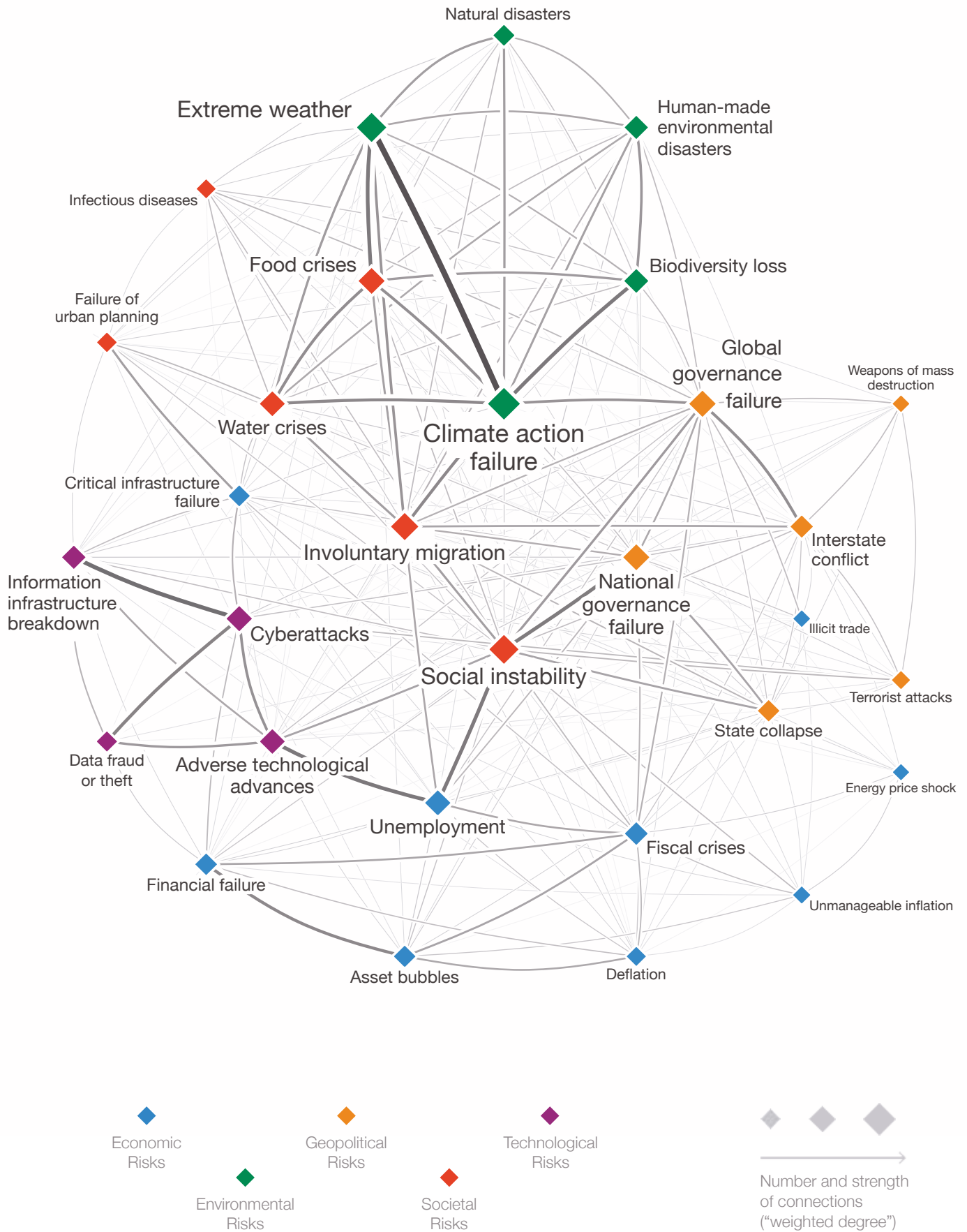
The Global Shapers Community is the World Economic Forum's network of young people driving dialogue, action and change.

Source: World Economic Forum Global Risks Perception Survey 2019–2020.

Note: We applied the same completion thresholds to survey responses from the Global Shapers as to the multistakeholder sample (see Appendix B: Global Risks Perception Survey and Methodology).

We received 236 responses for Part 1 "The World in 2020" and 190 for Part 2 "Assessment of Global Risks". The data for Part 3 "Global Risk Interconnections" were not used.

Figure IV: The Global Risks Interconnections Map 2020



Source: World Economic Forum Global Risks Perception Survey 2019–2020.

Note: Survey respondents were asked to select up to six pairs of global risks they believe to be most interconnected. See Appendix B of the full report for more details. To ensure legibility, the names of the global risks are abbreviated; see Appendix A for the full name and description.

The Global Risks Report 2020 15th Edition

Strategic Partners

Marsh & McLennan

Zurich Insurance Group

Academic Advisers

National University of Singapore

Oxford Martin School, University of Oxford

Wharton Risk Management and Decision Processes Center, University of Pennsylvania

Contents

Preface

By Børge Brende 4

Executive Summary

6

CHAPTER 1

Global Risks 2020: An Unsettled World 8

CHAPTER 2

The Fraying Fundamentals

Risks to Economic Stability
and Social Cohesion 18

CHAPTER 3

A Decade Left

Confronting Runaway
Climate Threat

*In collaboration with the Platform
for Global Public Goods* 28

CHAPTER 4

Save the Axolotl

Dangers of Accelerated
Biodiversity Loss

*In collaboration with the Platform
for Global Public Goods* 44

CHAPTER 5

Wild Wide Web

Consequences of
Digital Fragmentation

*In collaboration with the Platform
for the Fourth Industrial Revolution
and the Platform for Cybersecurity
and Digital Trust* 60

CHAPTER 6

False Positive

Health Systems under
New Pressures

*In collaboration with the Platform
on Health and Healthcare* 72

Appendices

Appendix A: Descriptions of
Global Risks 2020

Appendix B: Global Risks Perception
Survey and Methodology 84

Acknowledgements 92



Preface

The 15th edition of the World Economic Forum’s *Global Risks Report* comes as long-mounting, interconnected risks are being felt. The global economy is faced with a “synchronized slowdown”, the past five years have been the warmest on record, and cyberattacks are expected to increase this year—all while citizens protest the political and economic conditions in their countries and voice concerns about systems that exacerbate inequality. Indeed, the growing palpability of shared economic, environmental and societal risks signals that the horizon has shortened for preventing—or even mitigating—some of the direst consequences of global risks. It is sobering that in the face of this development, when the challenges before us demand immediate collective action, fractures within the global community appear to only be widening.

Global commerce has historically been a pillar and engine of growth—and a key tool for lifting economies out of downturns—but as we warn, significant restrictions were placed on global trade last year. This comes as G20

economies hold record high levels of debt and exhibit relatively low levels of growth. Ammunition to fight a potential recession is lacking, and there is a possibility of an extended low-growth period, akin to the 1970s, if lack of coordinated action continues. In addition, a potential decoupling of the world’s largest economies, the United States and China, is cause for further concern. The question for stakeholders—one that cannot be answered in the affirmative—is whether in the face of a prolonged global slowdown we are positioned in a way that will foster resiliency and prosperity.

On the environment, we note with grave concern the consequences of continued environmental degradation, including the record pace of species decline. Respondents to our Global Risks Perception Survey are also sounding the alarm, ranking climate change and related environmental issues as the top five risks in terms of likelihood—the first time in the survey’s history that one category has occupied all five of the top spots. But despite the need to

be more ambitious when it comes to climate action, the UN has warned that countries have veered off course when it comes to meeting their commitments under the Paris Agreement on climate change.

And on global health and technology, we caution that international systems have not kept up to date with the challenges of these domains. The global community is ill-positioned to address vulnerabilities that have come alongside the advancements of the 20th century, whether they be the widening application of artificial intelligence or the widespread use of antibiotics.

Today's risk landscape is being shaped in significant measure by an unsettled geopolitical environment—one in which new centres of power and influence are forming—as old alliance structures and global institutions are being tested. While these changes can create openings for new partnership structures, in the immediate term, they are putting stress on systems of coordination and challenging norms around shared responsibility. Unless stakeholders adapt multilateral mechanisms for this turbulent period, the risks that were once on the horizon will continue to arrive.

The good news is that the window for action is still open, if not for much longer. And, despite global divisions, we continue to see members of the business community signal their commitment to looking beyond their balance sheets and towards the urgent priorities ahead.

The Global Risks Initiative

It is fitting that this year's report, which makes clear the need for a multistakeholder approach to mitigating risk, coincides with the Forum's 50th anniversary. As the international organization for public-private cooperation, the Forum brings together leaders from the business, government and non-profit communities for action-oriented deliberations and uses the conclusions of this report to inform its multistakeholder initiatives throughout the year.

Indeed, the *Global Risks Report* is itself the result of a multistakeholder process. I am grateful for the long-standing relationship with our strategic partners, Marsh &

McLennan and Zurich Insurance Group, who offered invaluable input to produce this publication. I am also grateful to our academic partners: the National University of Singapore, the Oxford Martin School of the University of Oxford, and the Wharton Risk Management and Decision Processes Center at the University of Pennsylvania. Over the course of developing the report, the Forum benefited from a committed Advisory Board, who shaped the direction of early drafts and provided beneficial comments and insight throughout the writing process. The Forum also hosted a range of representatives from the public and private sectors in September and October for discussions in Geneva, New York and Washington, DC, insights from which can be found in these pages.

The foundation of the report is our annual Global Risks Perception Survey, completed by approximately 800 members of the Forum's diverse communities. I am particularly proud that for the first time we are also featuring the results from more than 200 members of our Global Shapers Community—a generation of emerging global social entrepreneurs and leaders. This younger generation is increasingly using its digital savviness—and its feet—to spotlight issues, particularly relating to climate change, that it sees as existential risks not only to its generation but to the wider global community.

The *Global Risks Report* is part of an expanded Global Risks Initiative launched by the Forum this past year that includes sustained analysis at the global, regional and industry levels. It is this qualitative and quantitative study of global risks, conducted in partnership with members of the business, academic and public-sector communities, that we hope will help bring stakeholders together in developing sustainable, integrated solutions to the world's most pressing challenges.



Børge Brende
President, World Economic Forum

Executive Summary

The world cannot wait for the fog of geopolitical and geo-economic uncertainty to lift. Opting to ride out the current period in the hope that the global system will “snap back” runs the risk of missing crucial windows to address pressing challenges. On key issues such as the economy, the environment, technology and public health, stakeholders must find ways to act quickly and with purpose within an unsettled global landscape. This is the context in which the World Economic Forum publishes the 15th edition of the *Global Risks Report*.

An unsettled world

Powerful economic, demographic and technological forces are shaping a new balance of power. The result is an unsettled geopolitical landscape—one in which states are increasingly viewing opportunities and challenges through unilateral lenses. What were once givens regarding alliance structures and multilateral systems no longer hold as states question the value of long-standing frameworks, adopt more nationalist postures in pursuit of individual agendas and weigh the potential geopolitical consequences of economic decoupling.

Beyond the risk of conflict, if stakeholders concentrate on immediate geostrategic advantage and fail to reimagine or adapt mechanisms for coordination during this unsettled period, opportunities for action on key priorities may slip away.

Risks to economic stability and social cohesion

Recent editions of the *Global Risks Report* warned of downward pressure on the global economy from macroeconomic fragilities and financial inequality. These pressures continued to intensify in 2019,

increasing the risk of economic stagnation. Low trade barriers, fiscal prudence and strong global investment—once seen as fundamentals for economic growth—are fraying as leaders advance nationalist policies. The margins for monetary and fiscal stimuli are also narrower than before the 2008–2009 financial crisis, creating uncertainty about how well countercyclical policies will work. A challenging economic climate may persist this year: according to the Global Risks Perception Survey, members of the multistakeholder community see “economic confrontations” and “domestic political polarization” as the top risks in 2020.

Amid this darkening economic outlook, citizens’ discontent has hardened with systems that have failed to promote advancement. Disapproval of how governments are addressing profound economic and social issues has sparked protests throughout the world, potentially weakening the ability of governments to take decisive action should a downturn occur. Without economic and social stability, countries could lack the financial resources, fiscal margin, political capital or social support needed to confront key global risks.

Climate threats and accelerated biodiversity loss

Climate change is striking harder and more rapidly than many expected. The last five years are on track to be the warmest on record, natural disasters are becoming more intense and more frequent, and last year witnessed unprecedented extreme weather throughout the world. Alarming, global temperatures are on track to increase by at least 3°C towards the end of the century—twice what climate experts have warned is the limit to avoid the most severe economic, social and

environmental consequences. The near-term impacts of climate change add up to a planetary emergency that will include loss of life, social and geopolitical tensions and negative economic impacts.

For the first time in the history of the Global Risks Perception Survey, environmental concerns dominate the top long-term risks by likelihood among members of the World Economic Forum’s multistakeholder community; three of the top five risks by impact are also environmental (see Figure 1, The Evolving Risks Landscape 2007–2020). “Failure of climate change mitigation and adaption” is the number one risk by impact and number two by likelihood over the next 10 years, according to our survey. Members of the Global Shapers Community—the Forum’s younger constituents—show even more concern, ranking environmental issues as the top risks in both the short and long terms.

The Forum’s multistakeholder network rate “biodiversity loss” as the second most impactful and third most likely risk for the next decade. The current rate of extinction is tens to hundreds of times higher than the average over the past 10 million years—and it is accelerating. Biodiversity loss has critical implications for humanity, from the collapse of food and health systems to the disruption of entire supply chains.

Consequences of digital fragmentation

More than 50% of the world’s population is now online, approximately one million people go online for their first time each day, and two-thirds of the global population own a mobile device. While digital technology is bringing tremendous economic and societal benefits to much of the global population, issues such as unequal access to the internet, the lack of a global

technology governance framework and cyber insecurity all pose significant risk. Geopolitical and geo-economic uncertainty—including the possibility of fragmented cyberspace—also threaten to prevent the full potential of next generation technologies from being realized. Respondents to our survey rated “information infrastructure breakdown” as the sixth most impactful risk in the years until 2030.

Health systems under new pressures

Health systems around the world are at risk of becoming unfit for purpose. New vulnerabilities resulting from changing societal, environmental, demographic and technological patterns threaten to undo the dramatic gains in wellness and prosperity that health systems have supported over the last century. Non-communicable diseases—such as cardiovascular diseases and mental illness—have replaced infectious diseases as the leading cause of death, while increases in longevity and the economic and societal costs of managing chronic diseases have put healthcare systems in many countries under stress. Progress against pandemics is also being undermined by vaccine hesitancy and drug resistance, making it increasingly difficult to land the final blow against some of humanity’s biggest killers. As existing health risks resurge and new ones emerge, humanity’s past successes in overcoming health challenges are no guarantee of future results.

There is still scope for stakeholders to address these risks, but the window of opportunity is closing. Coordinated, multistakeholder action is needed quickly to mitigate against the worst outcomes and build resiliency across communities and businesses.



Global Risks 2020: An Unsettled World



The world cannot wait for the fog of geopolitical and geo-economic uncertainty to lift. Opting to ride out the current period in the hope that the global system will “snap back” runs the risk of missing crucial windows to

address pressing challenges. On key issues such as the economy, the environment, technology and public health, stakeholders must find ways to act quickly and with purpose within an unsettled global landscape.



Powerful economic, demographic and technological forces are shaping a new balance of power. The result is an unsettled geopolitical landscape—one in which states are increasingly viewing opportunities and challenges through a unilateral lens. What were once givens regarding alliance structures and multilateral systems no longer hold as states question the value of longstanding frameworks, adopt more nationalist postures in pursuit of individual agendas and weigh the potential geopolitical consequences of economic decoupling.

Beyond the risk of conflict, if stakeholders concentrate on immediate geostrategic advantage and fail to reimagine or adapt mechanisms for coordination during this unsettled period, opportunities for action on key priorities will slip away.

Turbulence: The new normal

For much of the post-Cold War period, all but a few societies shared the aspiration of stable development in the context of formally agreed (if not universally observed) rules governed by multilateral institutions. Geopolitical challenges—from border conflicts to terrorist attacks—were often

addressed through cooperative institutions and in ways that sought to minimize interruptions to cooperation for global economic progress. And some have argued that greater economic interconnectedness and interdependence in the last 20 years—fostered by multilateral institutions—has acted as a check on great power conflict.¹

But new dynamics—in certain cases, underlying forces that are the result of progress over the last three decades—are causing states to re-evaluate their approach to geopolitics. Today's emerging economies are expected to comprise six of the world's seven largest economies by 2050.² Rising powers are already investing more in projecting influence around the world.³ And digital technologies are redefining what it means to exert global power.⁴ As these trends are unfolding, a shift in mindset is also taking place among some stakeholders—from multilateral to unilateral and from cooperative to competitive. The resulting geopolitical turbulence is one of unpredictability about who is leading, who are allies, and who will end up the winners and losers.

As states respond to the challenges and opportunities offered by today's epochal power-shift, some view multilateral institutions as obstacles rather than

FIGURE 1.1

Short-Term Risk Outlook

Percentage of respondents expecting risks to increase in 2020

Multistakeholders

■ Economic confrontations	78.5%
■ Domestic political polarization	78.4%
■ Extreme heat waves	77.1%
■ Destruction of natural ecosystems	76.2%
■ Cyberattacks: infrastructure	76.1%
■ Protectionism on trade/investment	76.0%
■ Populist and nativist agendas	75.7%
■ Cyberattacks: theft of money/data	75.0%
■ Recession in a major economy	72.8%
■ Uncontrolled fires	70.7%

Global Shapers

■ Extreme heat waves	88.8%
■ Destruction of ecosystems	87.9%
■ Health impacted by pollution	87.0%
■ Water crises	86.0%
■ Uncontrolled fires	79.8%
■ Economic confrontations	78.4%
■ Loss of trust in media sources	77.1%
■ Loss of privacy (to companies)	76.2%
■ Loss of privacy (to governments)	76.1%
■ Domestic political polarization	75.3%

■ Economic ■ Environmental ■ Geopolitical ■ Societal ■ Technological

Note: The Global Shapers Community is the World Economic Forum's network of young people driving dialogue, action and change. Source: World Economic Forum Global Risks Perception Survey 2019-2020. See Appendix B for details.

instruments for promoting their interests. The challenge to these institutions is rooted in concern within some societies about globalized systems and mechanisms of cooperation—what the International Monetary Fund (IMF) dubs a “trust recession”.⁵ According to the 2019 Edelman Trust Barometer, just one in five people believe “the system” is working for them.⁶

What were once givens regarding alliance structures and multilateral systems no longer hold

Expanding geopolitical frontiers

The current period of geopolitical change presents opportunities—for instance, to re-evaluate frameworks in which some stakeholders have been under-represented. Yet the turbulence threatens to undermine the international community’s ability to mitigate critical global risks by multiplying the domains in which rivalries can play out and limiting stakeholders’ capacity to address global challenges. Unless stakeholders can adapt to the present—while still preparing for the future—time will run out to address some of the most

pressing economic, environmental and technological challenges.

The economic frontier

The global economy is showing signs of vulnerability (see Chapter 2, The Fraying Fundamentals). At the time of writing, the IMF expected growth to be 3.0% in 2019—the lowest rate since the economic crisis of 2008-2009.⁷ At a time when global coordination in the form of more efficient trade could help boost growth, trade has instead been turned into an instrument for rivalry. The World Trade Organization (WTO) projected that growth in merchandise trade will slow to 1.2% in 2019 from 3.0% in 2018.⁸

FIGURE 1.2

Long-Term Risk Outlook

Top 10 risks by likelihood and impact over the next 10 years

Multistakeholders

Likelihood	Impact
■ Extreme weather	■ Climate action failure
■ Climate action failure	■ Weapons of mass destruction
■ Natural disaster	■ Biodiversity loss
■ Biodiversity loss	■ Extreme weather
■ Human-made environmental disasters	■ Water crises
■ Data fraud or theft	■ Information infrastructure breakdown
■ Cyberattacks	■ Natural disasters
■ Water crises	■ Cyberattacks
■ Global governance failure	■ Human-made environmental disasters
■ Asset bubble	■ Infectious diseases

Global Shapers

Likelihood	Impact
■ Extreme weather	■ Biodiversity loss
■ Biodiversity loss	■ Climate action failure
■ Climate action failure	■ Water crises
■ Natural disasters	■ Human-made environmental disasters
■ Human-made environmental disasters	■ Extreme weather
■ Water crises	■ Weapons of mass destruction
■ Data fraud or theft	■ Natural disasters
■ Involuntary migration	■ Food crises
■ Social instability	■ Infectious diseases
■ Cyberattacks	■ Cyberattacks

■ Economic	■ Environmental	■ Geopolitical
■ Societal	■ Technological	

Source: World Economic Forum Global Risks Perception Survey 2019-2020. See Appendix B for details.

While there was progress late last year towards a “Phase One” US-China trade deal,⁹ tensions between the two have harmed the economies of both countries and the global economic outlook as well: the tensions could cost US\$700 billion in lost output in 2020¹⁰—almost the amount of GDP lost by the entire European Union due to the financial crisis (US\$757 billion between 2008 and 2009).¹¹ The Organisation for Economic Co-operation and Development (OECD) warns, “Escalating trade conflicts are taking an increasing toll on confidence and investment, adding to policy uncertainty, aggravating risks in financial markets and endangering already weak growth prospects worldwide.”¹² Respondents to the Global Risks Perception Survey do not expect overall economic tensions to cease—over 78% of them see “economic confrontations” increasing in 2020 (see Figure 1.1).

The environmental frontier

In late 2019, UN Secretary-General António Guterres warned that a “point of no-return” on climate change is “in sight and hurtling toward us”.¹³ Respondents to the Forum’s Global Risks Perception Survey also are sounding the alarm. For the first time in the history of the survey, climate-related issues dominated all of the top-five long-term risks by likelihood among members of the Forum’s multistakeholder community (see Figure 1.2). And members of the Global Shapers Community—the Forum’s younger constituents—show even more concern, ranking environmental issues as the top risks in both the short and long terms (see Figure III, The Global Shapers Risk Landscape).

Yet, although immediate multilateral and multistakeholder coordination is needed to address global warming (see Chapter 3, A Decade Left, and Chapter 4, Save the Axolotl), global fracture—most recently exhibited at the 2019 UN Climate Change Conference COP25 in Madrid—and a growth in nationalist policies risk preventing meaningful action.¹⁴

States are adapting to one of the most dramatic effects of climate change—the melting of Arctic ice—not by redoubling efforts to prevent further environmental



Climate-related issues dominated all of the top-five long-term risks in terms of likelihood

degradation, but by exploiting the region for geostrategic advantage. The Arctic Council, which for more than 20 years has served as an important multilateral mechanism for collaboration among the eight Arctic States, is under stress. A new cold war is developing as countries—including China, Norway, Russia and the United States—compete for fish, gas and other natural resources; for the use of new shipping lanes; and to establish a strategic footprint in the region.¹⁵ Russia and China have prioritized developing the Northern Sea Route, with the latter dubbing its initiative the “Polar Silk Road”.¹⁶ The U.S. Department of Defense released its Arctic strategy in July; that document did not mention climate change

but did present a strategy in which the “end-state for the Arctic is a secure and stable region in which U.S. national security interests are safeguarded.”¹⁷

The digital frontier

Both sets of respondents to the Global Risks Perception Survey—the multistakeholder community and the Global Shapers—identify cyber-related issues, such as cyberattacks and data fraud or theft, within the list of top 10 long-term risks (see Figure 1.2). Indeed, while the growth of digitalization offers opportunities that can best be captured through coordinated approaches among stakeholders, it also creates areas in need of coordinated solutions.

One such area is artificial intelligence (AI). According to the UN's International Telecommunication Union, it will take "massive interdisciplinary collaboration" to unlock AI's potential.¹⁸ But because AI can also bring significant risk, multilateral cooperation is needed to address challenges such as security, verification, "deepfake" videos, mass surveillance and advanced weaponry.

78% Respondents expecting "economic confrontations" to increase in 2020

Despite the need for a common set of global protocols, AI has become a new frontier for competitive geopolitics. In 2017, Russian President Vladimir Putin said, "Whoever becomes the leader in this sphere will become the ruler of the world."¹⁹ China has strongly encouraged companies to invest in AI, making it a national security priority;²⁰ AI is a pillar of its current five-year plan (2016–2020) for science and technology development and its "made in China 2025" industrial plan.²¹ In the United States, the Defense Department's Joint Artificial Intelligence Center recently requested that its budget be tripled to US\$268 million,²² citing the rapid development of AI capabilities by China and Russia as a reason for urgency.

There is some progress. Already, stakeholders are coming together to design shared protocols for AI. The World Economic Forum's Centre for the Fourth Industrial Revolution has worked with the government of the United Kingdom to formulate guidelines for more ethical and efficient procurement of AI. These guidelines will be piloted in countries across Europe, the Middle East and Latin America. And, in May 2019, the OECD's 36 member states adopted Principles on AI—the first common set of principles that governments have adopted—to promote AI "that is innovative and trustworthy and that respects human rights and democratic values."²³ However,



challenges remain. Eleonore Pauwels of the United Nations University Centre for Policy Research warns that "the resurgence of nationalist agendas across the world may point to a dwindling capacity of the multilateral system to play a meaningful role in the global governance of AI."²⁴

A coming decoupling?

Geopolitical turbulence related to trade tensions and technological rivalries is part of a larger risk for the global community—the risk of the United States and China decoupling. Together, these two countries account for over 40% of global GDP,²⁵ and they are the world's leading innovators.²⁶ They are also the world's top two emitters of greenhouse gases.²⁷ Expanding the global economy, addressing climate change and realizing the full benefits of technology, therefore, depend on their ability to coordinate as part of a common global system that is capable of including other stakeholders.



REUTERS/MAXIM SHEMETOV

However, the trend today is not one in which these two countries are just competing across common domains but one in which each is looking to design its own systems—its own supply chains, 5G networks and global investment institutions. Already investment flows between the two have dropped,²⁸ each has moved to restrict technology from the other,²⁹ and some analysts predict China will look to reduce its dependence on the US dollar by holding more foreign currencies.³⁰

Even if the current trade tensions cool, we risk heading towards an era in which the two countries disentangle their economies and create barriers between one another. While leaders in Beijing and Washington have expressed disapproval of an economic decoupling, the policy measures being put in place are paving a road towards that destination.³¹

A return to a kind of cold war or iron curtain economic landscape would fundamentally change the way in which global business

and security have functioned over the past three decades. Countries would need to decide which economic system to be part of—something many have already said they do not want to do—and businesses would have to develop separate protocols.³²

The decline of economic integration would also remove what many see as a check against outright conflict.

A need for adaptive geopolitics

As the outlines of the next geopolitical era start to emerge, there is still uncertainty about where the distribution of power will settle and from where influence will emanate, but a snap back to the old order appears unlikely. If stakeholders attempt to bide their time, waiting for the old system to return, they will be ill-prepared for what lies ahead and may miss the point at which key challenges—economic, societal, technological or environmental—can be addressed. Instead, longstanding institutions must adapt to the present and be upgraded or reimaged for the future.

There are signs of adaptation in the creation of new institutions designed to function in this turbulent geopolitical climate. One example is the Franco-German “Alliance for Multilateralism”, a group of nations working to boost international cooperation in areas such as disarmament, digitalization and climate change.³³ Another is the African Continental Free Trade Agreement, which will bring together the 55 member states of the African Union to form the largest free trade area since the formation of the WTO.³⁴ Narrower, issue-specific, ad-hoc “coalitions of the willing” are proliferating—including Asian regional trade and investment instruments, the “Quad” (consultation among Australia, India, Japan and the United States), and the Global Coalition against Daesh. While aiming to address collective priorities, however, such adaptive approaches run the risk of being less effective because they lack the legitimacy of broad-based multilateral institutions. Still, they point to the need for continued coordination and partnership during an unsettled time.

Notes

- 1 Tanious, M. E. 2019. "The Impact of Economic Interdependence on the Probability of Conflict between States: The Case of 'American-Chinese Relationship on Taiwan Since 1995'". 14 January 2019. *Review of Economics and Political Science*. <https://www.emerald.com/insight/content/doi/10.1108/REPS-10-2018-010/full/html>
- 2 PwC Global. "The World in 2050: The Long View: How Will the Global Economic Order Change by 2050?" PwC. <https://www.pwc.com/gx/en/issues/economy/the-world-in-2050.html>
- 3 BBC News. "China Now Has More Diplomatic Posts Than Any Other Country". 27 November 2019. BBC. <https://www.bbc.com/news/world-asia-china-50569237>
- 4 Engelke, P. 2018. "Three Ways the Fourth Industrial Revolution Is Shaping Geopolitics". 24 August 2018. <https://www.weforum.org/agenda/2018/08/three-ways-the-fourth-industrial-revolution-is-shaping-geopolitics/>
- 5 Lipton, D. 2018 "Trust and the Future of Multilateralism". Introductory Remarks for the Eurofi High Level Seminar, IMF First Deputy Managing Director David Lipton, 30 April 2018. International Monetary Fund. <https://www.imf.org/en/News/Articles/2018/04/30/sp042618-trust-and-the-future-of-multilateralism>
- 6 Edelman. 2019. "2019 Edelman Trust Barometer". 20 January 2019. Edelman. <https://www.edelman.com/trust-barometer>
- 7 IMF (International Monetary Fund). 2019. World Economic Outlook, October 2019: Global Manufacturing Downturn, Rising Trade Barriers. Washington, DC: IMF. <https://www.imf.org/en/Publications/WEO/Issues/2019/10/01/world-economic-outlook-october-2019>
- 8 WTO (World Trade Organization). 2019. "Global Trade Growth Loses Momentum as Trade Tensions Persist". Press Release, 2 April 2019. World Trade Organization. https://www.wto.org/english/news_e/pres19_e/pr837_e.htm; "WTO lowers trade forecast as tensions unsettle global economy". Press Release, 1 October 2019. https://www.wto.org/english/news_e/pres19_e/pr840_e.htm
- 9 Reuters. 2019. "Factbox: What Is Actually in the U.S.-China 'Phase One' Trade Deal?" 16 December 2019. *Reuters Business News*. <https://www.reuters.com/article/us-usa-trade-china-details-factbox/factbox-what-is-actually-in-the-us-china-phase-one-trade-deal-idUSKBN1YK1QT>
- 10 Georgieva, K. 2019. "Transcript of International Monetary Fund Managing Director Kristalina Georgieva's Opening Press Conference, 2019 Annual Meetings". 17 October 2019. International Monetary Fund. <https://www.imf.org/en/News/Articles/2019/10/17/tr101719-transcript-managing-director-kristalina-georgieva-press-conference-2019-annual-meetings>
- 11 World Bank Open Data. "GDP (constant 2010 US\$) - European Union, 2007-2018". The World Bank. <https://data.worldbank.org/indicator/NY.GDP.MKTP.KD?end=2018&locations=EU&start=2007>
- 12 OECD (Organisation for Economic Co-operation and Development). 2019. "OECD Sees Rising Trade Tensions and Policy Uncertainty Further Weakening Global Growth". 19 September 2019. Organisation for Economic Cooperation and Development. <https://www.oecd.org/economy/oecd-sees-rising-trade-tensions-and-policy-uncertainty-further-weakening-global-growth.htm>
- 13 Manzanaro, S. S. 2019. "COP25 in Madrid: UN Secretary-General Guterres Says Planet Is 'Close to a Point of No Return.'" *Euronews*. 3 December 2019. <https://www.euronews.com/2019/12/02/live-un-leaders-and-delegates-arrive-in-madrid-for-the-climate-change-summit>
- 14 Temko, N. 2018. "COP24: Nationalism and the Challenge of Climate Change". *The Christian Science Monitor*. 27 November 2018. <https://www.csmonitor.com/World/2018/1127/COP24-Nationalism-and-the-challenge-of-climate-change>
- 15 Shea, N. 2019. "Scenes from the New Cold War Unfolding at the Top of the World". *National Geographic*. 8 May 2019. <https://www.nationalgeographic.com/environment/2018/10/new-cold-war-brews-as-arctic-ice-melts/>
- 16 Reuters. 2019. "Maersk Explores Arctic Shipping Route with Russia". *Reuters Business News*. 14 June 2019. <https://www.reuters.com/article/us-arctic-shipping-maersk/maersk-explores-arctic-shipping-route-with-russia-idUSKCN1TF0WW#targetText=Russia%20has%20made%20developing%20the,route%20the%20northern%20Suez%20Canal>
- 17 Office of the Under Secretary of Defense for Policy. 2019. *Report to Congress: Department of Defense Arctic Strategy*". June 2019. <https://media.defense.gov/2019/Jun/06/2002141657/-1/-1/1/2019-DOD-ARCTIC-STRATEGY.PDF>

- 18 ITU (International Telecommunication Union). 2017. *AI for Good Global Summit: Report*. June 2017. International Telecommunication Union. https://www.itu.int/en/ITU-T/AI/Documents/Report/AI_for_Good_Global_Summit_Report_2017.pdf
- 19 Maggio, E. 2017. "Putin Believes that Whatever Country Has the Best AI Will Be 'the Ruler of the World'". *Business Insider*. 4 September 2017. <https://www.businessinsider.com/putin-believes-country-with-best-ai-ruler-of-the-world-2017-9?r=US&IR=T>
- 20 Allen, G. C. 2019. *Understanding China's AI Strategy: Clues to Chinese Strategic Thinking on Artificial Intelligence and National Security*. Washington, DC: Center for a New American Security. <https://s3.amazonaws.com/files.cnas.org/documents/CNAS-Understanding-Chinas-AI-Strategy-Gregory-C.-Allen-FINAL-2.15.19.pdf?mtime=20190215104041>
- 21 Dai, S. and A. Shen. 2018. "'Made in China 2025': China Has a Competitive AI Game Plan But Success Will Need Cooperation". *South China Morning Post*. 1 October 2018. <https://www.scmp.com/tech/article/2166177/made-china-2025-china-has-competitive-ai-game-plan-success-will-need>
- 22 Ashizuka, T. 2019. "Pentagon Seeks to Triple AI Warfare Budget to Meet China's Rise". *Nikkei Asian Review*. 4 October 2019. <https://asia.nikkei.com/Business/Aerospace-Defense/Pentagon-seeks-to-triple-AI-warfare-budget-to-meet-China-s-rise>
- 23 OECD (Organisation for Economic Co-operation and Development). "OECD Principles on AI". Organisation for Economic Co-operation and Development Going Digital Project. <http://www.oecd.org/going-digital/ai/principles/>
- 24 Pauwels, E. 2018. "The New Geopolitics of Artificial Intelligence". 15 October 2018. World Economic Forum. <https://www.weforum.org/agenda/2018/10/artificial-intelligence-ai-new-geopolitics-un/>
- 25 IMF (International Monetary Fund). "GDP, Current Prices". *IMF Data Mapper*. International Monetary Fund. <https://www.imf.org/external/datamapper/NGDPD@WEO/OEMDC/ADVEC/WEOWORLD>
- 26 Schoff, J. L. and A. Ito. 2019. "Competing with China on Technology and Innovation". 10 October 2019. Carnegie Endowment for International Peace. <https://carnegieendowment.org/2019/10/10/competing-with-china-on-technology-and-innovation-pub-80010>
- 27 Friedrich, J., M. Ge and A. Pickens. 2017. "This Interactive Chart Explains World's Top 10 Emitters, and How They've Changed". 11 April 2017. World Resources Institute. <https://www.wri.org/blog/2017/04/interactive-chart-explains-worlds-top-10-emitters-and-how-theyve-changed>
- 28 Congressional Research Service. 2019. "U.S.-China Investment Ties: Overview and Issues for Congress". *In Focus*. 28 August 2019. <https://fas.org/sgp/crs/row/IF11283.pdf>
- 29 Yang, Y. and N. Liu. 2019. "Beijing Orders State Offices to Replace Foreign PCs and Software". *Financial Times*. 8 December 2019. <https://www.ft.com/content/b55fc6ee-1787-11ea-8d73-6303645ac406>
- 30 Khan, Y. 2019. "China Aims to Reduce Its Dependence on America by 'Decoupling' from the Dollar, ANZ Bank Says". *Market Insider*. 18 November 2019. <https://markets.businessinsider.com/news/stocks/china-diversifying-away-from-dollar-reserves-due-to-trade-war-anz-2019-11-1028695801>
- 31 Wang, O. "Chinese Economists Warn Beijing to Prepare for Decoupling from US". *South China Morning Post*. 7 July 2019. <https://www.scmp.com/news/china/article/3017550/chinese-economists-warn-beijing-prepare-decoupling-us>
- 32 Stromseth, J. 2019. *Don't Make Us Choose: Southeast Asia in the Throes of US-China Rivalry*. Foreign Policy at Brookings. https://www.brookings.edu/wp-content/uploads/2019/10/FP_20191009_dont_make_us_choose.pdf
- 33 DW (Deutsche Welle). 2019. "Germany Launches Alliance for Multilateralism". *DW News*. 26 September 2019. <https://p.dw.com/p/3QJOO>
- 34 TRALAC. 2019. "African Continental Free Trade Area (AfCFTA) Legal Texts and Policy Documents". Resources. TRALAC Trade Law Centre NPC. <https://www.tralac.org/resources/by-region/cfta.html>



The Fraying Fundamentals

Risks to Economic Stability and
Social Cohesion



Recent editions of the *Global Risks Report* have warned of downward pressure on the global economy from macroeconomic fragilities and financial inequality. These pressures continued to intensify in 2019, increasing the risk of economic stagnation. Low trade barriers, fiscal prudence and strong global investment—once seen as fundamentals for economic growth—are being

challenged as leaders advance nationalist policies and citizens' discontent hardens with systems that have failed to promote economic advancement for all. A challenging economic climate may persist: according to the Global Risks Perception Survey, members of the multistakeholder community see “economic confrontations” and “domestic political polarization” as the top risks in 2020.

The global economy is at risk of stagnation. Rising trade barriers, lower investment and high debt are straining economies around the world. The margins for monetary and fiscal stimuli are narrower than before the 2008–2009 financial crisis, creating uncertainty about how well countercyclical policies will work. This uncertainty is exacerbated by a tense geo-economic and geopolitical landscape (see Chapter 1, *Global Risks 2020*), as well as by domestic challenges. Profound citizen discontent—born of disapproval of the way governments are addressing economic and social challenges—has sparked protests throughout the world, potentially weakening the ability of governments to take decisive action should a downturn occur.

Economic risk factors are compounding with widespread domestic discontent towards economic systems

Macroeconomic risk factors

During the last decade, moderate but stable growth has given way to what the International Monetary Fund (IMF) has called a “synchronized slowdown”—weakened growth among the world’s economies.¹ We cautioned in last year’s *Global Risks Report* that a gradual deceleration was underway, and the evidence suggests that, since then, the slowdown of the world economy has further materialized. By the third quarter of 2019, six of the world’s largest seven economies (Japan is the exception), which together represent more than half of global production, had decelerated. The outlook is also precarious for other G20 economies. Except for Indonesia and South Korea, these economies are growing at a rate below 2%—with Argentina and Mexico contracting in the third quarter of 2019.² These trends likely explain why our multistakeholder community rated “recession in a major economy” as the ninth risk most likely to increase in 2020 (see Figure 1.1 in Chapter 1, *Global Risks 2020*).

Going forward, rising trade tensions, lower investment, weak confidence and high debt risk a prolonged slowdown of the world economy. At the time of writing this report, the IMF had lowered its last five estimates of world output for 2019 and expected a growth rate of 3.0%—a sharp decline from 3.6% in 2018 and the slowest since the 1.7% contraction in 2009.³ For 2020, the IMF had also downgraded its forecast from 3.7% to 3.4% (see Figure 2.1).

Trade tensions

“Economic confrontations between major powers” is the most concerning risk for 2020, according to members of the Forum’s multistakeholder community; this is the same risk our multistakeholder network rated as the top risk last year. It is clear why short-term economic risks ranked high in the Global Risks Perception Survey: global trade, which for decades has been an engine for growth, is slowing down. World Trade Organization (WTO) data for the first three quarters of 2019 shows that total world merchandise trade decreased 2.9% from the previous year (see Figure 2.2)—it decreased in the world’s top ten traders.⁴

Reduced trade volumes are largely the result of what the WTO has called “historically high levels of trade restrictions”.⁵ The potential result, according to the IMF, could be global growth slowing by 0.8 percentage points in 2020, should the United States and China uphold existing tariffs or implement new ones.⁶ While progress was made in late 2019 between the United States and China towards a trade agreement, the effects of having turned trade from an instrument of cooperation to a weapon of rivalry may persist.

Lower investment

Investment is indispensable for boosting productivity. Globally, investment has been affected by low expected returns, uncertainty about economic policy in major economies, and ongoing and emerging geopolitical tensions (see Chapter 1, *Global Risks 2020*). In our survey, “protectionism regarding trade and investment” and “populist and nativist agendas”—two major obstacles to the free flow of foreign direct investment (FDI)—were rated as the fifth and sixth risks most likely to increase through 2020.

FIGURE 2.1

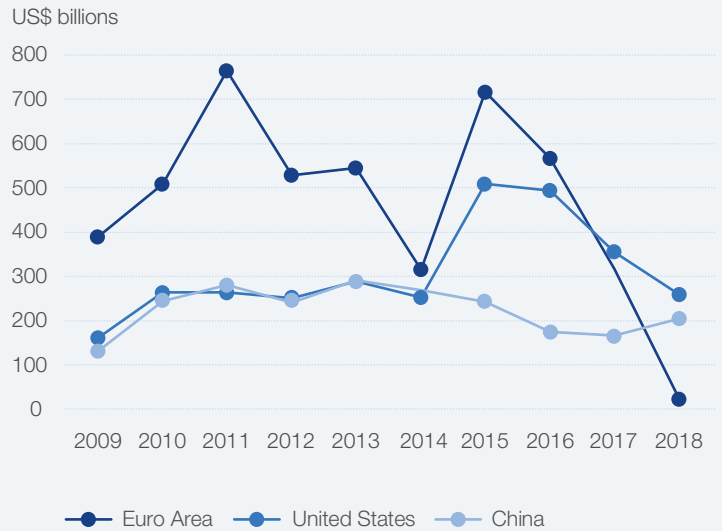
IMF World Output Projections



Source: IMF. 2018 and 2019. *World Economic Outlooks* and quarterly updates.

FIGURE 2.3

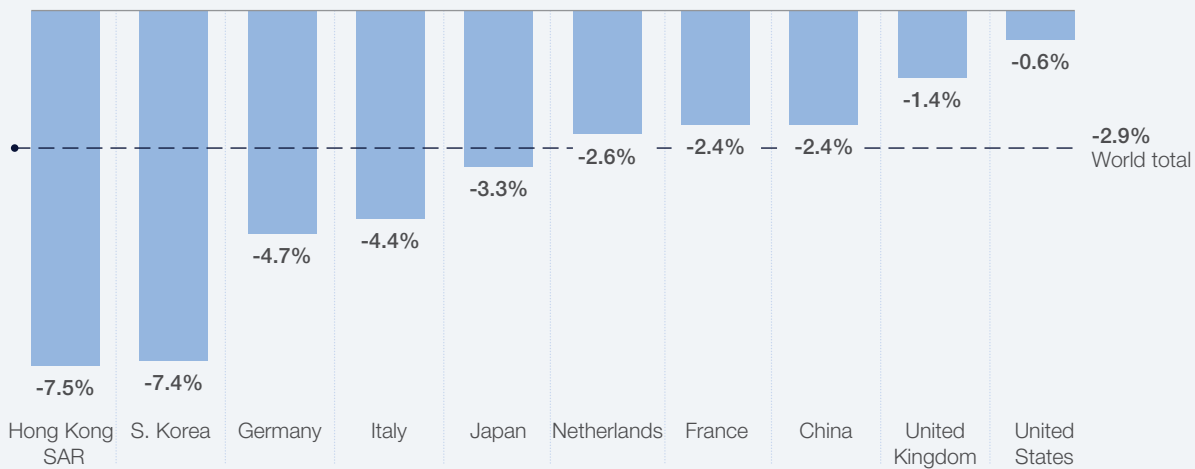
Foreign Direct Investment Net Inflows



Source: World Bank Open Data, <https://data.worldbank.org/indicator/BX.KLT.DINV.CD.WD?end=2018&locations=CN-XC-US&start=2009&view=chart>, accessed 15 December 2019.

FIGURE 2.2

Change in Trade: Q1-Q3 (2018) to Q1-Q3 (2019)



Source: World Economic Forum estimates from WTO data, <https://data.wto.org/>, accessed 8 January 2020.

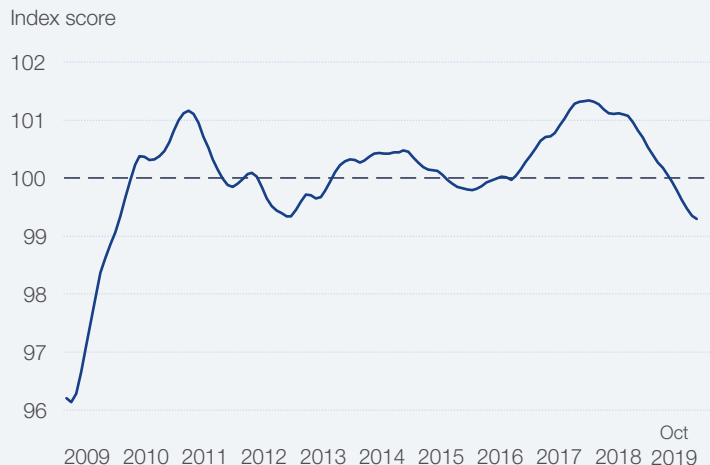
Like global growth, FDI remains lower than it was before the 2008–2009 crisis. It has decreased for the last three years. In 2018, net FDI inflows were down 38% compared to 2017, and less than half of the level they were in 2015.⁷ The sharpest decline has been in the euro area (see Figure 2.3), where less appealing yields, lower production and uncertainty surrounding Brexit have led net FDI inflows to the region to fall to a record low since the euro was adopted in 1999.⁸

Weak confidence

Business confidence, a precursor to investment, has also deteriorated during 2019. The Business confidence index—constructed by the Organisation for Economic Co-operation and Development (OECD) using production data and business sentiment to anticipate future performance—signals that the state of the global economy is expected to worsen in the short term. At the time of writing this report, the index had declined for

FIGURE 2.4

OECD Business Confidence Index



Source: OECD Data, Business confidence index, <https://data.oecd.org/leading/business-confidence-index-bci.htm>, accessed 3 January 2020.

Note: Numbers above 100 suggest an increased confidence in near future business performance, and numbers below 100 indicate pessimism towards future performance.

95%
of GDP: expected
G20 debt in 2024

FIGURE 2.5

G20 General Government Gross Debt



Source: World Economic Forum estimates with data from IMF DataMapper, https://www.imf.org/external/datamapper/GGXWDG_NGDP@WEO/OEMDC/ADVEC/WEOWORLD, accessed 15 December 2019.

14 consecutive months, dropping below the no-change threshold for the first time since 2016 and reaching a 10-year low in October of last year (see Figure 2.4).⁹

High debt

Private and public debt has been accumulating since the crisis. According to the IMF, the global ratio of debt-to-GDP increased by 11 percentage points between 2009 and 2017. Across G20 economies, public debt is expected to reach 90% of GDP in 2019—the highest level on record—and to grow even more, to 95% in 2024 (see Figure 2.5).¹⁰

Private debt has built up on the basis of lower interest rates—particularly in China and the United States, where more than 40% of total private debt is located.¹¹ In the second quarter of 2019, non-financial corporate debt reached 156% of GDP in China.¹² In the United States, non-financial corporate debt reached 47% of GDP in the third quarter—the highest level ever recorded—according to Federal Reserve Bank of St. Louis data.¹³ The IMF has listed “rising corporate debt burdens” as a key vulnerability in the global financial system.¹⁴

Narrow margins for stimuli

As economic warning signs begin to flash, there is a risk that the tools previously used to brake economic slides may no longer be available. Financial market stress and strained public finances are creating uncertainty as to whether conventional monetary and fiscal policy instruments, which have worked to boost growth in the past, could be as effective in the future.

Monetary constraints

As the IMF has signalled, interest rate cuts have helped boost growth, but they have also fostered higher debt and riskier rent-seeking, which affect financial market stability.¹⁵ In 2019, monetary policies worldwide saw profound reversals, with most central banks persistently cutting interest rates to very—sometimes historically—low levels.¹⁶ In the United States, after nine consecutive hikes between 2015 and 2018, the Federal Reserve lowered its target interest rate from 2.50% in December 2018 to 1.75% currently.¹⁷ The European Central Bank (ECB) cut its deposit



rate to a historic low of -0.50% in September 2019.¹⁸ The Bank of Japan's deposit rate has remained at -0.10% since February 2016.¹⁹ Such low rates raise concerns about the soundness of banking systems. The ECB has warned that decreasing profits are challenging Europe's banking sector;²⁰ in the second quarter of 2019, European banks yielded an average return-to-equity of 7.0%,²¹ compared to 12.1% in the United States.²²

The role and reach of monetary policies are also challenged by wider factors such as technological change, climate change and rising inequality. Christine Lagarde, President of the ECB, for example, announced a "strategic review" of the ECB's mandate to preserve price stability to "address the major changes that have taken place over the course of the last 16 years"—when the last such review was conducted.²³

Fiscal constraints

The margin for fiscal stimulus in most of the world's main economies has narrowed, as higher spending has reduced budget coffers. Public debt in 15 of the 20 largest economies

has increased every year since the 2008–2009 crisis.²⁴ Researchers from the ECB analysed four decades worth of data from 17 European countries and concluded that fiscal stimuli may not be effective when public debt is high.²⁵

At the same time, tax rates have increased across G20 economies—their average maximum income tax rate has risen by more than two percentage points since 2009, to 37.7%.²⁶ Lowering tax rates could be a potential stimulus measure, but strong political and social pressure may arise as these monies are often used for public services that attempt to combat inequality.

Higher debt and economic stagnation help to explain why "fiscal crises" are the top-rated risk for businesses globally over the next 10 years—according to our Executive Opinion Survey.²⁷ In the current global context, weak public finances have two implications: they jeopardize whatever remaining margin governments have to address a recession, and they could aggravate already hard-felt social tensions

(see 2019 *Regional Risks for Doing Business* report).²⁸ The world learned from the European sovereign debt crisis that drastic fiscal corrections and public austerity measures can shrink the welfare state with political and social consequences that many governments would be neither willing nor able to incur. However, if the combination of a prolonged economic slowdown and a public finance crisis pressures governments into spending to address citizens' immediate needs, they will be left with little margin for investment to confront the slowdown.

Vulnerable societies

Compounding the economic risk factors that are manifesting is a widespread domestic discontent with current economic systems, perceived to be rigged and unfair.

Recent social upheaval

Concern about inequality underlies recent social unrest on almost every continent, although it may be sparked by different tipping points—such as corruption, constitutional breaches, or the rise in prices for basic goods and services. Although global inequality has declined over the past three decades, domestic income inequality has risen in many countries—particularly in advanced economies—and reached historical highs in some.²⁹ The OECD reports that “income inequality in OECD countries is at its highest level for the past half century.”³⁰ Many of those protesting have long been excluded from their country's wealth and share frustration that the elite have captured gains at the expense of others.

In Chile, for example, a 3% increase in metro fares triggered violent demonstrations, forcing the government



REUTERS/DAMIR SAGOLJ

Economic growth, political will and social stability are fundamental for a model of “stakeholder capitalism”

to change its policy. Chile is one of the fastest growing and most stable Latin American economies, and it is becoming less unequal: its Gini coefficient—the most widely used measure of income inequality—fell from 0.57 in 1990 to 0.47 in 2017. Nonetheless, it still has the second highest Gini coefficient among OECD members, well above the OECD average of 0.32.³¹ In Hong Kong, the recent months-long demonstrations on political issues have also been aggravated by inequality: at 0.54, Hong Kong’s Gini coefficient is at its highest level in 45 years, significantly above those of China (0.39) or the United States (0.42). As Andrew Sheng and Xiao Geng have argued, “a powerful, but oft-ignored factor underlying the frustrations of Hong Kong’s people is inequality.”³²

In Lebanon, where the Gini coefficient is 0.51, nation-wide protests were triggered by the government’s decision to impose a tax on the popular communication app WhatsApp. In Iraq, protests began in October—mostly led by people from the disenfranchised working class and middle-income groups—over issues of corruption, unemployment and demands for access to basic public services.

Economic and political consequences

Inequality hinders growth and damages macroeconomic fundamentals, as the IMF has pointed out: it slows down economic activities and casts doubt on a country’s stability.³³ This damages investor confidence and undermines political capital—both fundamental conditions for prosperity, especially in times of economic volatility. In France, for example, the persistence of the “*gilets jaunes*” movement had caused businesses more than US\$11.4 billion in losses by December 2019 and complicated the government’s plans for economic revival. At the time of writing this report, growth in France was expected to slow from 1.7% in 2018 to 1.3% in 2020.³⁴ The protests in Chile cost businesses over US\$1.4 billion and

forced the government to cancel the Asia-Pacific Economic Cooperation (APEC) and COP25 summits scheduled to take place in Santiago.³⁵ Hong Kong’s economy contracted by 3.2% in the third quarter of 2019, with the Government Economist stating that “local social incidents dealt [it] a very severe blow”.³⁶

The profound political consequences of inequality can also undermine economic growth by making a country harder to govern—in ways ranging from legislative impasses to complete government paralysis. This risk is accentuated by the decentralized and spontaneous nature of recent demonstrations: with pop-up protests, it is difficult for governments to negotiate with demonstrators and develop concrete measures to meet their demands. During 2019, distinctive issues exacerbated by inequality forced the reshuffling of the entire presidential cabinet in Chile and the resignation of the heads of state in Bolivia, Iraq and Lebanon.

According to our expert community, “domestic political polarization” is the second risk most likely to increase in 2020—up from ninth in 2019. Our global business community also ranked “failure of national governance” as the sixth most concerning risk for doing business over the next 10 years.

Stakeholder capitalism

The World Economic Forum has argued since 1970 for the need to consider social well-being alongside economic gains. Unless the global economic system is reformed to be more socially conscious, the twin risks of prolonged slowdown and stronger defiance towards the current economic model will continue to exacerbate each other. Economic growth, political will and social stability will be fundamental to ensure a prompt and smooth transition to a more cohesive and sustainable model of “stakeholder capitalism”.³⁷

Notes

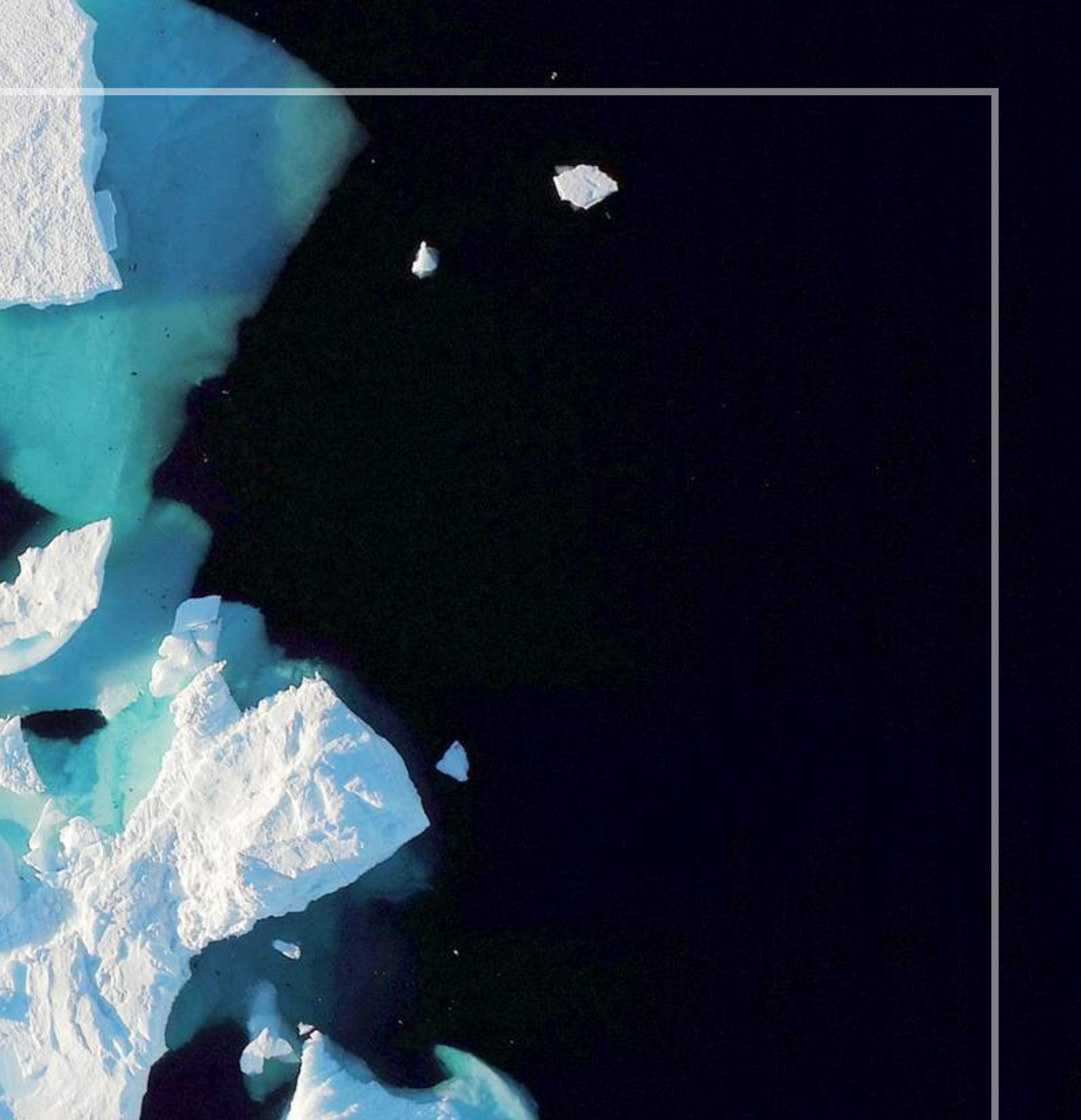
- 1 Gopinath, G. 2019. "The World Economy: Synchronized Slowdown, Precarious Outlook". *IMFBlog* post. 15 October 2019. <https://blogs.imf.org/2019/10/15/the-world-economy-synchronized-slowdown-precious-outlook/>
- 2 OECD Data. Quarterly GDP – Total, Percent change same period, previous year. <https://data.oecd.org/gdp/quarterly-gdp.htm>
- 3 IMF (International Monetary Fund). 2019. *World Economic Outlook, October 2019: Global Manufacturing Downturn, Rising Trade Barriers*. Washington, DC: IMF. <https://www.imf.org/en/Publications/WEO/Issues/2019/10/01/world-economic-outlook-october-2019>
- 4 WTO (World Trade Organization). WTO Data Portal: Total merchandise exports and imports – quarterly (Million US dollar). <https://data.wto.org/>, accessed 07 January 2020.
- 5 WTO (World Trade Organization). *World Trade Statistical Review 2019*. Geneva: WTO. https://www.wto.org/english/res_e/statis_e/wts2019_e/wts19_toc_e.htm
- 6 IMF (International Monetary Fund). 2019. Transcript of International Monetary Fund Managing Director Kristalina Georgieva's Opening Press Conference, 2019 Annual Meetings. 17 October 2019. <https://www.imf.org/en/News/Articles/2019/10/17/tr101719-transcript-managing-director-kristalina-georgieva-press-conference-2019-annual-meetings>
- 7 World Bank Open Data. "Foreign direct investment, net inflows (BoP, current US\$) - Euro area, World, United States, China, Japan." <https://data.worldbank.org/indicator/BX.KLT.DINV.CD.WD?end=2018&locations=XC-1W-US-CN-JP&start=2002>, accessed 15 December 2019.
- 8 Ibid.
- 9 OECD (Organisation for Economic Co-operation and Development). 2019. Business confidence index (BCI). <https://data.oecd.org/leadind/business-confidence-index-bci.htm>, accessed 03 January 2020.
- 10 IMF (International Monetary Fund). 2019. *IMF DataMapper* Database, "General government gross debt – Percent of GDP". https://www.imf.org/external/datamapper/GGXWDG_NGDP@WEO/CHN/FRA/DEU/IND/GBR/USA/JPN/AUS/BRA/CAN/IDN/ITA/KOR/MEX/RUS/SAU/ESP/CHE/NLD/TUR, accessed 15 December 2019.
- 11 Mbaye, S. and M. Moreno Badia. 2019. "New Data on Global Debt". *IMFBlog* post. 02 January 2019. <https://blogs.imf.org/2019/01/02/new-data-on-global-debt/>
- 12 Bloomberg. 2019. "China's Debt Ratio Is Growing as Its Economy Loses Steam". *Bloomberg News*. 16 July 2019. <https://www.bloomberg.com/news/articles/2019-07-16/china-s-debt-growth-keeps-marching-on-as-economy-loses-pace>
- 13 Faria-e-Castro, M. 2019. "Corporate Debt Since the Great Recession". *On the Economy* blog post. 13 August 2019. Federal Reserve Bank of St. Louis. <https://www.stlouisfed.org/on-the-economy/2019/august/corporate-debt-great-recession>
- 14 IMF (International Monetary Fund). 2019. *Global Financial Stability Report: Lower for Longer*. October 2019. <https://www.imf.org/en/Publications/GFSR/Issues/2019/10/01/global-financial-stability-report-october-2019#FullReport>
- 15 Adrian, T. and F. Natalucci. 2019. "Lower for Longer: Rising Vulnerabilities May Put Growth at Risk". *IMFBlog* post. 16 October 2019. <https://blogs.imf.org/2019/10/16/lower-for-longer-rising-vulnerabilities-may-put-growth-at-risk/>
- 16 Bloomberg. Rates & Bonds. <https://www.bloomberg.com/markets/rates-bonds>, accessed 03 January 2020.
- 17 Ibid.
- 18 ECB (European Central Bank). 2019. Interest rates – Deposit facility. Effective from 18 September 2019. <https://www.ecb.europa.eu/home/html/index.en.html>
- 19 Bank of Japan. 2019. The Bank's Market Operations – Interest Rate Applied to the Complementary Deposit Facility. <https://www.boj.or.jp/en/index.htm/>, accessed 15 December 2019.
- 20 ECB (European Central Bank). 2019. "Euro Area Banks: The Profitability Challenge". Keynote speech by Luis de Guindos, Vice-President of the ECB, at the ABI annual conference "Banking Union and Basel III – risk and supervision 2019". 25 June 2019. <https://www.ecb.europa.eu/press/key/date/2019/html/ecb.sp190625~6d33411cff.en.html>
- 21 EBA (European Banking Authority). 2019. "Low Profits and High Costs Remain a Key Challenge for the EU Banking Sector". Press Release, 04 October 2019. <https://eba.europa.eu/low-profits-and-high-costs-remain-a-key-challenge-for-the-eu-banking-sector>

- 22 Federal Reserve Bank of St. Louis. 2019. FRED Economic Data – Return on Average Equity for all U.S. Banks. <https://fred.stlouisfed.org/series/USROE>, accessed 15 December 2019.
- 23 ECB (European Central Bank). 2019. Press Conference. Christine Lagarde, President of the ECB, Luis de Guindos, Vice-President of the ECB. 12 December 2019. <https://www.ecb.europa.eu/press/pressconf/2019/html/ecb.is191212~c9e1a6ab3e.en.html>
- 24 IMF (International Monetary Fund). 2019. 2019. *IMF DataMapper* Database, “General government gross debt – Percent of GDP”. https://www.imf.org/external/datamapper/GGXWDG_NGDP@WEO/CHN/FRA/DEU/IND/GBR/USA/JPN/AUS/BRA/CAN/IDN/ITA/KOR/MEX/RUS/SAU/ESP/CHE/NLD/TUR, accessed 15 December 2019.
- 25 Nickel, C. and A. Tudyka. 2013. “Fiscal Stimulus in Times of High Debt: Reconsidering Multipliers and Twin Deficits”. *European Central Bank Working Paper Series* No. 1513. February 2013. <https://www.ecb.europa.eu/pub/pdf/scpwps/ecbwp1513.pdf?5ad1bf48075ff73ccf045eca21f8d413>
- 26 KPMG. 2019. Individual income tax rates table. <https://home.kpmg/xx/en/home/services/tax/tax-tools-and-resources/tax-rates-online/individual-income-tax-rates-table.html>
- 27 This is the survey that feeds into the Forum’s annual *Global Competitiveness Report*. It was conducted between January and April 2019 and received 12,879 responses.
- 28 World Economic Forum, in partnership with Marsh & McLennan Companies and Zurich Insurance Group. 2019. *Regional Risks for Doing Business Report 2019*. Insight Report. Geneva: World Economic Forum. <https://www.weforum.org/reports/regional-risks-for-doing-business-2019>
- 29 Gaspar, V. and M. Garcia-Escribano. 2017. “Inequality: Fiscal Policy Can Make the Difference”. *IMF Blog* post. 11 October 2017. <https://blogs.imf.org/2017/10/11/inequality-fiscal-policy-can-make-the-difference/>
- 30 OECD (Organisation for Economic Co-operation and Development). 2019. OECD Home, Social and welfare issues: Inequality. <http://www.oecd.org/social/inequality.htm>
- 31 The Gini coefficient scores 0 when income in an economy is equally distributed among every individual, and 1 when held by just one individual. See World Bank. *World Bank Open Data*, “GINI index (World Bank estimate) – Chile”. <https://data.worldbank.org/indicator/SI.POV.GINI?locations=CL>, accessed 15 December 2019.
- 32 Sheng, A. and X. Geng. 2019. “Hong Kong’s Real Problem Is Inequality”. *Project Syndicate*. 27 August 2019. <https://www.project-syndicate.org/commentary/hong-kong-protests-democracy-inequality-housing-by-andrew-sheng-and-xiao-geng-2019-08?barrier=accesspaylog>
- 33 IMF (International Monetary Fund). *IMF Fiscal Monitor: Tackling Inequality*. October 2017. <https://www.imf.org/en/publications/fm/issues/2017/10/05/fiscal-monitor-october-2017>
- 34 Alderman, L. 2018. “Unrest in France Hinders Macron’s Push to Revive Economy”. *The New York Times*. 11 December 2018. <https://www.nytimes.com/2018/12/11/business/france-economy-macron.html>; IMF (International Monetary Fund). *World Economic Outlook, October 2019. Global Manufacturing Downturn, Rising Trade Barriers*. Washington, DC: IMF. <https://www.imf.org/en/Publications/WEO/Issues/2019/10/01/world-economic-outlook-october-2019>
- 35 Vergara, E. 2019. “Chile Protests Resume, Demonstrations Crimp Economic Growth”. *AP News*. 05 November 2019. <https://apnews.com/d42ff6fca3c445a19783f59f984cb5a1>
- 36 Hong Kong Economy – The Government of the Hong Kong Special Administrative Region. 2019. “Economic Situation in the Third Quarter of 2019 and Latest GDP and Price Forecasts for 2019”. Press Release, 15 November 2019. https://www.hkeconomy.gov.hk/en/pdf/19q3_pr.pdf
- 37 Schwab, K. 2019. “What Kind of Capitalism Do We Want?” *Project Syndicate*. 2 December 2019. <https://www.project-syndicate.org/commentary/stakeholder-capitalism-new-metrics-by-klaus-schwab-2019-11>

An aerial photograph showing a large, dark, irregularly shaped area of melting ice or snow. The dark area is surrounded by lighter, textured ice. The overall scene is a stark, high-contrast landscape of melting ice.

A Decade Left

Confronting Runaway
Climate Threat



Geopolitical and economic strains discussed in previous chapters could compromise efforts across many realms, including and especially one in which we simply cannot afford failure: climate change. Indeed, “failure of climate-change mitigation and adaption” is this year’s number one long-term risk by impact and number

two by likelihood, according to survey respondents. This chapter takes stock of the planetary risks of a warming climate and assesses the capacities of government, business and societies to face the urgent and existential challenge of both mitigating and adapting to climate change in the coming decade.

Governments, markets and, in an increasing number of societies, voters are awakening to the urgent realities of climate change—it is striking harder and more rapidly than many expected.¹ The last five years are on track to be the warmest on record.² Climate-related natural disasters such as hurricanes, droughts and wildfires are becoming more intense and more frequent, reportedly now averaging a disaster a week.³ Polar ice is melting more quickly than anticipated,⁴ with drastic implications for sea levels and coastal populations.⁵ Severe weather is worsening: the last year witnessed unprecedented wildfires and devastating storms across the globe,⁶ sea ice loss in the Arctic and record-breaking heatwaves in Europe.

Global temperatures today are slightly over 1°C above pre-industrial levels. On the current trajectory set out in countries' nationally determined contributions (NDCs), which remain largely unchanged in the wake of the most recent UNFCCC Conference of Parties in Madrid in December (COP 25), that figure will rise to at least 3°C by the end of the century.⁷ Because each additional degree of warming will be proportionally more destructive, the damage will accelerate and be exponential. To avoid the most severe economic, social and environmental consequences, climate experts warn that the

temperature rise must be limited to 1.5°C.⁸ This equates to a remaining carbon budget of less than 10 more years of emissions at their current level.⁹

Climate realities

The near-term consequences of climate change add up to a “planetary emergency”.¹⁰ Implications are catastrophic, wide-ranging and intersecting. Worse still, the complexity of the climate system means that some impacts are still unknown. Established risks include:

Loss of life

More and more species are becoming extinct (see Chapter 4, Save the Axolotl). Humans, too, will experience loss of life—but potentially unequally. Women and children are 14 times more likely than men to die during natural disasters, which are likely to intensify or become more frequent because of climate change.¹¹ The elderly and infirm are also at higher risk.¹² Climate change will also lead to increased health spillovers, burdening already stretched health systems, particularly for the poorest and most vulnerable, including in many low- and middle-income countries,¹³ as explored in Chapter 6, False Positive.



REUTERS/DARREN STAPLES

Stress on ecosystems

Oceans are getting warmer, stormier and more acidic, impacting the health of sensitive marine ecosystems such as coral reefs. As glaciers and ice sheets melt, low-lying geographies will flood;¹⁴ indeed, by 2050, three times more people will be impacted than previously thought.¹⁵ This risk was explored in detail in the 2019 *Global Risks Report* chapter Fight or Flight, which examined the intersection of rapid urbanization and rising sea levels. Additionally, a scenario in which ice-cap melt creates disruption to the Gulf Stream could cause further ecosystem disorder, as well as major change in the pattern of severe weather perils. Another significant unknown risk relates to the potential thawing of permafrost—frozen soil around the poles that stores nearly twice as much carbon as the atmosphere currently holds.¹⁶ If the soil thaws, this carbon could be released with unprecedented consequences.

Food and water crises

Crop yields will likely drop in many regions, undermining the ability to double food production by 2050 to meet rising demand. Because agriculture, livestock and deforestation produce nearly a quarter of global emissions, more efficient use of land is critical; it's also one of the best potential carbon sequestration options.¹⁷ Water scarcity will increase as well—it already affects a quarter of the world's population.¹⁸

Increased migration

From 2008 to 2016, over 20 million people a year have been forced from their homes by extreme weather such as floods, storms, wildfires and hotter temperatures.¹⁹ Tropical Cyclone Idai, for example, displaced nearly 150,000 people in March 2019.²⁰ Rising sea levels will increasingly create refugees as people flee low-lying areas. Indeed, defence and intelligence agencies are now regularly warning that climate change could trigger conflicts severe enough to uproot entire populations.

Exacerbation of geopolitical tensions

Countries will face more potential points of contention as climate change reshapes the security of and access to historic common property resources, such as fishing waters.²¹ Melting sea ice could enable new shipping routes through the Arctic, as well as opportunities for natural

resource extraction,²² all of which could cause tension between countries already at odds over unresolved maritime and land boundaries (see Chapter 1, *Global Risks 2020*).²³ According to the UN, water was a major factor in conflict in 45 countries in 2017; disputes between upstream and downstream areas will likely intensify.²⁴ And as transition to a more decentralized, renewable energy economy changes geopolitical equations and creates new vulnerabilities for certain states and regions, states' relative position in the international system will shift as well.²⁵

US\$
165 billion
in worldwide economic stress and damage from natural disasters in 2018

Economic impacts

Worldwide economic stress and damage from natural disasters in 2018 totalled US\$165 billion, and 50% of that total was uninsured.²⁶ A report by federal agencies suggests that, in the United States alone, climate-related economic damage could reach 10% of gross domestic product (GDP) by the end of the century.²⁷ Over 200 of the world's largest firms estimated that climate change would cost them a combined total of nearly US\$1 trillion in the case of non-action. At the same time, there is broad recognition among these same firms that there are significant economic opportunities, provided the right strategies are put in place.²⁸ Countries will also experience losses unequally, with the highest economic costs being felt by large economies, while risk of exposure, death and non-economic costs is higher in smaller, poorer economies.²⁹

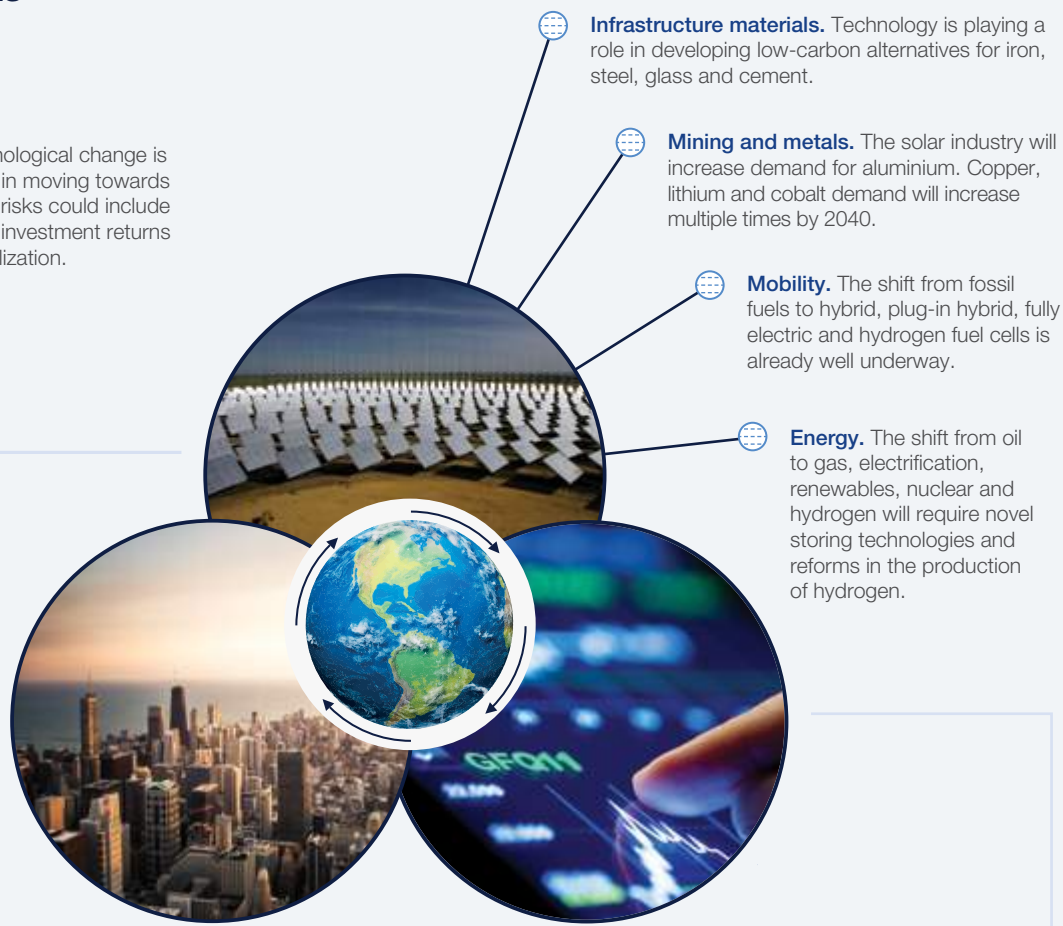
Capital market risks

Central banks increasingly see climate change as a systemic risk to the global capital market and recognize that

Transition Risks

Technological

Across many sectors, technological change is already transformative and, in moving towards lower carbon technologies, risks could include stranding assets, reducing investment returns and reducing market capitalization.



Societal

Transition to a low-carbon economy raises profound issues around the future job market, health and safety, and the broader fate of communities. For both investors and workers, transitioning quickly, effectively and equitably will be this generation's challenge.

Economic

A dramatic shift in the price of carbon—broadly seen as necessary to tackle climate change—implemented in a short time frame without taking into account wider economic and equity issues could be viewed as a politically unpalatable transition risk for many decision-makers. This is particularly the case given economic vulnerabilities already in place such as high debt, negative interest rates, rising income inequalities and elevated geopolitical risks. International initiatives such as the Carbon Pricing Leaders Coalition and national bi-partisan coalitions like the Climate Leadership Council in the United States are working on practical solutions—such as reallocating dividends from carbon pricing and adjusting border taxes—to these challenges. More comprehensive transition policy packages, which recognize these economic transition risks, such as the European Green New Deal, are also being explored.

PHOTOS: REUTERS/MARCELO DEL POZO; WORAPUT/GETTY IMAGES; KEVIN YOUNG/UNSPASH

non-action is not an option.³⁰ More common extreme weather events could make insurance unaffordable or simply unavailable for individuals and businesses:³¹ globally, the “catastrophe protection gap”—what should be insured but is not—reached US\$280 billion in 2018.³² The transition to a low-carbon economy also creates potential challenges that will need to be managed. For example, action to reduce emissions could turn approximately 30% of

current oil reserves, 50% of gas reserves and 80% of coal reserves into stranded assets for extractive companies and their investors (see Box 3.1).³³ Pension funds may face catastrophic shortfalls as industries consolidate and transition.³⁴ Climate risk may also cause disruption to the mortgage market, particularly in vulnerable regions such as Florida where 30-year mortgages could default *en masse* if homes become uninsurable over time.³⁵

Trade, labour and supply chain disruption

Climate change will affect trade by distorting prices and disrupting supply chains.³⁶ For example, with the Arctic sea ice melting at a record pace, a northern route through once-impassable waters has “emerged as a potential global shipping artery.”³⁷ Shifts in seasonable temperature and rainfall will place particular stress on economies reliant on agricultural output,³⁸ creating new winners and losers in the trade sphere.³⁹ The labour force will experience impacts as well, and not only in the structural transition to a low-carbon economy: for example, heat stress resulting from global warming is projected to cause productivity losses equal to 80 million full-time jobs in 2030.⁴⁰

At a crossroads

For the future of climate change mitigation, 2020 is a critical year: it presents the first opportunity for nations to revise their national plans to tackle climate change as set out under the 2015 Paris Climate Agreement, and to close the gap between what they have pledged and what is needed. An increasing number of governments are announcing long-term net-zero emissions goals and showing more interest in tackling outstanding challenges in developing potential low-carbon solutions. These include creating a low-carbon hydrogen supply chain at scale; reducing emissions through carbon capture, use and storage; managing the intermittency of renewables with grid-scale storage solutions; electrifying domestic and commercial heating; better recycling of electric car batteries; and mapping out the future availability of the raw materials needed to support the transition.

Nonetheless, achieving significant change in the near term will depend on greater commitment from major emitters. Failure to seize 2020’s opportunity to mitigate climate change will have three main consequences.

First, transition risks will increase (Box 3.1). Further delay in reducing emissions will make it harder to achieve carbon budget goals: companies and markets will ultimately be forced to adjust more rapidly, which could lead to higher costs, greater economic

disruptions, or draconian interventions from panicked policy-makers that imperil macroeconomic and financial stability. Communities will also suffer if jobs are lost without well-thought-through and equitable transition plans in place.

Over 40 central banks and supervisors are already examining how climate risks can be integrated into their economic and financial activities.⁴¹ The Bank of England has warned that corporations in incumbent “dirty” industries can expect to go bankrupt if they fail to understand the risk of their business models becoming obsolete as investment flees to net-zero-emission alternatives.⁴² The Financial Stability Board’s Taskforce on Climate-related Financial Disclosures announced recommendations in 2017 that have driven boardroom discussions regarding financial exposures and transition strategies.⁴³ Now supported by almost 900 companies, assessing financial risk of climate change is becoming more mainstreamed.⁴⁴ Governments are also moving towards mandatory disclosure of climate risks by listed companies.⁴⁵ The investor community is also responding to climate risk, with a recent notable development being the launch of the UN-convened Net Zero Asset Owners Alliance at the 2019 United Nations Climate Action Summit.⁴⁶

Climate change is striking harder and more rapidly than many expected

Second, the risk of unilateral geoengineering gambles will become more likely. Failure to implement effective regional or global climate policies increases the risk that countries may decide unilaterally to implement geoengineering projects such as ocean fertilization or stratospheric aerosol injection. This would risk further disruption to ecosystems: one recent study, for example, found that stratospheric sulphate aerosols could harm agricultural production, cancelling out benefits from the reduction in warming.⁴⁷

And lastly, and perhaps most vital, is the risk that the specific multilateral process mandated to address climate change loses momentum and action on climate stalls. For example, the recent failure at COP25 to develop a rule book for a new global carbon market means there is not yet a credible system that would allow countries to pay each other for projects that reduce emissions. The risk here is not simply that we lose an unaffordable five years, but that the perception of failure drains more political support from the multilateral process and undermines the prospects for future progress. However, encouraging steps are already being taken by various new geometries of governments, companies, investors, sub-national entities and civil society working together on key areas of climate action, such as the energy and industry transition, the mobilization of finance and agriculture, and nature-based solutions. These multistakeholder efforts to advance climate action, as highlighted at the 2019 UN Climate Action Summit, are becoming an increasingly important component of the international response. They are also

helpful mechanisms to bolster political confidence that climate change can be successfully tackled.

Can societies deliver?

Climate and corresponding economic risks threaten a 2008-style systemic collapse,⁴⁸ unless net human-caused carbon dioxide (CO₂) emissions fall by 50% by 2030 relative to 2010, and to net zero by 2050. Reaching these targets will require serious, interconnected economic and societal transitions at macro and micro levels that depend on technological innovation and commitment from governments and businesses. So far, however, commitments are inadequate given the urgency of the challenge and current trends are not encouraging.

Most critically, demand for energy is continuing to increase and much of this demand is still being met by fossil fuels. Global energy demand rose by 2.3% in 2018, the fastest pace in a decade.⁴⁹ China, the United States and India account for nearly 70% of the rise. Energy demand is expected to grow even further—by over 25% by 2040—driven by population growth, increasing incomes and urbanization: in developing economies, 1.7 billion people are expected to move to urban areas in the next two decades.⁵⁰

There is a clear tension between calls to green society and the drive, particularly in emerging markets, to boost economic growth through investment in carbon-heavy projects such as roads, dams, energy resources, mines and ports. For example, coal power plants built in Asia in the last decade accounted for nearly one-third of the total increase in CO₂ emissions in 2018.⁵¹ Global annual subsidies for fossil fuels are approximately double those for renewable power.⁵²

Beyond power generation, shifts in patterns of land use and how we manage our global food systems are also needed to reduce carbon emissions: agriculture, deforestation and wetlands development contribute 23% of all human-caused greenhouse gases.⁵³ Many current food and land use investment portfolios are often not consistent with delivering even a warming scenario.⁵⁴ Transitioning our carbon-based global



REUTERS/SEAN GARDNER

agriculture system to practices such as regenerative farming would require radical shifts in subsidies and investment. Similarly, about 10% of global emissions comes from the very high heat levels required to produce commodities—such as cement, steel and petrochemicals—and, although low-carbon alternatives do exist, they are currently costly.⁵⁵ New public-private initiatives such as the Mission Possible Platform, launched at the UN Climate Action Summit in September 2019, are designed to help heavy industry sectors achieve net-zero emissions by mid-century through collaboration with governments, international organizations and investors.

Although there are financing roadmaps for green energy, there are serious financing gaps for overall plans to mitigate and adapt to climate change. The UN estimates that, to meet 2030 goals for adaptation, developing countries will need US\$140 to US\$300 billion annually—much higher than currently available adaptation financing.⁵⁶ Moreover, investments in climate-related activities largely stay within wealthy nations' borders.⁵⁷ Only 49 developing countries have quantifiable climate-financing targets, and few of them look further than 2020, rendering them largely irrelevant to climate risks beyond this horizon.⁵⁸

Aside from a number of vanguard first-mover champions, most companies, too, appear ill-equipped to address climate risk. Many do not yet quantify physical climate risks in their direct operations and supply chains, and those that do are likely to be underestimating them significantly.⁵⁹ In the World Economic Forum's survey of business leaders, none of the top 10 risks globally are environmental, suggesting a critical blind spot.⁶⁰ On the other hand, those business leaders who are more exposed to climate change discussions among their peers become more aware of climate risks and thus become more likely to act. For example, industry partners of the World Economic Forum ranked environmental risks higher than business leaders surveyed more broadly.⁶¹ This awareness and concern for environmental risks is also likely influenced by other business organizations that focus on helping their members tackle climate and other related issues, demonstrating the importance of these networks and

organizations.⁶² Overall, lack of consistent awareness-raising among business leaders may create first-mover advantages for some, but it also potentially demonstrates the much more concerning overarching risk: that many businesses may not be planning for the physical and financial risks that climate change may have on their activities and across their value chains.

2.3% increase in global energy demand in 2018

Consequently, businesses may also struggle to anticipate future shifts in government policy and customer preferences in time to align their strategy—for example, the rapid rise in consumer demand for non-plastic packaging took companies by surprise. Increasing pressure to respond is generating transition risk at the individual company level as each company needs to reassess assets, reconcile trade-offs and develop new capabilities to move towards a more sustainable model. At the same time, there is growing acknowledgement among some critical financial-sector players that environmental risks could threaten the broader economic outlook, which could be a sign of more positive shifts moving forward.⁶³

A green social contract

Concern about climate change is increasing,⁶⁴ particularly among young people, and this could alter the paths societies take in confronting the challenge. Political winds are shifting: in 2019 climate change underpinned the Greens' surge in the European Parliament elections;⁶⁵ it also emerged as a key policy issue in the US Democratic presidential primaries and in elections in Australia, Canada and Switzerland.⁶⁶ Most recently, the European Commission, led by President Ursula von der Leyen, announced a broad set of plans—the “European Green Deal”—that is intended to re-evaluate the European economy in light of environmental risks.⁶⁷ Climate activism also increased in 2019. The non-violent civil disobedience

Alongside the risks, the next decade brings tremendous opportunity

movement Extinction Rebellion became more mainstream, with groups forming in 72 countries.⁶⁸ More remarkably, millions of schoolchildren participated in organized “climate strikes”.⁶⁹

In the long term, the mobilization of youth could lead to a new green social contract reordering political and business life, as today’s striking children gradually become tomorrow’s voters, workers, investors and consumers. Politicians will seek to attract them through policies such as the Green New Deal legislation that has been proposed in the United States. As today’s youth demand jobs that are compatible with their concern about climate change, workforce climate activism may become more common,⁷⁰ and companies without strong environmental credentials could struggle for talent.⁷¹ Lastly, as consumers, the new generation of climate

crusaders will make more sustainable lifestyle choices, such as eating plant-based diets or flying less, and demand more low-carbon goods.⁷²

In the short term, however, many current voters may be unwilling to support transition policies: in an age of economic anxiety and uncertainty, there is also concern about the implications for cost of living, jobs and the competitiveness of high-carbon sectors. This concern may pitch voters against climate action or make their support for climate policies ambiguous. For example, polling before Canada’s election found that many voters who identified climate change as a key concern were nevertheless reluctant to bear any cost to tackle it.⁷³ And Australia’s “climate change election”—which took place before the recent wildfires—resulted in an unexpected victory for a coalition opposed to aggressive action.⁷⁴

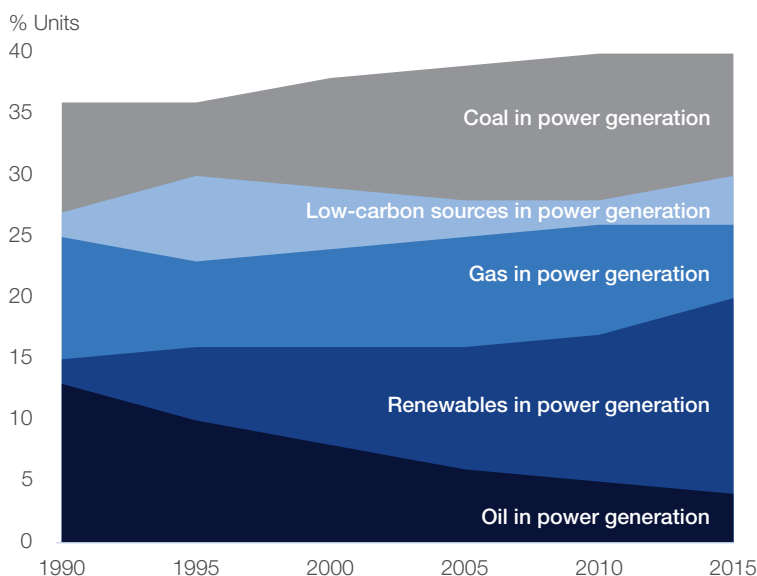
New political and social dynamics (or events such as dramatic natural disasters that can be climate-related) may be making available the policy space to embark on the radical trajectory needed to mitigate drastic warming. But building broad-based support for climate policies that can meet the Paris Agreement’s goals will require convincing voters that a just transition is possible. Policies that provide for social protection programmes and job training could help to limit disruption and exacerbation of socio-economic inequalities in the transition to a low-carbon economy.

The resilience decade

The next 10 years will shape the outlook for climate risk for the rest of the century. To avoid the worst consequences, global emissions need to peak almost immediately and decline precipitously—by 7.6% each year between 2020 and 2030.⁷⁵ This implies an additional US\$460 billion a year of clean energy investment over the next

FIGURE 3.1

Share of Renewables, Low-Carbon Sources and Fossil Fuels in Power Generation, World 1990–2015



Source: IEA. Data and statistics, “Energy Transitions Indicators”, <https://www.iea.org/data-and-statistics>

decade.⁷⁶ Far-reaching policies will be needed to transform industrial processes, transport, agriculture and land-use, alongside changes in consumer behaviours to scale the necessary critical solutions.⁷⁷

As policies shift and societies transition, options must be assessed holistically because disorderly transition could potentially exacerbate impacts with short-sighted responses. For example, materials needed for low-carbon technologies such as nickel, copper, cobalt and manganese could be mined from the seabed—but the impacts of deep-sea mining on ecosystems and ocean health could offset its benefits.⁷⁸ Likewise, the deployment of bioenergy with carbon capture and storage could require up to 700 mega hectares (an area twice the size of India) for bioenergy crops by the end of the century⁷⁹—and at a time when the global population may have reached nearly 11 billion people. Converting such large swaths of land to monocultures has clear consequences for food production and nature. Geopolitical relationships will shift as trade in fossil fuels becomes less economically important.

Alongside the risks, the next decade brings tremendous opportunity; technological breakthroughs are happening all the time. For example, most recently, a start-up announced it had developed a way to harness artificial intelligence and mirrors reflecting the sun to create the extreme heat required for industrial processes—a potential game-changer for the source of around 10% of global emissions each year.⁸⁰ Clean energy is increasing (see Figure 3.1) while also getting cheaper and creating jobs. The cost per unit of electricity from onshore wind and photovoltaic solar power plants has dropped by about 70% and 90% respectively over the last decade.⁸¹ In most countries, it is now cheaper to install new wind or solar power stations than new coal power plants.⁸² The International Renewable Energy Agency estimates that shifting to renewables could grow the world economy by 1% a year until 2050, a cumulative gain of over US\$52 trillion (see Figure 3.1).⁸³ Other industries, such as agriculture through regenerative growing practices, and food production through meat alternatives, carry still-untapped potential.



REUTERS/CRACK PALINGGI

New political and social dynamics may now also be creating the policy space available to embark on the radical trajectory needed to mitigate drastic warming. At the same time, adaptation needs to be given urgent priority, not only to prepare for the possibility of very dangerous levels of climate change in the future, but also to eliminate the resilience deficit we face today. A series of important initiatives—such as the report from the Global Commission for Adaptation, the Coalition for Climate Resilient Investment, and the Just Rural Transition—were launched in 2019 at the UN Climate Action Summit as a package of measures on resilience.⁸⁴ These initiatives aim to ensure infrastructure investment, spark innovation on adaptation and set out a principles for a just transition, among other goals.

The 2020s—the decade of delivery for the Sustainable Development Goals—needs to also be the resilience decade for climate. Concerted action is required not only to reduce emissions, but also to develop credible adaptation strategies, including climate-proofing infrastructure, closing the insurance protection gap and scaling up public and private adaptation finance. This will require governments and businesses to identify and prioritize risks and develop metrics and strategies to manage them.⁸⁵

Notes

- Oreskes, N., M. Oppenheimer and D. Jamieson. 2019. "Scientists Have Been Underestimating the Pace of Climate Change: A Book Entitled *Discerning Experts* Explains Why—and What Can Be Done about It". *Scientific American*. 19 August 2019. <https://blogs.scientificamerican.com/observations/scientists-have-been-underestimating-the-pace-of-climate-change/>
- Schwartz, J. and N. Popovich. 2019. "It's Official: 2018 Was the Fourth-Warmest Year on Record". *The New York Times*. 06 February 2019. <https://www.nytimes.com/interactive/2019/02/06/climate/fourth-hottest-year.html>; Kaufman, M. 2019. "All the Ways Climate Change Has Impacted Earth in 2019 (So Far)". *Mashable*. 16 March 2019. <https://mashable.com/article/climate-change-2019-list/>
- Harvey, F. 2019. "One Climate Crisis Disaster Happening Every Week, UN Warns". *The Guardian*. 07 July 2019. <https://www.theguardian.com/environment/2019/jul/07/one-climate-crisis-disaster-happening-every-week-un-warns>
- The Economist. 2019. "The Greenland Ice Sheet Is Melting Unusually Fast". *The Economist*. 17 July 2019. https://www.economist.com/graphic-detail/2019/06/17/the-greenland-ice-sheet-is-melting-unusually-fast?fsrc=gp_en?fsrc=scn/tw/te/bl/ed/thegreenlandicesheetismeltingunusuallyfastdailychart
- Kulp, S. A. and B. H. Strauss. 2019. "New Elevation Data Triple Estimates of Global Vulnerability to Sea-Level Rise and Coastal Flooding". *Nature Communications*. 10 (4844). 29 October 2019. <https://www.nature.com/articles/s41467-019-12808-z>; McGrath, M. 2019. "Climate Change: Global Impacts 'Accelerating' – WMO". *BBC News*. 28 March 2019. <https://www.bbc.com/news/science-environment-47723577>
- Marsh & McLennan. 2019. *The Burning Issue: Managing Wildfire Risk*. <https://www.mmc.com/insights/publications/2019/oct/wildfire-paper--oct--2019-.html>
- UNEP (United Nations Environment Programme). 2019. *Emissions Gap Report 2019*. Nairobi: UNEP. <https://wedocs.unep.org/bitstream/handle/20.500.11822/30797/EGR2019.pdf?sequence=1&isAllowed=y>
- IPCC (Intergovernmental Panel on Climate Change). 2018. Summary for Policymakers. In *Global Warming of 1.5°C: An IPCC Special Report*. Geneva: *World Meteorological Organization*. https://www.ipcc.ch/site/assets/uploads/sites/2/2018/07/SR15_SPM_version_stand_alone_LR.pdf; <https://www.ipcc.ch/sr15/>
- In 2018, the IPCC estimated the remaining carbon budget for a 66% chance of avoiding 1.5°C of temperature rise was 420 gigatonnes of CO₂—about 10 times global annual CO₂ emissions from fossil fuels and land-use change. See McSweeney, R. and R. Pearce. 2017. "Analysis: Just Four Years Left of the 1.5C Carbon Budget". *Carbon Countdown*. *Carbon Brief*. 05 April 2017. <https://www.carbonbrief.org/analysis-four-years-left-one-point-five-carbon-budget>
- The Club of Rome. 2019. "Nations Should Declare a Planetary Emergency Says Club of Rome". The Club of Rome. 24 September 2019. <https://www.clubofrome.org/2019/09/24/nations-should-declare-a-planetary-emergency-says-club-of-rome/>; see also Club of Rome. 2019. "Planetary Emergency Plan". <https://www.clubofrome.org/2019/09/23/planetary-emergency-plan/>
- UNDP (United Nations Development Programme). 2013. New York: "Gender and Disaster Risk Reduction". *Gender and Climate Change: Asia and the Pacific Policy Brief 3*. UNDP. <https://www.undp.org/content/dam/undp/library/gender/Gender%20and%20Environment/PB3-AP-Gender-and-disaster-risk-reduction.pdf>
- Christensen, J. 2019. "250,000 Deaths a Year from Climate Change Is a 'Conservative Estimate,' Research Says". *CNN Health*. 16 January 2019. <https://edition.cnn.com/2019/01/16/health/climate-change-health-emergency-study/index.html>
- Ebi, K. L., J. J. Hess and P. Watkiss. 2017. "Chapter 8: Health Risks and Costs of Climate Variability and Change". In *Injury Prevention and Environmental Health, 3rd edition*, edited by C. N. Mock, R. Nugent, O. Kobusingye and K. R. Smith. Washington, DC: International Bank for Reconstruction and Development/World Bank. <https://www.ncbi.nlm.nih.gov/books/NBK525226/>
- IPCC (Intergovernmental Panel on Climate Change). 2019. *Special Report on the Ocean and Cryosphere in a Changing Climate*. IPCC. <https://www.ipcc.ch/srocc/home/>
- Kulp and Strauss. 2019. Op. cit.
- Woods Hole Research Center. 2019. "Study: Winter Carbon Emissions Shifting Permafrost Region to a Carbon Source". Post. 21 October 2019. <https://whrc.org/study-winter-carbon-emissions-shifting-permafrost-region-to-a-carbon-source/>

- 17 IPCC (Intergovernmental Panel on Climate Change). 2019. *Special Report on Climate Change and Land*. IPCC. <https://www.ipcc.ch/report/srccl/>; Seddon, N. S. Sengupta, M. García-Espinosa, I. Hauler, D. Herr and A. R. Rizvi. 2019. *Nature-Based Solutions in Nationally Determined Contributions: Synthesis and Recommendations for Enhancing Climate Ambition and Action by 2020*. Gland, Switzerland and Oxford, UK: IUCN and University of Oxford. <http://4fqbik-2blqkb1nrebde8yxqj-wpengine.netdna-ssl.com/wp-content/uploads/2019/10/International-Union-for-Conservation-of-Nature-IUCN-and-Oxford-University.pdf>
- 18 World Resources Institute. 2019. "RELEASE: Update Global Water Risk Atlas Reveals Top Water-Stressed Countries and States". Press Release, 06 August 2019. <https://www.wri.org/news/2019/08/release-updated-global-water-risk-atlas-reveals-top-water-stressed-countries-and-states>
- 19 UNHCR (The UN Refugee Agency). 2016. "Frequently Asked Questions on Climate Change and Disaster Displacement". 6 November 2016. <https://www.unhcr.org/en-us/news/latest/2016/11/581f52dc4/frequently-asked-questions-climate-change-disaster-displacement.html>
- 20 UNHCR (The UN Refugee Agency). 2019. UNHCR Mozambique – Factsheet: Cyclone IDAI, May 2019. 19 May 2019. <https://reliefweb.int/report/mozambique/unhcr-mozambique-factsheet-cyclone-idai-may-2019>
- 21 Lanteigne, M. 2019. "The Changing Shape of Arctic Security". *NATO Review*. 28 June 2019. <https://www.nato.int/docu/review/2019/AI-so-in-2019/the-changing-shape-of-arctic-security/EN/index.htm>
- 22 The Economist. 2019. "Why Russia Is Ambivalent about Global Warming". *The Economist*. 19 September 2010. <https://www.economist.com/europe/2019/09/19/why-russia-is-ambivalent-about-global-warming>
- 23 Dellink, R., H. Hwang, E. Lanzi and J. Chateau. 2017. "International Trade Consequences of Climate Change". *OECD Trade and Environment Working Papers* 2017/01. Paris: OECD Publishing. <http://www.fao.org/3/a-bu414e.pdf>
- 24 Brosig, M., P. Frawley, A. Hill, M. Jahn, M. Marsicek, A. Paris, M. Rose, A. Shambaljamts and N. Thomas. 2019. *Implications of Climate Change for the U.S. Army*. United States Army War College. https://climateand-security.files.wordpress.com/2019/07/implications-of-climate-change-for-us-army-army-war-college_2019.pdf
- 25 IRENA (International Renewable Energy Agency). 2019. *A New World: The Geopolitics of the Energy Transformation*. IRENA. http://geopoliticsofrenewables.org/assets/geopolitics/Reports/wp-content/uploads/2019/01/Global_commission_renewable_energy_2019.pdf
- 26 Swiss Re Institute. 2019. "Nature Catastrophes and Man-Made Disasters in 2018: 'Secondary' Perils on the Frontline". https://www.swissre.com/dam/jcr:c37eb0e4-c0b9-4a9f-9954-3d0bb4339bfd/sigma2_2019_en.pdf
- 27 NCA (National Climate Assessment). 2018. *Fourth National Climate Assessment. Volume II: Impacts, Risks, and Adaptation in the United States*. NCA. <https://nca2018.global-change.gov/>
- 28 Green, M. 2019. "World's Biggest Firms Foresee \$1 Trillion Climate Cost Hit". Reuters. 04 June 2019. <https://www.reuters.com/article/us-climate-change-companies-disclosure/worlds-biggest-firms-foresee-1-trillion-climate-cost-hit-idUSKCN1T50CF>
- 29 Ricke, K., L. Drouet, K. Caldeira and M. Tavoni. 2018 (correction 25 March 2019). "Country-Level Social Cost of Carbon". *Nature Climate Change* 8 (2018): 895–900. <https://www.nature.com/articles/s41558-018-0282-y>; UNISDR (United Nations Office for Disaster Risk Reduction). 2018. *Economic Losses, Poverty & Disasters (1998-2017)*. https://www.preventionweb.net/files/61119_credeconomiclosses.pdf
- 30 Bank of England. 2019. "Open Letter on Climate-Related Financial Risks". *Bank of England News*. 17 April 2019. <https://www.bankofengland.co.uk/news/2019/april/open-letter-on-climate-related-financial-risks>
- 31 Nelson, A. 2019. "Climate Change Could Make Insurance Too Expensive for Most People – Report". *The Guardian*. 21 March 2019. <https://www.theguardian.com/environment/2019/mar/21/climate-change-could-make-insurance-too-expensive-for-ordinary-people-report>; Rudolph, M. J. 2019. *12th Annual Survey of Emerging Risks: Key Findings*. Canadian Institute of Actuaries, Casualty Actuarial Society, and Society of Actuaries, March 2019. <https://www.soa.org/globalassets/assets/files/resources/research-report/2019/12th-emerging-risk-survey.pdf>
- 32 Bevere, L. 2019. Sigma 2/2019: Secondary Natural Catastrophe Risks on the Front Line. 10 April 2019. Swiss Re Institute. <https://www.swissre.com/institute/research/sigma-research/sigma-2019-02.html>

- 33 McGlade, C. and P. Ekins. 2015. "The Geographical Distribution of Fossil Fuels Unused When Limiting Global Warming to 2°C". *Nature* 517 (2015): 187–90. <https://www.nature.com/articles/nature14016>
- 34 Conway, M. 2019. "Developing and Implementing Just Transition Policies". Expert Perspectives. World Resources Institute. <https://www.wri.org/climate/expert-perspective/developing-and-implementing-just-transition-policies>
- 35 Flavelle, C. 2019. "Climate Risk in the Housing Market Has Echoes of Subprime Crisis, Study Finds". *The New York Times*. 27 September 2019, Updated 30 September 2019. <https://www.nytimes.com/2019/09/27/climate/mortgage-climate-risk.html>
- 36 Dellink et al. 2017. Op. cit.
- 37 *The Economist* 2019. Op. cit.
- 38 Lafakis, C., L. Ratz, E. Fazio and M. Cosma. 2019. "The Economic Implications of Climate Change". *Moody's Analytics*. June 2019. <https://www.moodyanalytics.com/-/media/article/2019/economic-implications-of-climate-change.pdf>
- 39 Dellink et al. 2017. Op. cit.
- 40 ILO (International Labour Organization). 2019. "Increase in Heat Stress Predicted to Bring Productivity Loss Equivalent to 80 Million Jobs". *ILO News Report*, 01 July 2019. https://www.ilo.org/global/about-the-ilo/newsroom/news/WCMS_711917/lang--en/index.htm
- 41 NGFS (Network for Greening the Financial System). No date. Membership list. <https://www.ngfs.net/en/about-us/membership>
- 42 Carrington, D. 2019. "Firms Ignoring Climate Crisis Will Go Bankrupt, Says Mark Carney". *The Guardian*. 13 October 2019. <https://www.theguardian.com/environment/2019/oct/13/firms-ignoring-climate-crisis-bankrupt-mark-carney-bank-england-governor>
- 43 TCFD (Task Force on Climate-Related Financial Disclosures). 2017. *Recommendations of the Task Force on Climate-Related Financial Disclosures: Final Report*. <https://www.fsb-tcfd.org/wp-content/uploads/2017/06/FINAL-TCFD-Report-062817.pdf>
- 44 TCFD (Task Force on Climate-Related Financial Disclosures). TCFD Supporters. <https://www.fsb-tcfd.org/tcfd-supporters/>; World Economic Forum, in collaboration with PwC. 2019. *How to Set Up Effective Climate Governance on Corporate Boards Guiding Principles and Questions*. Geneva: World Economic Forum. http://www3.weforum.org/docs/WEF_Creating_effective_climate_governance_on_corporate_boards.pdf; Inman, P. 2019. "Corporations Told to Draw Up Climate Rules or Have Them Imposed". *The Guardian*. 08 October 2019. <https://www.theguardian.com/business/2019/oct/08/corporations-told-to-draw-up-climate-rules-or-have-them-imposed>
- 45 Robinson, N. 2019., "Are We Headed towards Mandatory Climate Disclosure?" CDSB (Climate Disclosure Standards Board) Blog, 01 August 2019. <https://www.cdsb.net/mandatory-reporting/947/are-we-headed-towards-mandatory-climate-disclosure>
- 46 UNEP (United Nations Environment Programme) Finance Initiative. 2019. United Nations-convened Net-Zero Asset Owner Alliance. <https://www.unepfi.org/net-zero-alliance/>
- 47 Proctor, J., S. Hsiang, J. Burney, M. Burke and W. Schlenker. 2018. "Estimating Global Agriculture Effects of Geoengineering Using Volcanic Eruptions". *Nature* 560 (2018): 480–83. <https://www.nature.com/articles/s41586-018-0417-3>
- 48 Watts, J. 2019. "Climate and Economic Risks 'Threaten 2008-Style Systemic Collapse'". *The Guardian*. 12 February 2019. <https://www.theguardian.com/environment/2019/feb/12/climate-and-economic-risks-threaten-2008-style-systemic-collapse>
- 49 IEA (International Energy Agency). 2019. "Global Energy Demand Rose by 2.3% in 2018, Its Fastest Pace in the Last Decade". *IEA News*, 26 March 2019, Updated 28 March 2019. <https://www.iea.org/newsroom/news/2019/march/global-energy-demand-rose-by-23-in-2018-its-fastest-pace-in-the-last-decade.html>
- 50 OECD/IEA (Organisation for Economic Co-operation and Development/International Energy Agency). 2018. *World Energy Outlook 2018: Executive Summary*. <https://webstore.iea.org/download/summary/190?fileName=English-WEO-2018-ES.pdf>
- 51 The Business Times. 2019. "China Firms Funding Coal Plants Offshore as Domestic Curbs Bite: Study". *The Business Times*. 22 January 2019. <https://www.businesstimes.com.sg/energy-commodities/china-firms-funding-coal-plants-offshore-as-domestic-curbs-bite-study>; Hanada, Y., Y. Ohira and Y. Fukumoto. 2019. "Cheap Coal Swells in Southeast Asia, Foiling Global Green Push". *Nikkei Asian Review*. 06 April 2019. <https://asia.nikkei.com/Business/Energy/Cheap-coal-swells-in-Southeast-Asia-foiling-global-green-push>

- 52 Matsumura, W. and Z. Adam. "Fossil Fuel Consumption Subsidies Bounced Back Strongly in 2018". IEA Commentary. <https://www.iea.org/commentaries/fossil-fuel-consumption-subsidies-bounced-back-strongly-in-2018>
- 53 Smith P., M. Bustamante, H. Ahammad, H. Clark and F. Tubiello. 2014. "Agriculture, Forestry and Other Land Use (AFOLU)". In *Climate Change 2014: Mitigation of Climate Change*. Contribution of Working Group III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change [Edenhofer, O., R. Pichs-Madruga, Y. Sokona, E. Farahani, S. Kadner, K. Seyboth, A. Adler, I. Baum, S. Brunner, P. Eickemeier, B. Kriemann, J. Savolainen, S. Schlömer, C. von Stechow, T. Zwickel and J.C. Minx (eds.)]. Cambridge, UK and New York: Cambridge University Press. https://www.ipcc.ch/site/assets/uploads/2018/02/ipcc_wg3_ar5_chapter11.pdf
- 54 FOLU (The Food and Land Use Coalition). 2019. *Growing Better: Ten Critical Transitions to Transform Food and Land Use*. FOLU. <https://www.foodandlandusecoalition.org/global-report/>
- 55 Roberts, D. 2019. "This Climate Problem Is Bigger than Cars and Much Harder to Solve". *Vox*. 10 October 2019. <https://www.vox.com/energy-and-environment/2019/10/10/20904213/climate-change-steel-cement-industrial-heat-hydrogen-ccs>
- 56 UNEP (United Nations Environment Programme). 2018. *The Adaptation Gap Report 2018: Health*. UNEP. https://wedocs.unep.org/bitstream/handle/20.500.11822/27114/AGR_2018.pdf?sequence=3
- 57 Yeo, S. 2019. "Where Climate Cash Is Flowing and Why It's Not Enough". *Nature*. 17 September 2019. <https://www.nature.com/articles/d41586-019-02712-3>
- 58 UNEP. 2018. *The Adaptation Gap Report 2018: Health*. Op. cit.
- 59 Goldstein, A., W. R. Turner, J. Gladstone and D. G. Hole. 2019. "The Private Sector's Climate Change Risk and Adaptation Blind Spots". *Nature Climate Change* 9 (2019): 18–25. <https://www.nature.com/articles/s41558-018-0340-5>
- 60 World Economic Forum, in partnership with Marsh & McLennan Companies and Zurich Insurance Group. 2019. *Regional Risks for Doing Business Report 2019*. Insight Report. Geneva: World Economic Forum. <https://www.weforum.org/reports/regional-risks-for-doing-business-2019>
- 61 Respondents to the Global Risks Perception Survey were asked about global risks over a 10-year horizon, while respondents to the Executive Opinion Survey were asked about risks for doing business in their country over the same horizon. The difference between the questions may in part explain the varied outcomes.
- 62 These organizations include, among others, the World Business Council for Sustainable Development (<https://www.wbcsd.org/>), the We Mean Business coalition (<https://www.wemeanbusinesscoalition.org/>) and the UN Global Compact (<https://www.unglobalcompact.org/>).
- 63 See, e.g., BlackRock Investment Institute. 2019. *Getting Physical: Scenario Analysis for Assessing Climate Risks*. Global Insights. April 2019. <https://www.blackrock.com/us/individual/literature/whitepaper/bii-physical-climate-risks-april-2019.pdf>; Goldman Sachs Research. 2019. "Taking the Heat: Making Cities Resilient to Climate Change". Goldman Sachs Insights. 05 September 2019. <https://www.goldmansachs.com/insights/pages/taking-the-heat.html>
- 64 Fagan, M. and C. Huang. 2019. "A Look at How People around the World View Climate Change". Pew Research Center, *Fact Tank*. 18 April 2019. <https://www.pewresearch.org/fact-tank/2019/04/18/a-look-at-how-people-around-the-world-view-climate-change/>
- 65 Henley, J. 2019. "European Elections: Triumphant Greens Demand More Radical Climate Action". *The Guardian*. 27 May 2019. <https://www.theguardian.com/environment/2019/may/28/greens-eu-election-mandate-leverage-climate-policy>
- 66 Morton, A. 2019. "How Australia's Election Will Decide Its Role in Climate Change". *Nature*. 16 May 2019. <https://www.nature.com/articles/d41586-019-01543-6>; Turner, C. 2019. "The 'Climate Change Election' Is Over. What Happens Now?" *The Globe and Mail*. 25 October 2019. <https://www.theglobeandmail.com/opinion/article-the-climate-change-election-is-over-what-happens-now/>; Henley, J. 2019. "Green Surge Expected in Swiss Elections as Climate Concern Grows". *The Guardian*. 18 October 2019. <https://www.theguardian.com/world/2019/oct/18/green-surge-expected-in-swiss-elections-as-climate-concern-grows>
- 67 Harvey, F., J. Rankin and D. Boffey. 2019. "European Green Deal Will Change Economy to Solve Climate Crisis, Says EU". *The Guardian*. 11 December 2019. <https://www.theguardian.com/environment/2019/dec/11/european-green-deal-will-change-economy-to-solve-climate-crisis-says-eu>

- 68 Snaith, E. 2019. "Extinction Rebellion: Who Are the Climate Activist Group Bringing Cities to a Standstill and What Are Their Aims?" *Independent*. 07 October 2019. <https://www.independent.co.uk/news/uk/home-news/extinction-rebellion-who-why-protests-climate-change-london-arrests-xr-a9143746.html>
- 69 Barclay, E. and B. Resnick. 2019. "How Big Was the Global Climate Strike? 4 Million People, Activists Estimate. It Was Likely the Largest Climate Protest in World History". *Vox*. 22 September 2019. <https://www.vox.com/energy-and-environment/2019/9/20/20876143/climate-strike-2019-september-20-crowd-estimate>
- 70 Weise, K. 2019. "Over 4,200 Amazon Workers Push for Climate Change Action, Including Cutting Some Ties to Big Oil". *The New York Times*. 10 April 2019. <https://www.nytimes.com/2019/04/10/technology/amazon-climate-change-letter.html>
- 71 Raval, A. and L. Hook. 2019. "Oil and Gas Advertising Spree Signals Industry's Dilemma". *Financial Times*. 06 March 2019. <https://www.ft.com/content/5ab7edb2-3366-11e9-bd3a-8b2a211d90d5>
- 72 BBC News. 2019. "'Flight Shame' Could Halve Growth in Air Traffic". *BBC News*. 02 October 2019. <https://www.bbc.co.uk/news/business-49890057>
- 73 Connolly, A. 2019. "Canadians Want to Stop Climate Change—But Half Don't Want to Pay an Extra Cent: Ipsos Poll". *Global News*. 26 September 2019. <https://globalnews.ca/news/5948758/canadians-climate-change-ipsos-poll/>
- 74 Rachman, G. 2019. "The Perilous Politics of Climate Change". *Financial Times*. 01 July 2019. <https://www.ft.com/content/70f290de-9bd8-11e9-9c06-a4640c9feebb>;
- Murphy, K. 2019. "Scott Morrison Says Australia's Record on Climate Change Misrepresented by Media". *The Guardian*. 25 September 2019. <https://www.theguardian.com/australia-news/2019/sep/26/scott-morrison-says-australias-record-on-climate-change-misrepresented-by-media>
- 75 UNEP. 2019. Op. cit.
- 76 Timperley, J. 2018. "Clean Energy Investment 'Must Be 50% Higher' to Limit Warming to 1.5C". *CarbonBrief*. 18 June 2018. <https://www.carbonbrief.org/clean-energy-investment-must-be-50-per-cent-high-limit-warming-one-point-five>
- 77 Committee on Climate Change. 2019. *Net Zero: The UK's Contribution to Stopping Global Warming*. May 2019. London: Committee on Climate Change. <https://www.theccc.org.uk/wp-content/uploads/2019/05/Net-Zero-The-UKs-contribution-to-stopping-global-warming.pdf>
- 78 Gallagher, M. B. 2019. "Understanding the Impact of Deep-Sea Mining". *MIT News*. 5 December 2019. <http://news.mit.edu/2019/understanding-impact-deep-sea-mining-1206>
- 79 Smith, P., S. J. Davis, F. Creutzig, S. Fuss and C. Yongsung. 2016. "Biophysical and Economic Limits to Negative CO₂ Emissions". *Nature Climate Change* 6 (2016): 42–50. <https://www.nature.com/articles/nclimate2870>
- 80 Egan, M. 2019. "Secretive Energy Startup Backed by Bill Gates Achieves Solar Breakthrough". *CNN Business*. 19 November 2019. <https://edition.cnn.com/2019/11/19/business/heliogen-solar-energy-bill-gates/index.html>
- 81 Lazard. 2018. "Levelized Cost of Energy and Levelized Cost of Storage 2018". Insights. 08 November 2018. <https://www.lazard.com/perspective/levelized-cost-of-energy-and-levelized-cost-of-storage-2018/>
- 82 Ellsmoor, J. 2019. "Renewable Energy Is Now the Cheapest Option—Even without Subsidies". *Forbes*. 15 June 2019. <https://www.forbes.com/sites/jamesellsmoor/2019/06/15/renewable-energy-is-now-the-cheapest-option-even-without-subsidies/#180bcaed5a6b>
- 83 Amin, A. Z. 2018. "A Just and Fair Energy Transition: An Opportunity to Tackle Climate Change and Create Prosperity". IRENA article. 13 December 2018. <https://www.irena.org/newsroom/articles/2018/Dec/An-Opportunity-for-Poland-and-the-World-to-Tackle-Climate-Change>
- 84 United Nations. 2019. *Report of the Secretary-General on the 2019 Climate Action Summit and The Way Forward in 2020*. Climate Action Summit 2019. https://www.un.org/en/climatechange/assets/pdf/cas_report_11_dec.pdf
- 85 Zurich. 2019. *Managing the Impacts of Climate Change: Risk Management Responses—Second Edition*. Zurich: Zurich Insurance Company. <https://www.zurich.com/en/knowledge/topics/global-risks/managing-impacts-climate-change-risk-management-responses-second-edition>





Save the Axolotl

Dangers of Accelerated Biodiversity Loss



Human-driven nature and biodiversity loss is threatening life on our planet. The previous chapter assessed where the world stands in 2020 in the face of existential climate risk. This chapter considers the other side of the same coin: how destabilizing tipping points in

nature could exacerbate the social and economic consequences of climate risk. At the same time, understanding nature's benefits could help societies leverage opportunities to stem the planetary emergency.



The axolotl, arguably one of the world's most recognizable salamanders, has a unique ability to regenerate severed limbs, which unlocks medicinal and scientific opportunities for everything from tissue repair to development and cancer. After centuries of inbreeding, captive populations are at risk and scientists could lose the opportunity to learn vital information about the animal's biology that could have significant benefits for human health.¹

On the loss of species

All species, including humans, depend for their survival on the delicate balance of life in nature.² Yet biodiversity—the diversity within species, between species, and within ecosystems—is declining faster than it has at any other time in human history.³ The current rate of extinction is tens to hundreds of times higher than the average over the past 10 million years—and it is accelerating.⁴ Although the world's 7.6 billion people represent just 0.01% of all living creatures, humanity has already caused the loss of 83% of all wild mammals and half of plants.⁵ If low estimates of the number of species are accurate—around 2 million—between 200 and 2,000 extinctions are occurring every year. At the upper end of the estimate, between 10,000 and 100,000 species are going extinct each year.⁶ How we grow

food, produce energy, dispose of waste and consume resources is destroying nature's delicate balance of clean air, water and life that all species—including humans—depend on for survival.⁷

Human activity endangers biodiversity in at least five main ways.⁸ First, agricultural and industrial expansion has led to the loss of over 85% of wetlands, altered 75% of land surface, and impacted 66% of ocean area. A second powerful threat is in the exploitation of plants and animals through harvesting, logging, hunting and fishing. Third, pollution: habitats are being destroyed by untreated waste; by pollutants from industrial, mining and agricultural activities; and by oil spills and toxic dumping. Marine plastic pollution alone has increased tenfold since 1980. A fourth critical driver of biodiversity loss is the introduction of

Biodiversity is declining faster than it has at any other time in human history

non-indigenous species that edge out native ones; this has increased by 40% globally over the same period. Fifth, climate change exacerbates nature loss, which in turn reduces nature's resilience to climate change—a vicious circle.⁹

Less directly, losses of biodiversity are driven by population growth, trade, consumption patterns and urbanization.¹⁰ By 2030, cities are expected to cover three times as much land as they did in 2000, with many of the expansions occurring in key biodiversity hotspots.¹¹ Inadequate export controls have facilitated the spread of invasive species, pests and diseases, which aggravate a quarter of plant extinctions and a third of animal ones.¹² Demand for food will more than double by 2050; meeting this demand will require an additional billion hectares of land—an area the size of Canada¹³—or increasing yields on existing land through the use of fertilizers and pesticides, which also contribute to biodiversity loss.

Implications for humanity

The dramatic loss of biodiversity brings serious risks for societies, economies and the health of the planet. Sir Robert Watson, chair of the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES),¹⁴ observes: “Biodiversity and nature’s contributions to people sound, to many people, academic and far removed from our daily lives. . . . Nothing could be further from the truth—they are the bedrock of our food, clean water and energy.”¹⁵ Humans rely on biodiversity in fundamental ways, from pollinating crops to curing diseases. Biodiversity loss has also come to threaten the foundations of our economy: one attempt to put a monetary value on goods and services provided by ecosystems estimates the worth of biodiversity at US\$33 trillion per year—close to the GDP of the United States and China combined.¹⁶ Risks arising from biodiversity loss include:

Food insecurity

Biodiversity underpins the world’s food system.¹⁷ It creates and maintains healthy soils, pollinates plants, purifies water and protects against extreme weather events, among other vital services.¹⁸ The ongoing loss of diversity in indigenous domesticated plants and animals is undermining the resilience of agricultural systems against pests, pathogens and climate change.¹⁹ Declining diversity of fish species is correlated with lower catches and higher incidence of stock collapse.²⁰ A new report from the United Nations’ Intergovernmental Panel on Climate Change (IPCC) identifies another risk: increased carbon-dioxide levels are lowering the nutritional value of food staples such as rice and wheat.²¹

83%

**wild mammal
species loss
caused by humanity**

Health risks

Well-functioning ecosystems support human health by providing clean air and water and a source of medicines.²² An estimated 50,000–70,000 plant species are harvested for traditional or modern medicine,²³ and around 50% of modern drugs were developed from natural products. Researchers are increasingly “reverting to nature” to look for new therapeutic options, efforts that are threatened by biodiversity loss.²⁴ Species currently endangered by biodiversity loss include the South American cinchona tree, the source of the malaria drug quinine.²⁵ In many cases, natural molecules for medical treatments are so complex that scientists are not yet able to chemically synthesize them, so they must harvest and store plants and seeds.²⁶ Some threatened organisms are critical for medical research: the Mexican axolotl (described above), for example, has unique characteristics that enable instructive comparisons with the human genome.²⁷

50% modern drugs developed from natural products

crisis: these microscopic plants that drift at the sea surface absorb carbon dioxide on a scale comparable to the world's forests,²⁹ and they are threatened by warming oceans.³⁰

Exacerbation of climate change

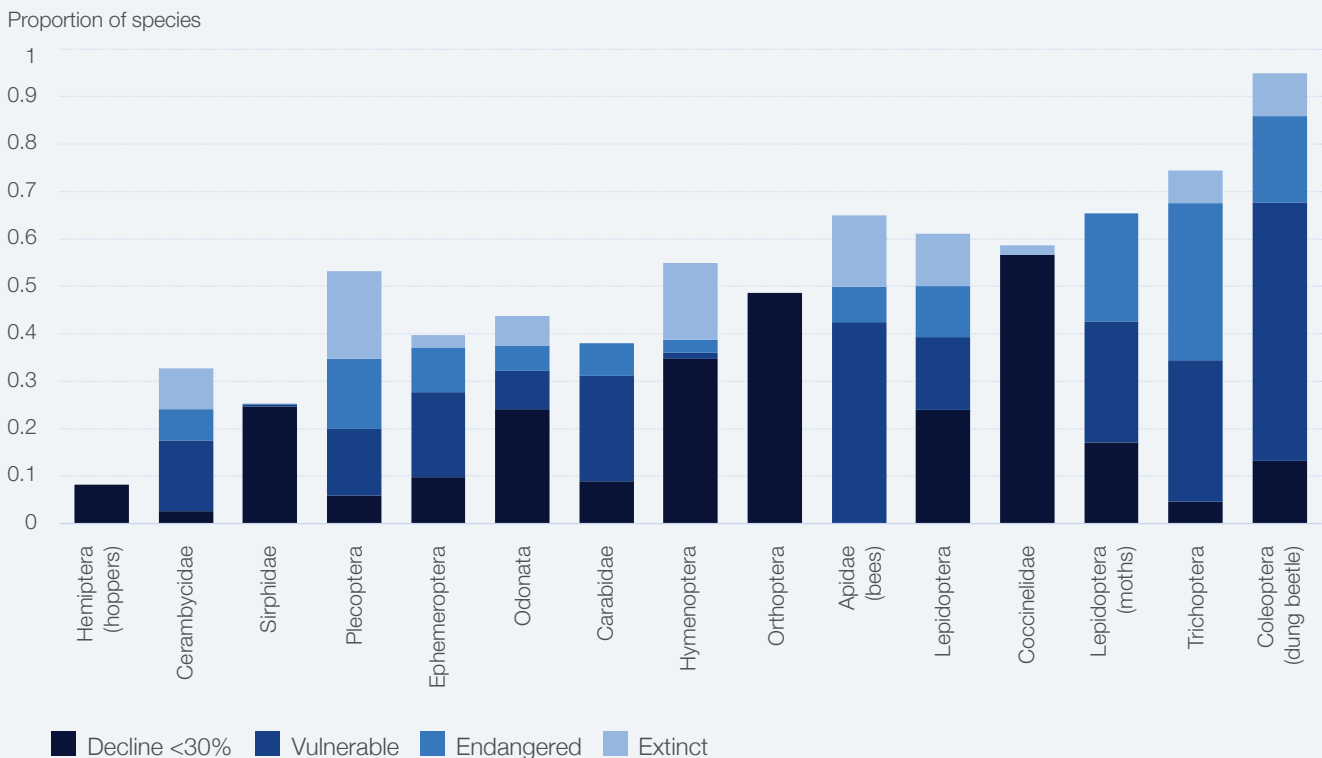
Terrestrial and marine biodiversity together support the reduction of greenhouse gas emissions and the conservation of carbon sinks, sequestering 5.6 gigatonnes of carbon per year—the equivalent of 60% of global human-driven emissions. The health of ecosystems that sequester carbon can depend on individual species: for example, endangered forest elephants are vital to the health of Central Africa's rainforests. Collapse of this ecosystem could release 3 billion tons of carbon, the equivalent of France's emissions for 27 years.²⁸ Phytoplankton provide another example of how depletion of species and ecosystems could exponentially worsen the climate

Business risk

The destruction of nature will inevitably impact bottom lines—for example, through reduced fish stocks disrupting commodity supply chains, economic losses from disasters such as flooding, and the loss of potential new sources of medicine. Extractives, construction, energy, fashion and textiles are among the sectors especially vulnerable to ecological destruction.³¹ All businesses should account for ecological risks to their operations and reputations, yet few do: a recent study of Fortune 500 companies found that nearly half mentioned biodiversity in their sustainability reports, but only five set specific, measurable and timebound targets.³² Nature-related risks are undervalued in business decision-making.

FIGURE 4.1

Species Decline: Insects



Data source: Sánchez-Bayo, F. and K. A. G. Wyckhuys. 2019. "Worldwide Decline of the Entomofauna: A Review of its Drivers". *Biological Conservation* 232 (April 2019): 8–27. <https://www.sciencedirect.com/science/article/pii/S0006320718313636>

Indigenous community livelihood and culture risks

Indigenous communities often rely on their diverse local ecosystems for food and other resources: for example, 60% of the world's indigenous population uses largely plant-based traditional medicines.³³ And the rest of humanity relies on indigenous communities to be stewards of ecosystems, protecting and preserving environmental resources. Indigenous peoples comprise less than 5% of the world's population but protect 80% of its biodiversity.³⁴

Beyond these known risks are unknowable losses—the risk of losing species we have not yet discovered that could have been domesticated for crops or given rise to new medicinal breakthroughs. For example, the ocean represents a “virtually untapped resource for discovery of novel chemicals with pharmaceutical potential,”³⁵ and recent bacterial samples from coastal sediments grown under saline conditions have yielded new antibiotic, antitumor and anti-inflammatory compounds.³⁶ Another recently discovered ocean organism, a rare genus of marine bacteria called *Serinicoccus*, was shown to selectively destroy melanoma cancer cells.³⁷ With continued loss of biodiversity, we may never know what we have missed out on.

Imagine if ...

Many and varied ecosystems are in decline or at risk of destruction from human activity. While their complexity makes it very hard to predict which losses would be most consequential, it is clear the stakes are high. Here we consider three potential ecosystem collapses or extinctions that could have profound impacts for humanity and the Earth.

Insect decline

A world without insects, according to one entomologist, would be a “flowerless world with silent forests, a world of dung and old leaves and rotting carcasses accumulating in cities and roadsides.”³⁸ One recent study estimates that insects have declined by 40% in recent decades (see Figure 4.1), and a third are endangered.³⁹ It identifies deforestation, urbanization, pollution and the widespread use of pesticides in commercial agriculture as the principal



REUTERS/ARND WIEGMANN

causes. Insects are the main food source for many species higher in the food chain, such as birds, reptiles, amphibians and fish. As the author of the study points out, “[if] this food source is taken away, all these animals starve to death.”⁴⁰

Insects are also the world's top pollinators: 75% of the 115 top food crops rely on animal pollination, including nutrient-rich foods like fruit, vegetables, nuts and seeds, as well as cash crops such as coffee and cocoa.⁴¹ Dwindling insect populations will force farmers to seek alternative means of pollination,⁴² or shift to staple crops that do not rely on pollinators. However, these crops—such as rice, corn, wheat, soybeans and potatoes—are often energy-dense, nutrient-poor and already over-consumed globally, contributing to an epidemic of obesity and diet-related disease.⁴³ Increasing their prevalence in the food supply at the expense of fruits, nuts, vegetables and seeds could exacerbate this global health crisis (see Chapter 6, False Positive).

Approximately 1 million insect species have been documented, but “untold millions await discovery.”⁴⁴ As with the broader community of species discussed above, it is impossible to know what humanity could lose from the extinction of insect species that are not yet known to science.

Nature-related risks are undervalued in business decision-making



REUTERS/ANDY CLARK

Coral reef collapse

Coral reefs are home to some of the planet's most biodiverse ecosystems. They are critical to ocean health: although they make up less than 1% of the ocean floor, 25% of fish species rely on reefs for at least part of their life cycle.⁴⁵ Ocean reefs contribute to the livelihoods of at least 500 million people worldwide, mostly in less-developed economies.⁴⁶ Coral reefs generate US\$36 billion per year for the global tourism industry, with the Great Barrier Reef in Australia accounting for more than 15% of that total (US\$5.7 billion).⁴⁷ They provide vital protection from coastal flooding and storm surges: one recent study found that losing just the top layer of coral could result in US\$4 billion more in flood damages per year.⁴⁸

Coral reefs are threatened partly by overfishing, industrial activity and pollution, but even more by the planet's rapid warming. When the water surrounding them becomes too warm, corals expel the algae living within the tissue of the reef, turning the corals white—also known as “coral bleaching”. If corals are bleached for prolonged periods, they will die. A recent study found that severe marine heatwaves can lead not just to bleaching, but also to the immediate death of reefs.⁴⁹ If global temperatures stabilize at an increased 1.5°C, coral reefs could decline by 70% to 90%; with higher rises, they would disappear.⁵⁰

The disappearance of coral reefs could have dire consequences for life on land

as well as in the ocean. Up to 80% of the oxygen humans breathe comes from the ocean.⁵¹ Without reefs, coastal communities would be more vulnerable to storms, and migration away from low-lying population centres and islands could increase. As the oceans “become largely lifeless or at least extremely transformed”,⁵² the fishing and tourism industries could be wiped out. In some regions, collapsing fish stocks could increase security risks, such as piracy and terrorism.⁵³

Disappearance of the Amazon

Around 12 million hectares of tropical forest worldwide were lost in 2018, equivalent to 30 football fields per minute.⁵⁴ The Amazon alone has lost approximately 17% of its size over the last 50 years, and rates of deforestation have been rising since 2012.⁵⁵ The Amazon now absorbs around a third less carbon than it did a decade ago,⁵⁶ and a recent study found that increasing dryness in the atmosphere is leaving ecosystems even more vulnerable to fire and drought.⁵⁷ The rapid disappearance of more of the rainforest could exacerbate the effects of climate change: if 20% to 25% of the forest is lost, scientists warn that the Amazon could pass a tipping point where a vicious cycle of drought, fire and canopy loss takes hold that cannot be stopped. This tipping point could be reached within decades.⁵⁸ The destruction of the forests of Borneo offer an ominous precedent: mass deforestation and fires there have led to the loss of over 50% of lowland tropical rainforest.⁵⁹

Because the Amazon is the world’s most diverse ecosystem and home to about 10% of terrestrial species,⁶⁰ its destruction means potentially undiscovered cures for disease would be lost forever. More intense fires and flooding in the region, as well as more unpredictable rainfall patterns and droughts, could also ensue. This would undermine food production, increase water scarcity and reduce hydropower generation, with economic costs exceeding US\$3 trillion.⁶¹ Global agricultural markets might suffer as well,⁶² since Brazil is one of the world’s largest agricultural exporters of products including soybeans, maize and meat. A significant decline in Brazil’s agricultural output could increase volatility of food prices, which history shows can trigger instability and contribute to long-term

deteriorations in security. Indigenous communities who rely on the rainforest would struggle and possibly disappear. The tourism industry, critical for South American economies, could be badly affected.

No silver bullet

The UN declared 2010 to be the International Year of Biodiversity. Notwithstanding the appearance of biodiversity as a top risk by both likelihood and impact on the GRPS (see Figure II, The Global Risks Landscape 2020), 10 years later, general confusion persists about what precisely biodiversity is, why it relates to human prosperity and how to confront its loss. Achievement of the Aichi Biodiversity Targets for 2020 has lagged.⁶³ Since the targets were set in 2011, global production of metals, minerals, fossil fuels and biomass has increased by more than 20%, while an area larger than Mexico has been deforested.

80% oxygen that humans breathe comes from the ocean

Solutions to stemming biodiversity loss will be as complex as the problem itself. No longer can nature be protected by either “sparing” (preserving areas of land where species can thrive away from production) or “sharing” (integrating processes where nature and food production coexist).⁶⁴ Both approaches are required and both will involve trade-offs: how should biodiversity be weighed against social and economic imperatives such as food production and economic development? For example, organic agriculture avoids the use of harmful chemicals but might require more land for comparable yields.⁶⁵ Similarly, the production of biofuels and bioenergy with carbon capture and storage (BECCS) is a potential game-changer for negative carbon emissions.⁶⁶ However, BECCS also uses large swaths of agricultural land, with implications for future socio-economic developments, food security and biodiversity management.

Bio-economic transitions would create feedback loops that must also be considered. For example, developing climate-resistant crop varieties could help farming systems adapt to a warming planet—but deepening our reliance on a handful of staple crops grown in large-scale, intensive monoculture farming systems could ultimately undermine the resilience of the food system by reducing genetic diversity and increasing vulnerability to pests and disease.⁶⁷ On a smaller scale, urban tree-planting might actually result in a net loss of street-tree carbon storage over time because of the “unique demographics of urban ecosystems”.⁶⁸

Inequities in development trajectories that characterize the climate debate are also inherent in any coordinated response to

biodiversity loss. Certain countries, for example, may incur a stiffer penalty for the protection of the planet by virtue of their geography and natural resources. However, conservation efforts do not necessarily require trade-offs in development priorities or human rights.⁶⁹ In fact, efforts to address declining biodiversity ought to be inextricably linked to other social agendas, such as poverty alleviation,

healthcare, disaster relief and protection of human rights.⁷⁰ It is vital to expand discussion around biodiversity loss to include researchers from non-empirical disciplines as well as farmers, indigenous communities, businesses and other stakeholders.

The new nature economy

While trade-offs may be unavoidable, there are also potential “win-wins”. Consider diets. The livestock sector accounts for 70% of agricultural land use;⁷¹ it is also responsible for about 14% of global greenhouse gas emissions.⁷² Reducing meat consumption would be good for nature and the climate. In a growing number of countries it would be good for people as well, as overconsumption of meat could be leading to worse health outcomes.⁷³ Another win-win example is the

circular economy, in which waste is designed out and materials are kept in use for as long as possible: besides helping to decouple resource demand from economic growth, this can contribute to lower emissions and less habitat loss.

There is also a business rationale for preserving or restoring natural ecosystems.⁷⁴ On average, the costs of restoration are outweighed tenfold by its benefits to communities.⁷⁵ Restoring coastal mangroves, for example, can protect land from storm surges and coastal erosion, develop fisheries and support ecotourism. Investing in the restoration of wetlands, mangroves and coral reefs could reduce insurance costs for businesses in coastal areas vulnerable to flooding. Likewise, financing ecological forestry practices could reduce insurance costs for businesses, such as power and water utilities, that are exposed to wildfire risks.⁷⁶ According to the Organisation for Economic Co-operation and Development (OECD), restoring 46% of the world’s degraded forests could provide up to US\$30 in benefits for every dollar spent, boosting local employment and increasing community awareness of biodiversity’s importance.⁷⁷

A critical challenge for the biodiversity agenda will be finding investment models that mobilize private finance to capture a share of this opportunity. New approaches are emerging, such as resilience-financing structures through which businesses can invest in the restoration of ecosystems in return for a reduction in insurance premiums or risk-financing costs. Better data to track the effectiveness of investments will be critical. However, given the sums involved—one estimate puts the current cost of protecting biodiversity at US\$100 billion per year⁷⁸—public funding will also be needed. Habitat protection and restoration are highly beneficial public goods for which government investment is more than justified. The People’s Bank of China, for instance, now offers capital relief for banks that make green loans.⁷⁹ The International Union for Conservation of Nature is developing a species conservation metric that will help companies, banks and governments to quantify their contribution.⁸⁰ A renewed interest in nature-based solutions can help combat climate change as well as mitigate the exacerbating effects of nature loss on the climate.

70%
**agricultural land
use accounted
for by livestock
sector**



Beyond policy interventions, stemming the impacts of biodiversity loss may require a fundamental shift in thinking about the economic value of nature. Gross domestic product (GDP), the primary performance indicator for economies, fails to account for “natural capital”—the stock of a country’s ecosystems, natural resources and human capital.⁸¹ Businesses, governments and individuals would be better served by another metric—or series of metrics—that more accurately describes an economy’s overall health, thus incorporating the costs of ecosystem degradation. The Gaborone Declaration for Sustainability in Africa, for example, is encouraging member countries to use metrics such as “ecosystem valuation” and “natural capital accounting” in measuring economic activity and decision-making.⁸²

The most effective solutions may imply significant disruption or shifts to existing business models. For example, the fashion industry could reduce its impacts on biodiversity by shifting towards transforming old clothes into new ones and creating garments that are durable rather than disposable—an opportunity worth US\$560 billion.⁸³ Extractive industries’ negative impacts on biodiversity could be mitigated if mining companies were to move to a resource services model,⁸⁴ in which the companies retain ownership of metals over their lifecycle and keep them in use for as long as possible.

Later in 2020, governments will gather in Kunming, China, to revisit global targets on protecting ecosystems and halting species loss. This is a critical moment: as climate change exacerbates ecosystem collapse, we could be causing irreversible ecosystem damage with serious economic and social consequences.⁸⁵ Some of the most serious impacts will not occur gradually, but rather suddenly and violently, as critical thresholds are breached. Messaging around biodiversity loss and its impacts is key to underscoring the meaning and impact of biodiversity loss for societies. Consumers also have a role to play in demanding sustainable policy-making and products.

The rapid degradation of our life support system means a lot more is needed. As we find ourselves at the doorstep of the “sixth mass extinction”, both businesses and regulators have a huge role to play in shifting paradigms about who pays for the externalities created by business-as-usual. The World Economic Forum will be publishing the *New Nature Economy Report*—to be released in three parts during 2020—setting out risks, key transformation pathways and financing for a nature-positive economy. We have the science and evidence required to pivot in this direction, but there is an acute need for champions who can shift systems and prioritize investment for safeguarding nature.

Notes

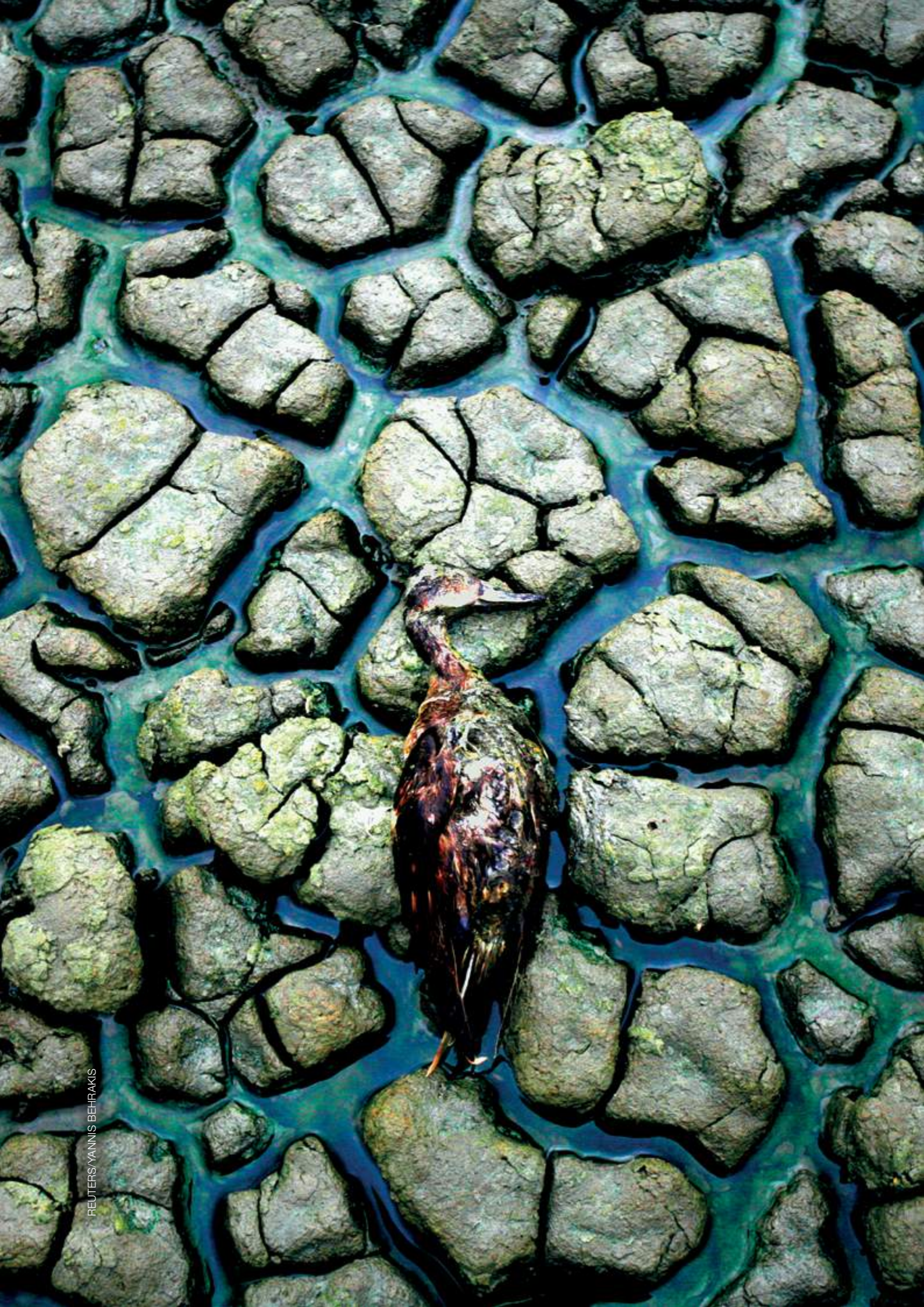
- 1 Vance, E. "Biology's Beloved Amphibian — The Axolotl — Is Racing Towards Extinction". *Nature*. 15 November 2017. <https://www.nature.com/articles/d41586-017-05921-w>
- 2 Borenstein, S. 2019. "UN Report: Humans Accelerating Extinction of Other Species". *AP News*. 06 May 2019. <https://www.apnews.com/aaf1091c5aae40b0a110daaf04950672>
- 3 IPBES (Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services). 2019. Summary for policymakers of the global assessment report on biodiversity and ecosystem services of the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services, Unedited Advance Version, 06 May 2019. See also UN Convention on Biological Diversity (<https://www.cbd.int/>, which defines "biodiversity" as "the variability among living organisms from all sources including, inter alia, terrestrial, marine and other aquatic ecosystems and the ecological complexes of which they are part; this includes diversity within species, between species and of ecosystems").
- 4 IPBES. 2019. Op. cit.
- 5 Bar-On, Y. M., R. Phillips, and R. Milo. 2018. "The Biomass Distribution on Earth". *PNAS* 115 (25): 6506–11. <https://www.pnas.org/content/115/25/6506>
- 6 WWF (World Wildlife Fund). 2019. "How Many Species Are We Losing?" Our Work, How Much Is Being Lost? https://www.panda.org/our_work/biodiversity/biodiversity/
- 7 Borenstein. 2019. Op. cit.
- 8 IPBES. 2019. Op. cit.
- 9 See also IPCC (Intergovernmental Panel on Climate Change). 2018. Summary for Policymakers. In *Global Warming of 1.5°C: An IPCC Special Report*. Geneva: World Meteorological Organization. https://www.ipcc.ch/site/assets/uploads/sites/2/2018/07/SR15_SPM_version_stand_alone_LR.pdf; <https://www.ipcc.ch/sr15/>
- 10 United Nations. 2019. "UN Report: Nature's Dangerous Decline 'Unprecedented'; Species Extinction Rates 'Accelerating'". Sustainable Development Goals. 06 May 2019. <https://www.un.org/sustainabledevelopment/blog/2019/05/nature-decline-unprecedented-report/>
- 11 Seto, K. C., B. Günerlap, and L. R. Hutyra. 2012. "Global Forecasts of Urban Expansion to 2030 and Direct Impacts on Biodiversity and Carbon Pools". *PNAS* 109 (40): 16083–88. <https://www.pnas.org/content/109/40/16083.short>
- 12 Blackburn, T. M., C. Bellard, and A. Ricciardi. 2019. "Alien Versus Native Species as Drivers of Recent Extinctions". *Frontiers in Ecology and the Environment* 17 (4): 203–07. <https://esajournals.onlinelibrary.wiley.com/doi/abs/10.1002/fee.2020>
- 13 Tilman, D., C. Balzer, J. Hill, and B. L. Befort. 2011. "Global Food Demand and the Sustainable Intensification of Agriculture". *PNAS* 108 (50): 20260–64. <https://www.pnas.org/content/108/50/20260>
- 14 Based on a review of about 15,000 scientific and government sources and compiled by 145 expert authors from 50 countries, the global report (IPBES. 2019. Op. cit.) is the first comprehensive look in 15 years at the state of the planet's biodiversity.
- 15 IPBES (Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services). 2018. "Media Release: Biodiversity and Nature's Contributions Continue Dangerous Decline, Scientists Warn: Human Well-Being at Risk. Landmark Reports Highlight Options to Protect and Restore Nature and Its Vital Contributions to People". Media Release. <https://www.ipbes.net/news/media-release-biodiversity-nature%E2%80%99s-contributions-continue-%C2%A0dangerous-decline-scientists-warn>
- 16 Bos, G. 2017. "Tomorrow's Production Systems Will Be Closer to Nature". IUCN (International Union for Conservation) Blog post, 09 January 2017. <https://www.iucn.org/news/business-and-biodiversity/201701/tomorrows-production-systems-will-be-closer-nature>. Other estimates have put the monetary value of goods and services provided by ecosystems at as high as US\$125 trillion per year, or around two-thirds higher than global GDP. See Costanza, R. R. de Groot, P. Sutton, S. van der Ploeg, S. J. Anderson, I. Kubiszewski, S. Farber and R. K. Turner. 2014 "Changes in the Global Value of Ecosystem Services". *Global Environmental Change* 26 (2014): 152–58. <https://community-wealth.org/sites/clone.community-wealth.org/files/downloads/article-costanza-et-al.pdf>; OECD (Organisation for Economic Co-operation and Development). 2019. Biodiversity: Finance and the Economic and Business Case for Action. Report prepared by the OECD for the French G7 Presidency and the G7 Environment Ministers' Meeting, 5–6 May 2019. <https://www.oecd.org/environment/resources/biodiversity/G7-report-Biodiversity-Finance-and-the-Economic-and-Business-Case-for-Action.pdf>
- 17 "FAO (Food and Agriculture Organization of the United Nations)." The Biodiversity That Is Crucial for our Food and Agriculture Is Disappearing by the Day. Press Release, 22 February 2019. <http://www.fao.org/news/story/en/item/1180463/icode/>

- 18 FAO (Food and Agriculture Organization of the United Nations). 2019. *The State of the World's Biodiversity for Food and Agriculture*, J. Bélanger & D. Pilling (eds.). FAO Commission on Genetic Resources for Food and Agriculture Assessments. Rome. <http://www.fao.org/3/CA3129EN/ca3129en.pdf>
- 19 IPBES. 2019. Op. cit.; Roe, D., N. Seddon and J. Elliott. 2019. "Biodiversity Loss Is a Development Issue: A Rapid Review of Evidence". Issue Paper. London: International Institute for Environment and Development.
- 20 Roe, D. 2019. "Biodiversity Loss—More Than an Environmental Emergency". *The Lancet Planetary Health* 3 (7): PE287–E289, 01 July 2019. [https://www.thelancet.com/journals/lanplh/article/PIIS2542-5196\(19\)30113-5/full-text](https://www.thelancet.com/journals/lanplh/article/PIIS2542-5196(19)30113-5/full-text); Roe, Seddon and Elliott. 2019. Op. cit.
- 21 IPCC (United Nations' Intergovernmental Panel on Climate Change). 2019. *Climate Change and Land. Special Report*. <https://www.ipcc.ch/srccl/>
- 22 WHO (World Health Organization). 2015. "Loss of Biodiversity Impacts Human Health". <https://www.who.int/globalchange/publications/phe-pr.pdf?ua=1>
- 23 IUCN. 2009. "New International Standard for Sustainable Wild Collection of Medicinal and Aromatic Plants". IUCN Support. 26 May 2009. <https://www.iucn.org/content/new-international-standard-sustainable-wild-collection-medicinal-and-aromatic-plants>
- 24 Thomford, N. E., D. A. Senthelane, A. Rowe, D. Munro, P. Seele, A. Maroyi and K. Dzobo. 2018. "Natural Products for Drug Discovery in the 21st Century: Innovations for Novel Drug Discovery". *International Journal of Molecular Sciences* 19 (6): 158. <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6032166/>
- 25 Roe. 2019. Op. cit.; Roe, Seddon and Elliott. 2019. Op. cit.
- 26 Technical University of Denmark. 2018. "Scientists to Produce Anti-Cancer Drugs in Yeast". *Science Daily*. 07 December 2018. <https://www.sciencedaily.com/releases/2018/12/181207121419.htm>
- 27 Learn, J. R. 2019. "Complete Axolotl Genome Could Reveal the Secret of Regenerating Tissues". *Smithsonian.com*. 24 January 2019. <https://www.smithsonianmag.com/science-nature/complete-axolotl-genome-could-reveal-secret-regenerating-tissues-180971335/>
- 28 Newer, R. 2019. "The Thick Gray Line: Forest Elephants Defend Against Climate Change". *The New York Times*. 19 August 2019. <https://www.nytimes.com/2019/08/19/science/elephants-climate-change.html?action=click&module=Discovery&pg-type=Homepage>
- 29 Morello, L. 2010. "Phytoplankton Population Drops 40 Percent Since 1950". *Scientific American*. 29 July 2010. <https://www.scientificamerican.com/article/phytoplankton-population/>; Watts, S. 2017. "Global Warming Is Putting the Ocean's Phytoplankton in Danger". *Pacific Standard*. 29 December 2017. <https://psmag.com/environment/global-warming-is-putting-phytoplankton-in-danger>; University of Leicester. 2015. "Failing Phytoplankton, Failing Oxygen: Global Warming Disaster Could Suffocate Life on Planet Earth". *ScienceDaily*. ScienceDaily, 01 December 2015. <https://www.sciencedaily.com/releases/2015/12/151201094120.htm>
- 30 IPBES. 2019. Op. cit.; Isbell, F., D. Craven, J. Connolly, M. Loreau, B. Schmid, C. Beierkuhnlein, T. M. Bezemer, C. Bonin, H. Bruelheide, E. de Luca, A. Ebeling, J. N. Griffin, Q. Guo, Y. Hautier, A. Hector, A. Jentsch, J. Kreyling, V. Lanta, P. Manning, S. T. Meyer, A. S. Mori, S. Naeem, P. A. Niklaus, H. W. Polley, P. B. Reich, C. Roscher, E. W. Seabloom, M. D. Smith, M. P. Thakur, D. Tilman, B. F. Tracy, W. H. van der Putten, J. van Ruijven, A. Weigelt, W. W. Weisser, B. Wilsey and N. Eisenhauer. 2015. "Biodiversity Increases the Resistance of Ecosystem Productivity to Climate Extremes". *Nature* 526: 547–77.
- 31 OECD. 2019. Op. cit.
- 32 Addison, P. F. E., J. W. Bull, and El J. Milner-Gulland. 2018. "Using Conservation Science to Advance Corporate Biodiversity Accountability". *Conservation Biology*. 15 July 2018. <https://conbio.onlinelibrary.wiley.com/doi/10.1111/cobi.13190>
- 33 Roe. 2019. Op. cit.; Roe, Seddon and Elliott. 2019. Op. cit.
- 34 Raygorodetsky, G. 2018. "Indigenous Peoples Defend Earth's Biodiversity—But They're in Danger". *National Geographic*. 16 November 2018. <https://www.nationalgeographic.com/environment/2018/11/can-indigenous-land-stewardship-protect-biodiversity/>
- 35 Kanase, H. R. and K. N. M. Singh. 2018. "Marine Pharmacology: Potential, Challenges, and Future in India". *Journal of Medical Sciences* 38 (2): 49–53. <http://www.jmedscindmc.com/article.asp?issn=1011-4564;year=2018;volume=38;issue=2;page=49;epage=53;aulast=Kanase#ft1>

- 36 Ibid; Newman, T. 2019. "Why Scientists Are Searching the Ocean for New Drugs". *Medical News Today*. 08 June 2019. <https://www.medicalnewstoday.com/articles/325384.php>.
- 37 Ibid.
- 38 Jarvis, B. 2018. "The Insect Apocalypse Is Here". *The New York Times Magazine*. 27 November 2018. <https://www.nytimes.com/2018/11/27/magazine/insect-apocalypse.html> (citing David L. Wagner, an entomologist at the University of Connecticut).
- 39 Sánchez-Bayo, F. and K. A. G. Wyckhuys. 2019. "Worldwide Decline of the Entomofauna: A Review of Its Drivers". *Biological Conservation*. 232 (April 2019): 8–27. <https://www.sciencedirect.com/science/article/pii/S0006320718313636>
- 40 Carrington, D. 2019. "Plummeting Insect Numbers 'Threaten Collapse of Nature'". *The Guardian*. 10 February 2019. <https://www.theguardian.com/environment/2019/feb/10/plummeting-insect-numbers-threaten-collapse-of-nature>
- 41 Bartomeus, I., S. G. Potts., I. Steffan-Dewenter, B. E. Vaissière, M. Woyciechowski, K. M. Krewenka, T. Tscheulin, S. P. M. Roberts, H. Szentgyörgyi, C. Westphal and R. Bommarco. 2014. "Contribution of Insect Pollinators to Crop Yield and Quality Varies with Agricultural Intensification". *PeerJ*. Published online 27 March 2014. doi: 10.7717/peerj.328. <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3976118/>
- 42 Ibid.
- 43 Benton, T. G. and R. Bailey. 2019. "The Paradox of Productivity: Agricultural Productivity Promotes Food System Inefficiency". *Global Sustainability*. Published online by Cambridge University Press. 29 April 2019. https://www.cambridge.org/core/services/aop-cambridge-core/content/view/4D5924A-F2AD829EC1719F52B73529CE4/S2059479819000036a.pdf/paradox_of_productivity_agricultural_productivity_promotes_food_system_inefficiency.pdf
- 44 Yong, E. 2019. "Is the Insect Apocalypse Really Upon Us?" *The Atlantic*. 19 February 2019. <https://www.theatlantic.com/science/archive/2019/02/insect-apocalypse-really-upon-us/583018/>
- 45 Loria, K. 2018. "What Happens If All the Coral Reefs Die?" World Economic Forum Global Agenda, published in collaboration with *Business Insider*. 20 April 2018. <https://www.weforum.org/agenda/2018/04/what-happens-if-all-the-coral-reefs-die>
- 46 IUCN (International Union for Conservation). "Coral Reefs and Climate Change". IUCN Issues Brief. <https://www.iucn.org/resources/issues-briefs/coral-reefs-and-climate-change>
- 47 Deloitte Access Economics. 2017. *At What Price? The Economic, Social and Icon Value of the Great Barrier Reef*. Brisbane, Australia: Deloitte Access Economics. <https://www2.deloitte.com/content/dam/Deloitte/au/Documents/Economics/deloitte-au-economics-great-barrier-reef-230617.pdf>
- 48 Berger, M. O. 2018. "Coral Reef Loss Could Cost Countries Billions". *Pacific Standard*. 22 June 2018. <https://psmag.com/environment/the-financial-cost-of-losing-a-reef>
- 49 Leggat, W. P., E. F. Camp, D. J. Suggett, S. F. Heron, A. J. Fordyce, S. Gardner, L. Deakin, M. Turner, L. J. Beeching, U. Kuzhiumparambil, C. M. Eakin and T. D. Ainsworth. 2019. "Rapid Coral Decay Is Associated with Marine Heatwave Mortality Events on Reefs". *Current Biology* 29 (16): 2723–2730.e4. <https://doi.org/10.1016/j.cub.2019.06.077>
- 50 IPCC (Intergovernmental Panel on Climate Change). 2018. Summary for Policymakers of IPCC Special Report on Global Warming of 1.5°C Approved by Governments. IPCC Newsroom Post. 08 October 2018. <https://www.ipcc.ch/2018/10/08/summary-for-policymakers-of-ipcc-special-report-on-global-warming-of-1-5c-approved-by-governments/>
- 51 Loria. 2018. Op. cit.
- 52 Loria. 2018. Op. cit.
- 53 Sow, M. 2017. "Figures of the Week: Piracy and Illegal Fishing in Somalia". Africa in Focus. Brookings. 12 April 2018. <https://www.brookings.edu/blog/africa-in-focus/2017/04/12/figures-of-the-week-piracy-and-illegal-fishing-in-somalia/>; Farquhar, S. 2017. "When Overfishing Leads to Terrorism: The Case of Somalia". *World Affairs Journal of International Issues*. 21: 68–77. https://www.researchgate.net/publication/319680762_When_Overfishing_Leads_To_Terrorism_The_Case_of_Somalia
- 54 McGrath, M. 2019. "Deforestation: Tropical Tree Losses Persist at High Levels". *BBC News*. 25 April 2019. <https://www.bbc.com/news/science-environment-48037913>
- 55 The Economist. 2019. "The Amazon Is Approaching an Irreversible Tipping Point". *The Economist*. 01 August 2019. <https://www.economist.com/briefing/2019/08/01/the-amazon-is-approaching-an-irreversible-tipping-point>

- 56 McSweeney, R. 2015. "Amazon Rainforest Is Taking Up a Third Less Carbon Than a Decade Ago". *Plants and Forests*. 18 March 2015. <https://www.carbonbrief.org/amazon-rainforest-is-taking-up-a-third-less-carbon-than-a-decade-ago>
- 57 Smith, E. 2019. "Human Activities Are Drying Out the Amazon: NASA Study". NASA, Global Climate Change. <https://climate.nasa.gov/news/2928/human-activities-are-drying-out-the-amazon-nasa-study/>
- 58 The Economist. 2019. Op. cit.; Irfan, U. 2019. "The Amazon Rainforest's Worst-Case Scenario Is Uncomfortably Near". *Vox*. 27 August 2019. <https://www.vox.com/2019/8/27/20833275/amazon-rainforest-fire-wildfire-dieback>
- 59 World Wildlife Fund. 2019. Borneo Deforestation. https://wwf.panda.org/our_work/forests/deforestation_fronts2/deforestation_in_borneo_and_sumatra/
- 60 World Wildlife Fund. 2019. Amazon Facts. <https://www.worldwildlife.org/places/amazon>
- 61 Lapola, D. M., P. Pinho, C. A. Quesada, B. B. N. Strassburg, A. Rammig, B. Kruijt, F. Brown, J. P. H. B. Ometto, A. Premezida, J. A. Marengo, W. Vergara and C. A. Nobre. 2018. "Limiting the High Impacts of Amazon Forest Dieback with No-Regrets Science and Policy Action". *PNAS* 115 (46): 11671–79. <https://www.pnas.org/content/115/46/11671>
- 62 Bailey, R. and L. Wellesley. 2017. *Chokepoints and Vulnerabilities in Global Food Trade*. London: Chatham House. <https://www.chathamhouse.org/sites/default/files/publications/research/2017-06-27-chokepoints-vulnerabilities-global-food-trade-bailey-wellesley.pdf>
- 63 CBD (Convention on Biological Diversity). 1993. Convention, Strategic Plan 2011–2020, Aichi Biodiversity Targets. <https://www.cbd.int/sp/targets/>
- 64 Pearce, F. 2018. "Sparing vs Sharing: The Great Debate Over How to Protect Nature". E360 (YaleEnvironment360). <https://e360.yale.edu/features/sparing-vs-sharing-the-great-debate-over-how-to-protect-nature>
- 65 Searchinger, T. D., W. Wiersma, T. Beringer and P. Dumas. 2018. "Assessing the Efficiency of Changes in Land Use for Mitigating Climate Change". *Nature* 563: 249–53. <https://www.nature.com/articles/s41586-018-0757-z>
- 66 IPCC. 2018. Op. cit.
- 67 Benton and Bailey. 2019. Op. cit.
- 68 PLOS. 2019. "Urban Trees 'Live Fast, Die Young' Compared to Those in Rural Forests: Unusual Features of Street-Tree Life Cycles Should Inform Urban Greening Campaigns". *ScienceDaily*. 08 May 2019. <https://www.sciencedaily.com/releases/2019/05/190508142450.htm>
- 69 Roe. 2019. Op. cit. Recent exposure of alleged human rights abuses by conservationists could exacerbate perceptions of such a trade-off. See BuzzFeed News: Warren, T. and K. J. M. Baker. 2019. "WWF Funds Guards Who Have Tortured and Killed People". BuzzFeed News. 04 March 2019. <https://www.buzzfeednews.com/article/tom-warren/wwf-world-wide-fund-nature-parks-torture-death>; Warren, T. and K. J. M. Baker. 2019. "A Leaked Report Shows WWF Was Warned Years Ago Of 'Frightening' Abuses". BuzzFeed News. 05 March 2019. <https://www.buzzfeednews.com/article/katiejmbaker/wwf-report-human-rights-abuses-rangers>; Warren, T. and K. J. M. Baker. 2019. "WWF Says Indigenous People Want This Park. An Internal Report Says Some Fear Forest Ranger 'Repression.'". 08 March 2019. <https://www.buzzfeednews.com/article/katiejmbaker/wwf-eu-messok-dja-fears-repression-ecoguards>
- 70 Roe, Seddon and Elliott. 2019. Op. cit.
- 71 FAO (Food and Agriculture Organization of the United Nations). 2018. *Shaping the Future of Livestock Sustainably, Responsibly, Efficiently*. The 10th Global Forum for Food and Agriculture (GFFA) Berlin, 18–20 January 2018. <http://www.fao.org/3/i8384en/i8384EN.pdf>
- 72 Watts, G. 2019. "The Cows that Could Help Fight Climate Change". BBC Future. 06 August 2019. <https://www.bbc.com/future/article/20190806-how-vaccines-could-fix-our-problem-with-cow-emissions>
- 73 GBD 2017 Diet Collaborators. 2019. "Health Effects of Dietary Risks in 195 Countries, 1990–2017: A Systematic Analysis for the Global Burden of Disease Study 2017". *The Lancet* 393 (10184): 1958–72. 22 May 2019. [https://www.thelancet.com/article/S0140-6736\(19\)30041-8/fulltext](https://www.thelancet.com/article/S0140-6736(19)30041-8/fulltext)
- 74 Avery, H. 2019. "Conservation Finance: Can Banks Embrace Natural Capital? (Part 1)". Biofin, The UNDP Biodiversity Finance Initiative. <http://www.biodiversityfinance.net/news-and-media/conservation-finance-can-banks-embrace-natural-capital-part-1>

- 75 IPBES (Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services). 2018. *The Assessment Report on Land Degradation and Restoration: Summary for Policymakers*. Bonn, Germany: IPBES Secretariat. https://www.ipbes.net/system/tdf/spm_3bi_ldr_digital.pdf?file=1&-type=node&id=28335
- 76 Jones, D. and K. Pflieger. 2019. "Can We Use Nature to Mitigate Wildfire Risk?" Brink. 23 September 2019. <https://www.brinknews.com/can-we-use-nature-to-mitigate-wildfire-risk/>
- 77 OECD. 2019. Op. cit.
- 78 Schwab, N. and K. Rechberger. 2019. "We Need to Protect 30% of the Planet by 2030. This Is How We Can Do It". World Economic Forum Global Agenda. 22 April 2019. <https://www.weforum.org/agenda/2019/04/why-protect-30-planet-2030-global-deal-nature-conservation/>
- 79 Avery. 2019. Op. cit.
- 80 Avery, H. 2019. "Conservation Finance: Can Banks Embrace Natural Capital?" *Euromoney*. 08 October 2019. <https://www.euromoney.com/article/b1hh1rccjthqmd/conservation-finance-can-banks-embrace-natural-capital>
- 81 Schwab, K. 2019. "Ending Short-Termism by Keeping Score". Project Syndicate. 17 October 2019. <https://www.project-syndicate.org/commentary/scorecard-to-end-short-termism-by-klaus-schwab-2019-10>
- 82 Gaborone Declaration for Sustainability in Africa. 2012. Ecosystem Valuation and Natural Capital Accounting. <http://www.gaboronedeclaration.com/nca>
- 83 Souchet, F. 2019. "Fashion Has a Huge Waste Problem. Here's How It Can Change". World Economic Forum Global Agenda. 28 February 2019. <https://www.weforum.org/agenda/2019/02/how-the-circular-economy-is-redesigning-fashion-future/>
- 84 United Nations. 2019. "UN Report: Nature's Dangerous Decline 'Unprecedented'; Species Extinction Rates 'Accelerating'". Sustainable Development Goals Blog entry. 06 May 2019. <https://www.un.org/sustainabledevelopment/blog/2019/05/nature-decline-unprecedented-report/>; Sonter, L. J., S. H. Ali and J. E. M. Watson. 2019. "Mining and Biodiversity: Key Issues and Research Needs in Conservation Science". *Proc Biol Sci*. 285 (1892): 20181926. <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6283941/>
- 85 OECD. 2019. Op. cit.





Wild Wide Web

Consequences of Digital Fragmentation



Heightened geopolitical tensions discussed in previous chapters also risk negatively influencing the huge economic potential of the next generation of technologies. The current lack of global technology governance and the presence of cybersecurity blind spots increase

the risk of a fragmented cyberspace and competing technology regulations. This chapter contemplates how a fragmented cyberspace and differing technological standards could hinder economic growth, exacerbate geopolitical rivalries and further divide societies.

The 4IR: The new economy

More than 50% of the world's population is now online;¹ roughly one million more people join the internet each day.² Two-thirds of humanity own a mobile device.³ Fourth Industrial Revolution (4IR) technologies are already bringing tremendous economic and societal benefits to much of the global population.

The next wave of 4IR technologies will dramatically reshape economies and societies. Precision medicine, autonomous vehicles and drones are all fast-growing markets (see Figure 5.1), while artificial intelligence (AI) alone is expected to boost global growth by 14% by 2030.⁴

Smart technologies have enormous potential to improve both human life and the health of the planet. For example, satellite-based applications can aid rural farmers to irrigate their crops efficiently.⁵ Prostheses can be 3D printed.⁶ Autonomous vehicles can be employed by the elderly to support better mobility.⁷ The Internet of Things (IoT) can even help to lower CO₂ emissions by optimizing energy consumption and reducing traffic congestion.⁸

However, many unintended consequences have also surfaced. Cyberattacks have become a common hazard for individuals

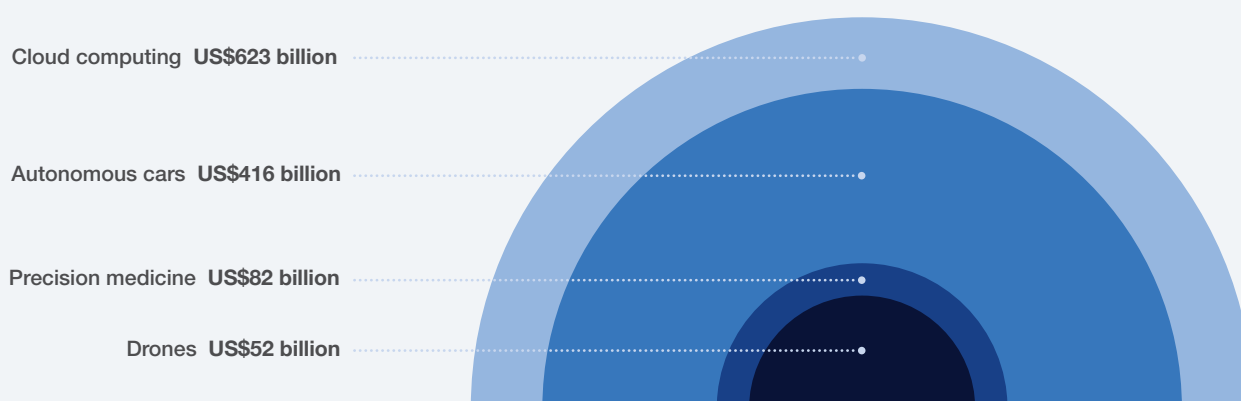
and businesses: our surveys rank them as the seventh most likely and eighth most impactful risk, and the second most concerning risk for doing business globally over the next 10 years (see Figure II, The Global Risks Landscape). Fifth generation (5G) networks, quantum computing and AI are creating not only opportunities but also new threats of their own. The lack of a global governance framework for technology risks fragmenting cyberspace, which could deter economic growth, aggravate geopolitical rivalries and widen divisions within societies.

The dangers of digital innovation

Cyberattacks. The digital nature of 4IR technologies makes them intrinsically vulnerable to cyberattacks that can take a multitude of forms—from data theft and ransomware to the overtaking of systems with potentially large-scale harmful consequences. Operational technologies are at increased risk because cyberattacks could cause more traditional, kinetic impacts as technology is being extended into the physical world, creating a cyber-physical system. However, using “security-by-design” principles to integrate cybersecurity features into new products is still secondary to getting products quickly out into the market.

FIGURE 5.1

2025 Market Projections for 4IR Technologies



Sources: Cloud computing: <https://www.researchcosmos.com/reports/cloud-computing-market/92916729>; Precision medicine: <https://www.globenewswire.com/news-release/2019/08/22/1905339/0/en/Global-Precision-Medicine-Market-Expected-To-Reach-over-USD-86-25-Billion-By-2025-Zion-Market-Research.html>; Drones: https://www.researchandmarkets.com/research/vx2jd5/global_unmanned?w=5; Autonomous cars: https://www.marketwatch.com/press-release/autonomous-car-market-value-at-expected-to-reach-usd-41639-billion-by-2025-cagr-412-2019-07-26?mod=mw_quote_news

Cyberattacks on critical infrastructure—rated the fifth top risk in 2020 by our expert network—have become the new normal across sectors such as energy,⁹ healthcare,¹⁰ and transportation.¹¹ Such attacks have even affected entire cities.¹² Public and private sectors alike are at risk of being held hostage. Organized cybercrime entities are joining forces,¹³ and their likelihood of detection and prosecution is estimated to be as low as 0.05% in the United States.¹⁴ Cybercrime-as-a-service is also a growing business model, as the increasing sophistication of tools on the Darknet makes malicious services more affordable and easily accessible for anyone.

The IoT is also amplifying the potential cyberattack surface. It is estimated that there are already over 21 billion IoT devices worldwide,¹⁵ and their number will double by 2025.¹⁶ Attacks on IoT devices increased by more than 300% in the first half of 2019,¹⁷ while in September 2019, IoTs were used to take down Wikipedia through classic distributed denial of service (DDoS) attacks,¹⁸ and the risk of IoT devices being used as intermediaries is expected to increase.¹⁹ In 2021, cybercrime damages might reach US\$6 trillion²⁰— what would be equivalent to the GDP of the world's third largest economy.²¹

Vulnerable data. 4IR technologies run on data, making privacy a major challenge. IoT devices collect and share data that are potentially highly sensitive for individuals, companies and states, from personal identification and medical records to national security information. The data brokering market—aggregating, disaggregating, copying, searching and selling data for commercial purposes—is worth an estimated US\$200 billion a year.²² Data theft can enable the manipulation of individual and collective behaviour, leading to physical and psychological harm.

Artificial intelligence (AI). AI has been dubbed both “the most impactful invention” and our “biggest existential threat”.²³ Indeed, we may not even be able to comprehend AI's full potential—or its full risk. Some risks—such as manipulation through fake news and “deepfakes”—are well known.²⁴ Others are yet to be fully

uncovered, including in such areas as brain-computer interfaces and hyper-automation (combining robotics and AI).²⁵

Fifth generation (5G). 4IR technologies rely on high-speed digital infrastructure—on 5G networks and, further down the road, 6G.²⁶ While 5G technology can be built in part on existing 4G infrastructure, significant shortfalls in capacity are expected as early as 2020 in some countries.²⁷ Current projections show the risk of a US\$1 trillion global gap in telecommunication infrastructure investments through 2040.²⁸ In developed countries, the challenge is not only to build modern infrastructure but also to overcome reliance on legacy systems, on which the public and private sectors currently spend up to 80% of their technology budgets. Here, introducing new, safe and reliable systems into existing capabilities is key; some entities have already begun to do this.²⁹

One million

additional people joining the internet daily

Quantum computing. Quantum computing could dramatically reduce the time needed to solve the mathematical problems on which encryption techniques currently rely—from months to minutes and seconds.³⁰ It risks rendering useless most of our existing data security and critical infrastructure systems, including military networks, email and power grids.³¹

Cloud computing. While many technical advancements of 4IR are essentially digitally based, cloud computing has the potential to enhance trans-sectoral development, expand technological access to remote areas and further link AI to other 4IR technologies. At the same time, with increasingly more data hosted in the cloud, companies are amassing personal information like never before, which could ultimately create potential new data privacy and security risks.³²

The proliferation of standards makes it more difficult to converge on a single one

The importance of global tech and cyber governance

Attempts to address the security challenges of 4IR technologies are maturing, but they are often still fragmented and limited in scope and participants. Numerous initiatives bring together businesses and governments to build trust, promote security in cyberspace, assess the impact of cyberattacks and assist victims.³³ Multilateral efforts, such as the Council of Europe's Budapest Convention, also aim to define responsible behaviour in cyberspace and harmonize the patchwork of existing laws and regulations.³⁴ Collaborative incident response and information-sharing efforts attempt to centralize cybersecurity capabilities to reduce the impact of cyberattacks.³⁵

International efforts to develop AI standards are also ongoing (for example, in the field of AI and ethics alone, there are over 80 frameworks),³⁶ yet the large increase in such initiatives serves to fragment the response to the threat, often imposing burdensome and sometimes conflicting obligations on organizations operating across national boundaries. The proliferation of standards also makes it more difficult for countries and companies to converge on a single one as more AI-enabled systems are adopted.

Even more critical, international and national policies are not keeping up with technological advances. The need is urgent for a more comprehensive, inclusive and agile global governance architecture to address the dynamic and intertwined security issues raised by the 4IR. The “age of digital interdependence” will benefit all societies only if the wide-ranging geopolitical, economic and societal risks it could bring are managed in a coordinated and inclusive way.³⁷ The current disruption of the multilateral system (see Chapter 1, Global Risks 2020) renders the development of such a framework more challenging.

Geopolitical risks

Digital innovation is both influencing and being influenced by geopolitical tension, which amplifies the possibility for risk and minimizes the chances for cooperation. At the same time, the private sector exercises significant power to impact outcomes in this realm. Indeed, global tech companies have leveraged open digital borders to integrate global supply chains and connect people worldwide—but these companies are also challenging some core competencies of nation states, such as standard-setting and monetary policies. Technological predominance and future national competitiveness go hand in hand. The lack of a global tech governance framework increases business influence on standard-setting, the foreign participation in national critical infrastructure, foreign acquisition of domestic technology, the offshoring of data, and technology transfer as a price to access foreign markets,³⁸ influencing *societal risks* as well (see below). Additional risks for states include:

Parallel cyberspace. Connectivity depends on internationally established protocols. Historically, multilateral stakeholders have tended to favour a fairly open and loosely regulated cyberspace. However, current international developments point to an increased risk of divergence in protocols—old and new—that could lead to fragmentation of cyberspace and future technologies.³⁹ Additionally, if countries continue to seek “cyber-sovereignty”—national or regional versions of the internet⁴⁰—global interconnectivity could be further disrupted.

First-mover advantage. Patents in 4IR technologies are being filed at an increasing rate.⁴¹ Governments as well as businesses want to be at the forefront of cutting-edge technologies because they stand to benefit from being the first to make breakthroughs. First-mover advantage can shift geopolitical balance by influencing standards, systems and production chains.



A new digital arms race. Digital dependency is changing the nature of international and national security, raising three urgent issues: how to protect critical infrastructure, uphold societal values and prevent the escalation of state-on-state conflicts. Digital technologies increasingly feature in asymmetric warfare, enabling attacks by smaller countries and non-state actors on larger states. Viruses developed as cyberweapons have been re-purposed by adversaries after being released into cyberspace. Cyberspace has become an extension of the military domain, triggering new technological arms races.⁴²

In 2019, several countries agreed to pursue the establishment of guiding principles for the use of lethal autonomous weapons systems.⁴³ However, key military powers are resisting international legal regulation in this area, increasing the risk of serious future mishaps.

Interruption of international interconnectivity. Increased intelligence-sharing between government cybersecurity agencies and infrastructure operators has strengthened the appreciation of challenges related to cyberattacks and improved

preparedness efforts. It has also raised the question of whether the participants in critical information infrastructure are trustworthy. The fragmentation of cyberspace will render those efforts moot and create possibly insurmountable technological incompatibilities for law enforcement to cooperate across varying systems.

Economic risks

It is no surprise that technology hardware supply chains have driven recent research and development (R&D) and trade debates between major global economies.⁴⁴ Many countries are heavily scrutinizing investment in—or acquisition of—technology companies by foreign investors. Countries are increasingly looking at foreign investment in universities to assess risks of intellectual property—in the form of research and its potential commercial applications—vanishing abroad. Technology transfers in exchange for market access have become a contested part of trade negotiations.

These issues highlight the trade-offs countries are making between near-term economic gain at a time of slow growth and longer-term security in an increasingly challenging geopolitical context. Europe's

desire for its own cloud—in part to retain valuable data now being extracted by foreign players—risks it falling behind in this global race. Other economic risks include:

Fragmentation costs. In today's hyperconnected global economy, it is estimated that a total shutdown of the internet would result in a daily GDP loss of 1.9% in a high-connectivity country and 0.4% in a low-connectivity country.⁴⁵ Fragmentation of cyberspace and technologies could aggravate these economic consequences by having negative effects on businesses' use of cloud services,⁴⁶ increased transactional costs of doing business across parallel jurisdictions and lower productivity by requiring different production lines for different markets. These economic consequences undermine businesses' ability to realize the potential of 4IR technologies.

Loss of sustainability. As the world is on the brink of climate collapse (see Chapter 3, A Decade Left), the necessary duplication of efforts for overcoming such technical fragmentation would not only be economically counterproductive, but also environmentally inefficient. This inefficiency is further amplified by countries' pursuit of isolated national technology regulations. Adaptation to different products for different markets would

inevitably increase the negative environmental footprint of any industry. At the same time, today's ecological footprint of mass data generated for and by AI—for example, the energy required to run servers—is already considerable.⁴⁷

Monetary and fiscal risks. The lack of coordinated efforts by nations on how to capture wealth created by open trade and through digital means is a major challenge, creating disparities with local companies and between countries. Moreover, new digital currencies operating outside a clear regulatory framework could undermine sovereign currencies and international cooperation against money laundering. Collapse in confidence in digital currencies could also threaten financial stability.⁴⁸ At the same time, innovation in this space could provide social benefit but this requires, as

then-IMF Chair Christine Lagarde warned, “being alert to risks in terms of financial stability, privacy or criminal activities, and ensuring appropriate regulation is in place to steer technology toward the public good.”⁴⁹

Societal risks

The differential speed of 4IR developments around the world risks widening divides between nations. Highly digitized economies have the capacities and capital to invest in future technologies, leaving behind others—especially in Africa, ASEAN and Latin America—that currently trail in areas such as patents, IoT development and market capitalization.⁵⁰ Societal risks include:

Digital divide and wealth gaps. A widening digital divide between countries risks a vicious cycle, as increasing wealth gaps and a brain drain make it harder for those left behind to catch up, and easier for regions to miss critical investment opportunities that would allow access to new 4IR technology markets. Hence, countries could lose out on the compounding effect of investments and subsequently lack the R&D capabilities needed to thrive, contributing to yet further brain drain. Within countries, wealth gaps could also increase: automation is forecasted to hit low-skilled workers and women the hardest.⁵¹ Societal divides could also widen between rural and urban areas in developing economies,⁵² and between smart and non-smart cities in developed countries.⁵³ The wide-scale affordability of new technologies will be one important factor for minimizing the digital divide.⁵⁴

A human dystopia. Given the growing societal awareness of problems such as biased algorithms and cyberbullying,⁵⁵ there are many calls for deeper engagement on questions of ethics in the development and use of 4IR technologies.⁵⁶ Due diligence must be applied to avoid negative consequences for under-represented communities. The lack of a global technological framework could lead to a dystopia involving, for example, cyberbullying without consequences, workplace surveillance and the erosion of employee privacy.⁵⁷

While the open cyberspace has allowed the democratization of certain processes and increased access to information and data, growing opportunities for promoting

80

number of international frameworks of ethics and AI



falsehoods (accidentally and deliberately) have resulted in a gradual erosion of trust in media, social networks and even governments.

Data are increasingly being collected on citizens by government and business alike, and these data are then monetized and used to refine the development and deployment of new technologies back towards these citizens, as consumers. Amassing of data by a handful of small entities leads to a further entrenchment of gaps between advanced and emerging economies.

Global governance challenges for businesses

Businesses, just as economies, rely on concerted global technology governance. Fragmentation and incompatibility between global cybersecurity and technology frameworks risk weakening businesses' capabilities to adapt to the emerging challenges discussed in this chapter in a timely way, as raising transactional costs increases the financial burden on businesses.

More and more firms operate in complex, global and digital service ecosystems that not only expose them to their own cyber and technological weaknesses, but also to those of other participants—including customers, suppliers and managed system providers. At the same time,

businesses are facing the challenge of implementing existing cybersecurity and 4IR standards (where they exist), while ensuring compliance with fragmented regulations on accountability, transparency, bias and privacy for developing—or simply applying—4IR technologies. Because government and corporate leaders equally share the responsibility for promoting global cybersecurity and digital trust, cooperation between the public and private sectors is more vital than ever in areas such as information-sharing, collaboration with law enforcement agencies, and skill and capacity development.

The new digital geopolitical race (see Chapter 1, *Global Risks 2020*) also risks affecting businesses' development of 4IR technologies and their market readiness to harness the benefits of the 4IR transformation. An open and interconnected cyberspace, along with global technological compatibility, are essential for businesses to be able to counter the dislocating impacts of social media, the economic impacts of global technology giants and potential security issues resulting from the digital technology race between the world's leading economies. By advocating for fair and concerted global actions on any 4IR-related governance frameworks, businesses can mitigate risks, ensure trust towards consumers and governments, and increasingly benefit from the 4IR.

Notes

- 1 ITU (International Telecommunication Union). 2019. *Measuring Digital Development: Facts and Figures 2019*. Geneva: ITU. <https://www.itu.int/en/ITU-D/Statistics/Documents/facts/FactsFigures2019.pdf>
- 2 Kemp, S. 2019. "Digital 2019: Global Digital Overview". Datareportal. <https://datareportal.com/reports/digital-2019-global-digital-overview>
- 3 Turner, A. 2019. "How Many Phones Are in the World?" Bankmycell. <https://www.bankmycell.com/blog/how-many-phones-are-in-the-world>
- 4 PwC. 2019. "Sizing the Prize. What's the Real Value of AI for Your Business and How Can You Capitalise?" <https://www.pwc.com/gx/en/issues/analytics/assets/pwc-ai-analysis-sizing-the-prize-report.pdf>
- 5 Patel, K. 2018. "Smart Phones Bring Smart Irrigation". NASA Earth Observatory. <https://earthobservatory.nasa.gov/images/92903/smart-phones-bring-smart-irrigation>
- 6 Amputee Coalition. 2019. "3D Printed Prosthetics, Where Are We Today". *Amputee Coalition Blog* post, 08 February 2019. <https://www.amputee-coalition.org/3d-printed-prosthetics/>
- 7 Chapman, M. M. 2019. "Self-Driving Cars Could Be Boon for Aged, After Initial Hurdles". *The New York Times*. 23 March 2017. <https://www.nytimes.com/2017/03/23/automobiles/wheels/self-driving-cars-elderly.html>
- 8 Roberts, D. 2019. "Smarter Cities Will be More Efficient Cities". *Forbes Council* post, 22 November 2019. <https://www.forbes.com/sites/forbestechcouncil/2019/11/22/smarter-cities-will-be-more-efficient-cities/#3bd950332128>
- 9 Siemens and Ponemon Institute. 2019. *Caught in the Crosshairs: Are Utilities Keeping Up with the Industrial Cyber Threat?* Houston: Siemens Gas and Power. <https://assets.new.siemens.com/siemens/assets/api/uuid:35089d45-e1c2-4b8b-b4e9-7ce-8cae81eaa/version:1572434569/siemens-cybersecurity.pdf>
- 10 Muresan, R. 2019. "Healthcare Continues to Be Prime Target for Cyber Attacks". Bitdefender *Business Insights Blog* post. 07 January 2019. <https://businessinsights.bitdefender.com/healthcare-prime-target-for-cyber-attacks>
- 11 Palmer, D. 2019. "Hackers Target Transportation and Shipping Companies in new Trojan Malware Campaign". *ZDNet*. 23 September 2019. <https://www.zdnet.com/article/hackers-target-transportation-and-shipping-industries-in-new-trojan-malware-campaign/>
- 12 Chokshi, N. 2019. "Hackers Are Holding Baltimore Hostage: How They Struck and What's Next". *The New York Times*. 22 May 2019. <https://www.nytimes.com/2019/05/22/us/baltimore-ransomware.html>
- 13 Keesem, L. 2019. "The Business of Organized Cybercrime: Rising Intergang Collaboration in 2018". *SecurityIntelligence*. 20 March 2019. <https://securityintelligence.com/the-business-of-organized-cybercrime-rising-intergang-collaboration-in-2018/>
- 14 Eoyang, M., A. Peters, I. Mehta and B. Gaskew. 2018. *To Catch a Hacker: Toward a Comprehensive Strategy to Identify, Pursue, and Punish Malicious Cyber Actors*. Third Way. 29 October 2018. <https://www.thirdway.org/report/to-catch-a-hacker-toward-a-comprehensive-strategy-to-identify-pursue-and-punish-malicious-cyber-actors>
- 15 Gartner. 2017. *Leading the IoT: Gartner Insights on How to Lead in a Connected World*. https://www.gartner.com/imagesrv/books/iot/iotEbook_digital.pdf (page 2).
- 16 IDC (International Data Corporation). 2019. "The Growth in Connected IoT Devices Is Expected to Generate 79.4ZB of Data in 2025, According to a New IDC Forecast". IDC. 18 June 2019. <https://www.idc.com/getdoc.jsp?containerId=prUS45213219>
- 17 Doffman, Z. 2019. "Cyberattacks on IoT Devices Surge 300% in 2019, 'Measured in Billions', Report Claims". *Forbes*. 14 Sept. 2019. <https://www.forbes.com/sites/zakdoffman/2019/09/14/dangerous-cyberattacks-on-iot-devices-up-300-in-2019-now-ram-pant-report-claims/#45642d105892>
- 18 Venkat, A. 2019. "Wikipedia Investigates DDoS Attack". Bankinfosecurity.com, Information Security Media Group (ISMG). 09 September 2019. <https://www.bankinfosecurity.com/wikipedia-investigates-ddos-attack-a-13049>
- 19 Collard, A. 2019. "Large-Scale IoT Attack Coming". *Gadget*. 6 December 2019. <https://gadget.co.za/large-scale-iot-attack-coming/>

- 20 Walker, I. 2019. "Cybercriminals Have Your Business in Their Crosshairs and Your Employees Are in Cahoots with Them". *Forbes*. 31 January 2019. <https://www.forbes.com/sites/ivywalker/2019/01/31/cybercriminals-have-your-business-their-crosshairs-and-your-employees-are-in-cahoots-with-them/#683a874a1953>
- 21 World Bank Open Data. 2019. https://data.worldbank.org/indicator/NY.GDP.MKTP.CD?most_recent_value_desc=true, accessed 1 December 2019.
- 22 WebFX. 2015. "What Are Data Brokers – And What Is Your Data Worth?". *FX Blog* post. April 2015. <https://www.webfx.com/blog/general/what-are-data-brokers-and-what-is-your-data-worth-infographic/>
- 23 Smith, B. 2019. "The combustion engine was the most impactful invention regarding the economy. Today, it could be compared with the impact of artificial intelligence". Microsoft Portugal (@PTMicrosoft) citing Brad Smith (@BradSmi #WebSummit", 05 November 2019. <https://twitter.com/PTMicrosoft/status/1191748602554650625>; Clifford, C. 2019. "Elon Musk: 'Mark My Words – A.I. Is Far More Dangerous Than Nukes'". *CNBC*. 13 March 2019. <https://www.cNBC.com/2018/03/13/elon-musk-at-sxsw-a-i-is-more-dangerous-than-nuclear-weapons.html>
- 24 Metz, C. "Internet Companies Prepare to Fight the 'Deepfake' Future". *The New York Times*. 24 November 2019. <https://www.nytimes.com/2019/11/24/technology/tech-companies-deepfakes.html>
- 25 Saha, S., K. A. Mamun, K. Ahmed, R. Mostafa, G. R. Naik, A. Khandoker, S. Darvishi and M. Baumert. 2017. "Progress in Brain Computer Interfaces: Challenges and Trends". <https://arxiv.org/ftp/arxiv/papers/1901/1901.03442.pdf>
- 26 Li, J. 2019. "Forget about 5G, China Has Kicked Off Its Development of 6G". *Quartz*. 07 November 2019. <https://qz.com/1743790/forget-5g-china-begins-development-of-6g/>
- 27 Grijpink, F., A. Ménard, H. Sigurdson and N. Vucevic. 2018. "The Road to 5G: The Inevitable Growth of Infrastructure Cost". McKinsey. February 2018. <https://www.mckinsey.com/industries/technology-media-and-telecommunications/our-insights/the-road-to-5g-the-inevitable-growth-of-infrastructure-cost>
- 28 Global Infrastructure Hub. 2019. Investment forecasts for Telecommunications. Global Infrastructure Outlook. <https://outlook.gihub.org/sectors/telecommunication>
- 29 Miller, J. 2018. "Spending on Legacy IT Continues to Grow, But There Is Light at the End of the Tunnel". *Federal News Network*. 17 August 2018. <https://federalnewsnetwork.com/ask-the-cio/2018/08/spending-on-legacy-it-continues-to-grow-but-there-is-light-at-the-end-of-the-tunnel/>; Bobeldijk, Y. 2017. "Banks Face Spiralling Costs from 50-Year-Old IT". *Financial News*. 02 October 2017. <https://www.fnLondon.com/articles/banks-face-spiraling-costs-from-archaic-it-20170912>
- 30 Gibney, E. 2019. "Hello Quantum World! Google Publishes Landmark Quantum Supremacy Claim". *Nature*. 23 October 2019. <https://www.nature.com/articles/d41586-019-03213-z>
- 31 Herman, A. and I. Friedson. 2018. *Quantum Computing: How to Address the National Security Risk*. Washington, DC: Hudson Institute. April 2018. <https://s3.amazonaws.com/media.hudson.org/files/publications/Quantum18FINAL4.pdf>
- 32 Smith, Z. 2019. "Can Big Money Crack Big Tech? The New Trends Threatening Today's Digital Giants". *Observer*. 05 October 2019. <https://observer.com/2019/10/amazon-google-microsoft-cloud-computing-big-tech-big-money/>
- 33 See the IGF (Internet Governance Forum) for a discussion of The Paris Call for Trust and Security in Cyberspace; the Cybersecurity Tech Accord; the Charter of Trust for a secure digital world; the Global Commission on Stability in Cyberspace, and the Global Cyber Alliance. See also the home page of the CyberPeace Institute, <https://cyberpeaceinstitute.org/>
- 34 Other examples include the UN's Group of Governmental Experts (UN GGE) and the new Open-Ended Working Group (OEWG) on Developments in the Field of Information and Telecommunications in the Context of International Security. Organizations such as the International Telecommunication Union, the World Bank and Interpol have also developed technology and security measures.
- Efforts have been led by regional organizations as well, such as the Organisation for Security and Cooperation in Europe, the Council of Europe, the Organization of American States, the ASEAN Regional Forum and the Organization of American States.
- See also recommendation 4 in United Nations. 2019. *The Age of Digital Interdependence: Report of the UN Secretary-General's High-level Panel on Digital Cooperation*. June 2019. <https://digitalcooperation.org/wp-content/uploads/2019/06/DigitalCooperation-report-web-FINAL-1.pdf>

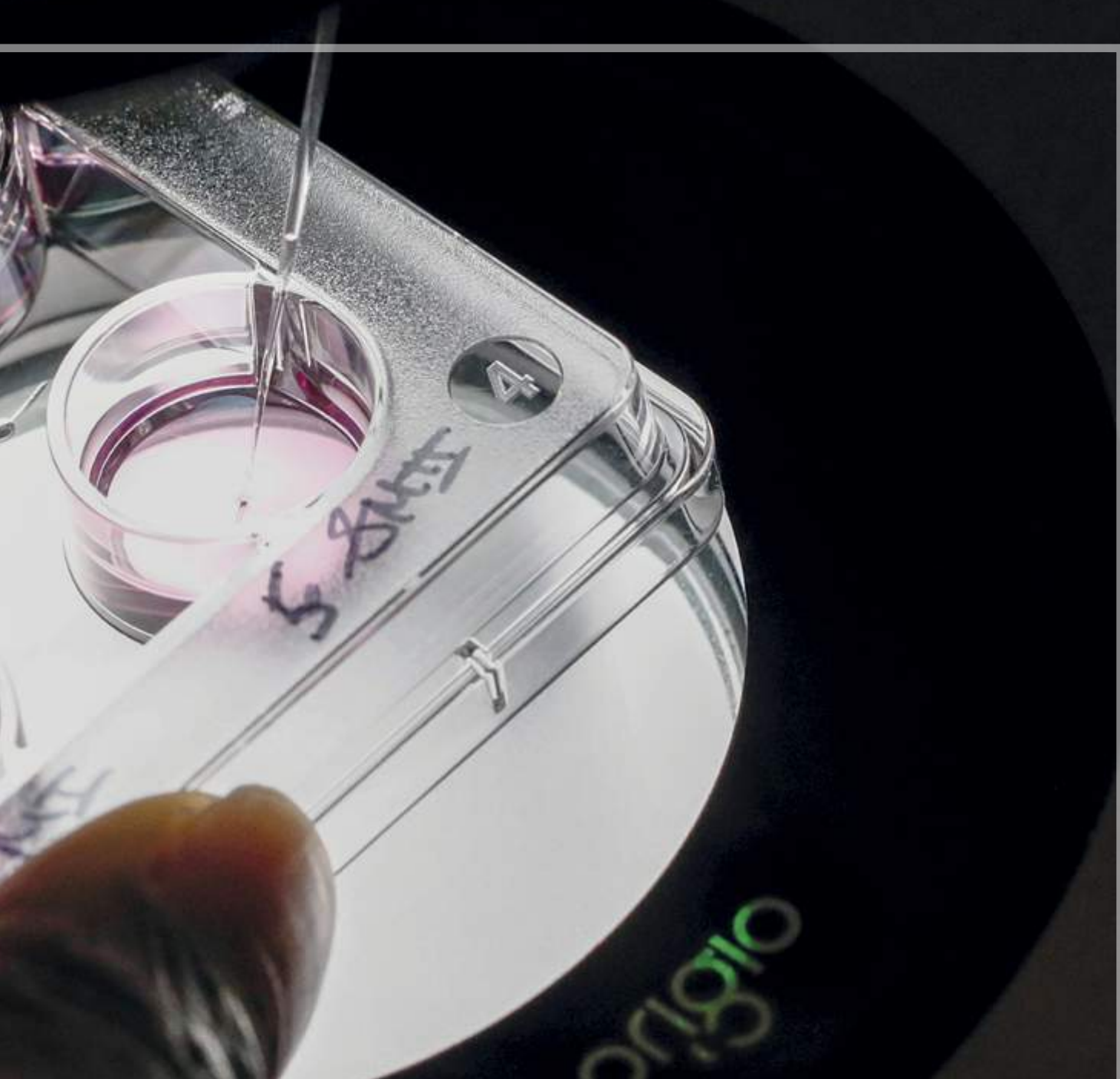
- 35 Examples include the Forum of Incident Response and Security Teams (FIRST), Information Sharing and Analysis Centers (ISACs), the Cyber Threat Alliance and the Cyber Defense Alliance.
- 36 Cihon, P. 2019. *Technical Report: Standards for AI Governance: International Standards to Enable Goal Coordination in AI Research & Development*. Oxford: Center for Governance of AI Future of Humanity Institute. April 2019. https://www.fhi.ox.ac.uk/wp-content/uploads/Standards_-FHI-Technical-Report.pdf
- 37 United Nations. 2019. Op. cit.
- 38 McDonald, J. 2019. "China Promises No Forced Tech Transfers, Access to Finance". *Associated Press*. 29 October 2019. <https://apnews.com/5dcec36663324b34b290f3f7f-378c6f3>
- 39 Waters, R. 2019. "No End in Sight to Split Internet Say Researchers". *Financial Times*. 20 February 2019. <https://www.ft.com/content/69f97e7e-34a3-11e9-bd3a-8b2a211d90d5>
- 40 Stanek, R. 2019. "Four Steps to Help Prepare for an Increasingly Balkanized Internet". 07 November 2019. *Forbes*. <https://www.forbes.com/sites/forbestechcouncil/2019/11/07/four-steps-to-help-prepare-for-an-increasingly-balkanized-internet/#7a8589086755>; Russia Today. 2019. "Russia to Launch 'Independent Internet' for BRICS Nations – Report". *Russia Today*. 28 November 2017. <https://www.rtt.com/russia/411156-russia-to-launch-independent-internet/>
- 41 KTU (Kaunas University of Technology). 2019. "Patent Filings around the World: Can Lithuania Compete?" *KTU News*. 23 October 2019. <https://en.ktu.edu/news/patent-filings-around-the-world-can-lithuania-compete/>; Benassi, M., E. Grinza and F. Rentocchini. 2019. "The Rush for Patents in the Fourth Industrial Revolution: An Exploration of Patenting Activity at the European Patent Office". *SPRU Working Papers Series*, SWPS 2019-12 (June). Sussex: University of Sussex Business School. <https://www.sussex.ac.uk/webteam/gateway/file.php?name=2019-12-swps-benassi-et-al.pdf&site=25>
- 42 Tao, A. L. 2019. "Black Hat Asia 2019: Get Ready for the Cyber Arms Race". *ComputerWeekly.com*. 02 April 2019. <https://www.computerweekly.com/news/252460807/Black-Hat-Asia-2019-Get-ready-for-the-cyber-arms-race>
- 43 CCW (Meeting of the High Contracting Parties to the Convention on Prohibitions or Restrictions on the Use of Certain Conventional Weapons Which May Be Deemed to Be Excessively Injurious or to Have Indiscriminate Effects). CCW, Final Report of the 2019 Meeting of the High Contracting Parties to the CCW (advance version), CCW/MSP/2019/CRP.2/Rev.1., 15 November 2019. [https://www.unog.ch/80256EDD006B8954/\(httpAs-sets\)/815F8EE33B64DADDC12584B7004CF3A4/\\$file/CCW+MSP+2019+CRP.2+Rev+1.pdf](https://www.unog.ch/80256EDD006B8954/(httpAs-sets)/815F8EE33B64DADDC12584B7004CF3A4/$file/CCW+MSP+2019+CRP.2+Rev+1.pdf)
- 44 Markman, J. 2019. "Trade War with China Will Hit U.S. Tech Companies Hard". *Forbes*. 30 September 2019. <https://www.forbes.com/sites/jonmarkman/2019/09/30/trade-war-with-china-will-hit-u-s-tech-companies-hard/#7621e04c6cca>
- 45 Deloitte. 2016. *The Economic Impact of Disruptions to Internet Connectivity. A Report for Facebook*. Deloitte. <https://www2.deloitte.com/content/dam/Deloitte/global/Documents/Technology-Media-Telecommunications/economic-impact-disruptions-to-internet-connectivity-deloitte.pdf>
- 46 Accenture. 2017. *Digital Fragmentation: Adapt to Succeed in a Fragmented World*. Accenture. https://www.accenture.com/_acnmedia/pdf-60/accenture-digital-fragmentation-interactive-pov.pdf#zoom=50
- 47 Hao, K. 2019. "Training a Single AI Model Can Emit as Much Carbon as Five Cars in Their Lifetimes. Deep Learning Has a Terrible Carbon Footprint". *MIT Technology Review*. 06 June 2019. <https://www.technologyreview.com/s/613630/training-a-single-ai-model-can-emit-as-much-carbon-as-five-cars-in-their-lifetimes/>
- 48 Wagner, K. 2019. "Facebook Says Central Banks Have Nothing to Fear from Libra". *Bloomberg*. 17 September 2019. <https://www.bloomberg.com/news/articles/2019-09-17/facebook-says-central-banks-have-nothing-to-fear-from-libra>
- 49 IMF (International Monetary Fund). 2019. Opening Statement by Christine Lagarde to the Economic and Monetary Affairs Committee of the European Parliament. 04 September 2019. <https://www.imf.org/en/News/Articles/2019/09/04/sp090419-Opening-Statement-by-Christine-Lagarde-to-ECON-Committee-of-European-Parliament>
- 50 UNCTAD (United Nations Conference on Trade and Development). 2019. *Digital Economy Report 2019. Value Creation and Capture: Implications for Developing Countries*. New York: United Nations. https://unctad.org/en/PublicationsLibrary/der2019_en.pdf

- 51 Hong, S. and H. G. Shell. 2018. "The Impact of Automation on Inequality". *Economic Synopses* 29 (2018). <https://files.stlouisfed.org/files/htdocs/publications/economic-synopses/2018/11/19/the-impact-of-automation-on-inequality.pdf>; Hassan, A. 2019. "Workplace Automation Will Hit Women Harder Than Men". *Quartz*. 01 April 2019. <https://qz.com/1583578/workplace-automation-will-hit-women-harder-than-men/>
- 52 ITU (International Telecommunication Union). 2018. *ICTs, LDCs and the SDGs: Achieving Universal and Affordable Internet in the Least Developed Countries*. Geneva: ITU. <https://www.itu.int/en/ITU-D/LDCs/Pages/Publications/LDCs/D-LDC-ICTLDC-2018-PDF-E.pdf>
- 53 Martinez, M. 2019. "Will There Be a Digital Divide between Smart and Dumb Cities?" *Smart.City_Lab Blog* post. 11 July 2019. <https://www.smartcitylab.com/blog/digital-transformation/will-there-be-a-digital-divide-between-smart-and-dumb-cities/>
- 54 Roy Morgan. 2019. *Measuring Australia's Digital Divide: The Australian Digital Inclusion Index 2019*. https://www.csi.edu.au/media/2019_ADII_Report.pdf
- 55 Ionos. 2019. "Social Networks: The 5 Most Common Dangers and Which Actions to Take". *Digital Guide*. 06 September 2019. <https://www.ionos.com/digitalguide/online-marketing/social-media/social-networks-dangers-of-social-media/>
- 56 The Royal Society. 2019. *iHuman: Blurring Lines between Mind and Machine*. September 2019. London: The Royal Society. <https://royalsociety.org/-/media/policy/projects/i-human/report-neural-interfaces.pdf>
- 57 United Nations. 2019. United Nations, General Assembly. Report of the Special Rapporteur on Extreme Poverty and Human Rights, A/74/493 (11 October 2019). <https://undocs.org/A/74/493>



False Positive

Health Systems under New Pressures



The institutions and approaches that have until now enabled health progress across the world are straining under gathering pressures and seem outmatched against new risks.

Health systems around the world are at risk of becoming unfit for purpose. Changing societal, environmental, demographic and technological patterns are straining their capacity. Vaccine hesitancy and drug resistance are undermining progress against pandemics, making it increasingly difficult to land the final blow

against some of humanity's biggest killers. Meanwhile, new vulnerabilities threaten to undo the dramatic gains in wellness and prosperity that health systems have supported over the last century. Non-communicable diseases (NCDs)—such as cardiovascular diseases or mental illness—have replaced infectious diseases as the leading cause of death. As existing health risks resurge and new ones emerge, humanity's past successes in overcoming health challenges are no guarantee of future results.

The slowing of health progress

Global investments in health in recent decades have yielded substantial gains to both longevity and quality of life. Over the long history of our species, the average life expectancy at birth for people in most societies ranged from 20 to 50 years. Since 1950, this has improved significantly—to 72 years globally,¹ of which 63 years on average are lived in good health, free of disease or disability (see Figure 6.1).²

Many factors have contributed to this success: scientific breakthroughs; better hygiene, sanitation and nutrition; health policies and investments made possible by prosperity; international cooperation; and individual choices. Vaccines illustrate this point: after germ theory took hold in the late 19th century, scientists developed vaccines for many deadly infectious diseases including smallpox, measles, polio, pertussis, diphtheria, tetanus and tuberculosis. Smallpox—once among the deadliest diseases—was the first to be eradicated by national programmes and international cooperation in surveillance and containment, reinforced by people’s trust in health systems and their willingness to be vaccinated. Coordinated immunization programmes continue to prevent millions of deaths annually.³

However, strained health systems are leading to worrying trends. Gains in lifespan and healthspan (the number of years spent in good health) seem to be slowing in both developed and developing countries.⁴ For example, recent data published by the Centers for Disease Control and Prevention shows that US life expectancy declined in 2017 for the third year in a row, the longest sustained drop for a century—since the combined effects of World War I and a global influenza pandemic.⁵ In Singapore, although life expectancy has increased since 1990, people are spending more of their lives in sickness.⁶ Disparities in health outcomes persist within and across countries. A baby born in Hong Kong SAR can expect to live for 85 years, versus just 52 years in the Central African Republic (Figure 6.1).⁷ Meanwhile, rich-poor health gaps are growing in countries including the United Kingdom and the United States.⁸

Pressures on health systems

Gathering pressures are straining health systems on many fronts. In this section, we discuss long-standing challenges as well as the next generation of health pressures that health systems are now confronting.

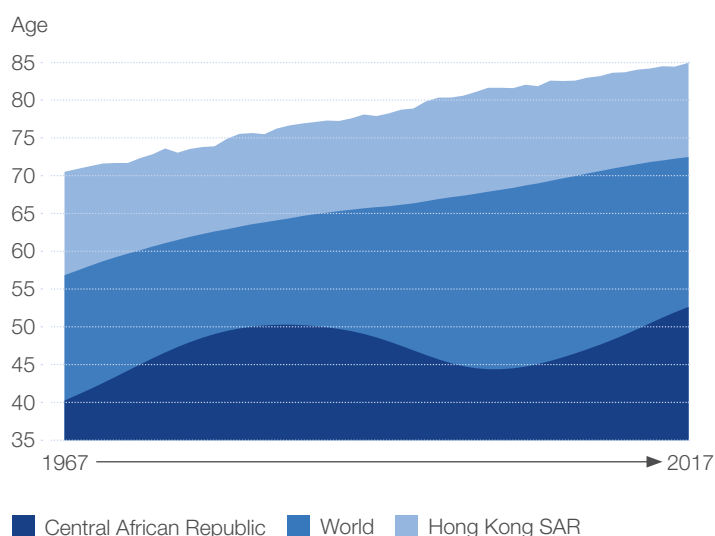
Familiar foes

There is no guarantee that health systems will continue to improve health, and clear signs of strain are apparent. Despite historic, hard-won success against diseases such as smallpox, some of humanity’s most formidable global health threats still linger—and other threats, thought to have been quashed, are resurgent.

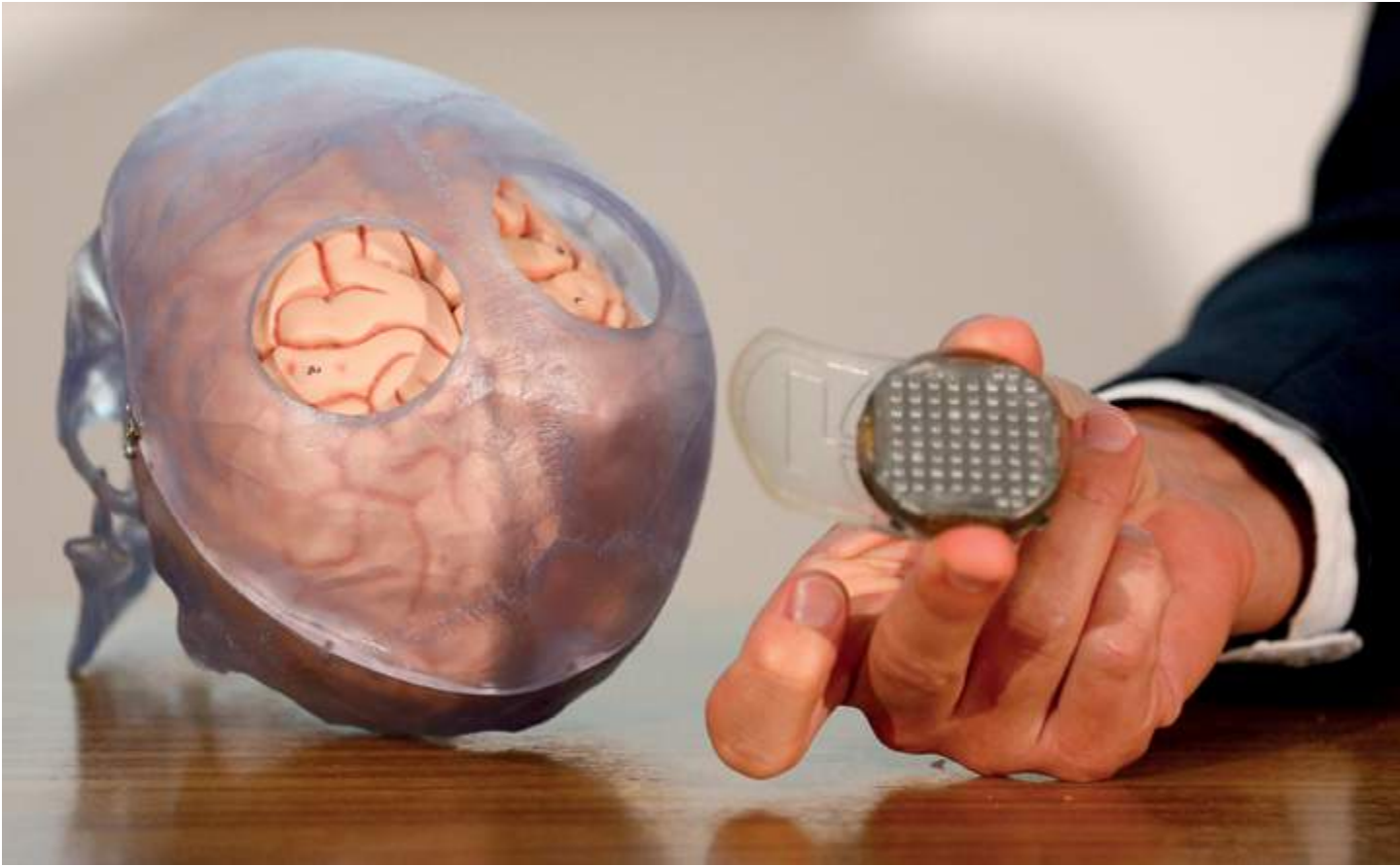
Persisting pandemics. Thirty years ago, polio was endemic in 125 countries, causing 350,000 clinical cases per year. After an extraordinary international effort and US\$20 billion in investment, today there are 99.9% fewer cases and polio remains endemic in only Afghanistan, Pakistan and possibly Nigeria—where geopolitical challenges have complicated eradication.⁹ Polio could potentially be eradicated in the next four years—but the estimated cost to make that happen would be another US\$4.2 billion.¹⁰ The last mile is proving the hardest, for reasons including persistent political instability and community

FIGURE 6.1

Life Expectancy at Birth, 1967–2017



Source: World Bank Open Data, <https://data.worldbank.org/>, accessed 15 December 2019.



resistance—which often stems in part from a perception that investments in polio eradication come at the expense of other health priorities.¹¹ Letting up is not an option because the short- and long-term benefits of eradicating this enduring scourge would be massive.

Similar stories can be told about HIV/AIDS, tuberculosis and malaria. After years of remarkable progress as a result of sustained political commitment and funding via the Global Fund, ambitions to end these epidemics by 2030 are being undermined by factors such as diseases’ increasing resistance to drugs.¹²

Vaccine hesitancy. The World Health Organization (WHO) considers reluctance or refusal to vaccinate to be among the top 10 threats to global health.¹³ Growing vaccine hesitancy has led to outbreaks of measles worldwide, including in developed countries where it had largely been eliminated.¹⁴ New York City spent US\$6 million in 2019 responding to a completely preventable measles outbreak.¹⁵ Making fewer headlines than the massive Ebola outbreak in the Democratic Republic of Congo, that country

33 years

widest gap in life expectancy between countries

also recently saw the world’s largest measles outbreak, affecting over 200,000 people in less than a year.¹⁶ The resurgence of measles is a symptom of complacency and recklessness.

Antimicrobial resistance (AMR). As measles and other infectious diseases strain health systems by siphoning off limited resources and attention, overuse of antibiotics poses a direct threat to health and healthcare. AMR makes antibiotics less effective at treating illnesses. Surgeries that have become routine, infections we now think of as easily treatable, and some common illnesses could again become life-threatening.¹⁷ The WHO estimates that AMR could result in 10 million deaths by 2050.¹⁸

Global health security risks.

Considerable progress has been made since the Ebola epidemic in West Africa in 2014–2016, but health systems worldwide are still under-prepared for significant outbreaks of other emerging infectious diseases, such as SARS, Zika and MERS. A recent first-of-its-kind comprehensive assessment of health security and related capabilities across 195 countries found fundamental weaknesses around the world: no country is fully prepared to handle an epidemic or pandemic.¹⁹ Meanwhile, our collective vulnerability to the societal and economic impacts of infectious disease crises appears to be increasing.²⁰

Serious as these risks are, it can be argued that health systems nonetheless have a blueprint to mitigate them, and success requires only adequate attention. The same cannot be said for new health risks.

Emerging Risks

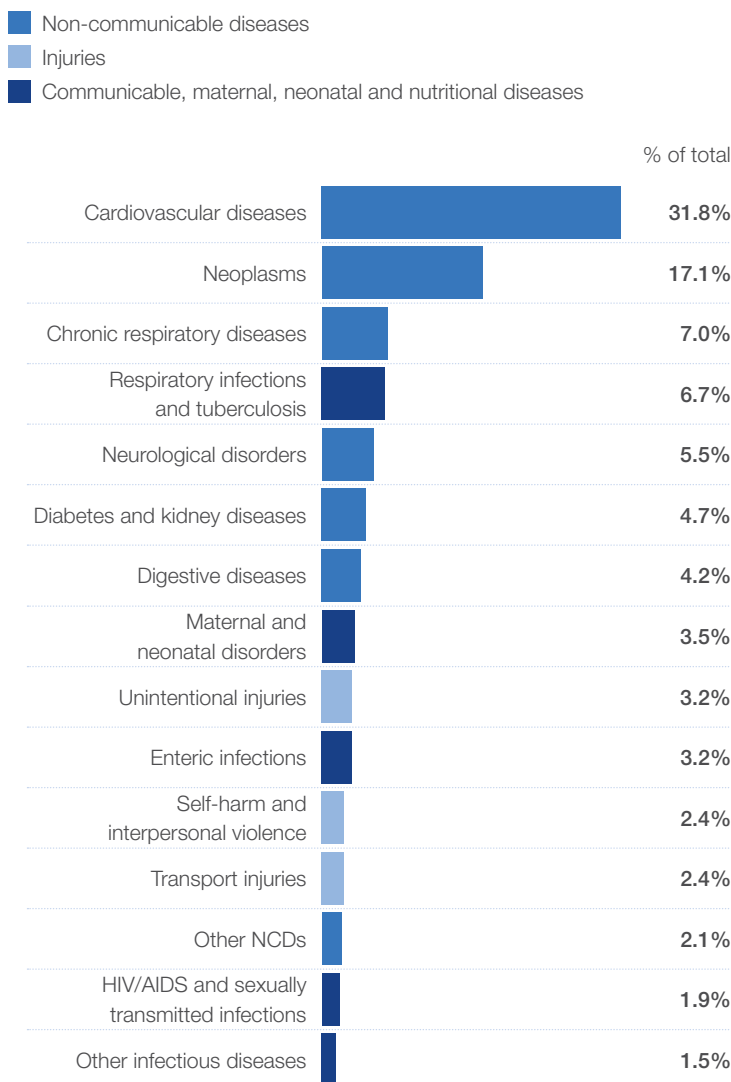
Longevity, lifestyle and climate changes are transforming disease burdens. Health systems need new infrastructure, resources and skills, but in many parts of the world they are failing to adapt—even as healthcare spending soars to unsustainable levels.

Non-communicable diseases (NCDs).

As populations grow, age and urbanize, NCDs and mental disorders have replaced infectious diseases as the leading threats to health and health systems worldwide. Once considered diseases of the rich world—linked to low-quality diets, little exercise and the use of tobacco and alcohol—chronic and degenerative conditions are now a global epidemic (see Figure 6.2). They account for 41 million deaths each year, of which 85% are in low- and middle-income countries, where people might grow old and ill before they become rich.²¹ By 2030, the WHO expects this figure to increase by 11 million, reaching 52 million in total, and deaths from infectious diseases to decline by 7 million.²² Depression and anxiety disorders are on the rise—they increased by 54% and 42% respectively from 1990 to 2013, according to WHO data.²³ Currently 700 million people worldwide are estimated to have a mental disorder.²⁴

While infectious diseases and pandemics pose an acute threat to human life, NCDs have a gradually crippling effect on the well-being of individuals and societies. Besides causing enormous physical and psychological suffering, the four leading NCDs—heart disease, cancer, diabetes and respiratory diseases, along with mental illness—could have cost the global economy an estimated US\$47 trillion (in treatment and lost productivity) over the 2010s and 2020s.²⁵ Dementia is expected to cost a further US\$2 trillion by 2030,²⁶ as each year brings 10 million new cases.²⁷ NCDs and mental disorders are difficult to prevent and treat as they stem from varied and complex causes, develop slowly, and often co-exist with other chronic conditions. Effective interventions need to target both individuals and

FIGURE 6.2
Top Global Causes of Death, 2017



Source: IHME (Institute for Health Metrics and Evaluation), *Global Burden of Disease Study 2017*, <http://www.healthdata.org/policy-report/findings-global-burden-disease-study-2017>

Dementia affects 10 million more people each year

populations, overcoming entrenched habits and commercial interests. Even in richer countries, the medical and social care costs of NCDs could bankrupt health systems.

NCDs could also disrupt societal cohesion: growing health inequalities could widen economic inequalities, earlier onset among younger people could stifle the economic growth necessary to fund care for older people, and ageing electorates could prioritize spending on pensions and healthcare over other issues such as education, infrastructure and climate resilience.

Climate change health effects. The WHO deems climate change to be “the greatest threat to global health in the 21st century”.²⁸ Human-induced climate change is already impacting the health of millions and challenging health systems globally.²⁹ It affects the quality of the air we breathe and both the quality and quantity of the water we drink and the food we eat. Air pollution is already costing the world more than US\$5 trillion from decreased productivity every year.³⁰ Extreme weather conditions are putting populations around the world at risk of food and water insecurity. Today’s children face a future of increasingly serious climate-related hazards: less nutritious crops, air pollution exacerbated by burning fossil fuels, rising average temperatures and other weather-related disruptions to livelihoods.³¹

Climate change also exacerbates the incidence of infectious diseases. Warming temperatures are expanding mosquito-friendly habitats beyond the tropics, spreading diseases such as malaria, dengue, yellow fever, West Nile virus and Zika into new regions. In 2015, the El Niño effect allowed Zika to spread from Brazil to the rest of South America.³² In 2012, the United States logged a record 5,500 cases of West Nile virus and an increase of 70% in dengue fever.³³ By 2080, extreme global warming could expose a billion people to mosquito-borne diseases in previously unaffected regions such as Europe and East Africa.³⁴



REUTERS/VALENTYN OGIRENKO

Demand–capacity mismatch. As more people live for longer with increasing health and social care needs, and as new drugs and technologies are developed, surging demand and expectations are stretching current approaches to financing care. Health expenditure growth is outpacing inflation in most countries.³⁵ It has reached an unsustainable 18% of GDP in the United States,³⁶ resulting in an increasing transfer of financial risk from insurance companies to individuals through rising premiums, co-pays and deductibles; and in bipartisan anger over drug prices, hospital bills and out-of-pocket spending.

Most health systems continue to focus on reactive care in hospitals—detecting and treating disease—and give too little attention to NCD prevention and control. They have yet to adapt their infrastructure to combine online, remote and retail care settings to improve information, screening, treatment and support for patients and carers. Health systems—and governments more broadly—will also need better health policies, regulations and promotion strategies to reduce environmental and lifestyle risk factors of NCDs.

Workforce limitations. Most health systems are training and retaining too few doctors, nurses and other health workers. For example, the UK National Health Service has an estimated 94,000 unfilled vacancies in hospital and community services³⁷—almost 8% of its total workforce—and risks an exodus due to burnout and low morale.³⁸ Disparities persist across countries, regions, care levels and areas of medicine. Nearly half of the world’s population lives in countries with over 100,000 people for every psychiatrist.³⁹ Even in the United States, with 10.8 psychiatrists per 100,000 people, almost half of those currently practising are expected to retire soon.⁴⁰ The brain drain of health workers places further strain on poorer and rural parts of the world.

New breakthroughs, new risks

Transformative technologies, medicines and insurance that could vastly improve the reach and quality of healthcare are on the horizon—but they also bring new risks and trade-offs for health systems and societies.



ultimately make it possible for everyone—even in currently fragile, over-burdened health systems—to access high-quality, consistent, affordable, timely and convenient care.

But new technologies also raise risks, including risks of compromising patient safety and privacy, as well as introducing bias. Errors by individual health workers affect only their patients, whereas the consequences of AI errors could unfold at a whole new scale. Since training data sets in health often skew white and male,⁴⁴ AI could fail to spot symptoms or devise effective treatment plans for everyone else. These outcomes will be tough to predict or avoid because AI’s black-box nature makes it difficult to understand how it reaches conclusions—making it hard to spot bias. Health data are especially vulnerable to cyberattacks,⁴⁵ with risks of individuals being identified even from anonymized data (see Chapter 5, Wild Wide Web).

Pharmaceutical revolution. Highly complex, specialized new drugs promise radically better treatment for devastating diseases—but they come at exorbitant prices. For example, three recently launched cell and gene therapies cost up to US\$2 million per patient. Over the next few years, between 15 and 30 new

US\$
2 million
cost per patient of recent cell
and gene therapies

Disruptive technologies. Over the centuries health systems have embraced many innovations, sometimes without waiting for them to be proven safe and effective. Healthcare providers and payers are already using today’s emerging technologies—machine learning and artificial intelligence (AI), sensors, digital therapies, telemedicine and so on—to support both clinical and operational decisions: to triage symptoms,⁴¹ interpret diagnostic tests,⁴² create personalized treatment plans⁴³ and predict re-admissions at a hospital or epidemics in a population. Combined with human capacity, these technologies could



REUTERS/YVES HERMAN/ILLUSTRATION

million-dollar drugs are expected to enter the market, mostly for cancer.⁴⁶ New pricing models—such as multi-year payments contingent on patient outcomes—are starting to emerge to address the high costs and risks of these treatments.

But health systems are finding it difficult to adapt amid questions over who should pay, how high a price can be justified, and what can be given up to afford new therapies. As people's expectations rise, unequal access to better therapies could deepen health inequalities within and across countries, eroding trust in health systems and societal cohesion. In the longer run, if (or when) gene-editing technologies become available to enhance physical, cognitive or behavioural capabilities, these could result in a society of genetically enhanced haves and the merely natural have-nots.

Risk pools of one. Health insurance looks set to be transformed by big data and analytics. As with in-car devices used by car insurers to reward responsible drivers with lower premiums, health insurers can (with the consent of customers and the appropriate levels of data security), capture, store and analyse personal health and behavioural data from wearable—and eventually implantable—devices. Personalized risk assessment

could lead to rewards and incentives for people to live healthier lifestyles, but if unchecked by regulation, it could also potentially put insurance beyond the reach of people judged to be higher risk for genetic, environmental or behavioural reasons.

In some jurisdictions, steps have already been taken to mitigate this risk in response to the concerns of people who have taken predictive genetic tests for certain diseases. In 2018, the UK Government, together with the Association of British Insurers (ABI), consolidated existing agreements on the use of genetic information and created the Code on Genetic Testing and Insurance. Given the rapid advances taking place in genetic research, this Code will be reviewed every three years to consider the technical, ethical and societal implications of insurability. Among other principles, the Code commits insurance companies to treat applicants for insurance fairly and not require or pressure any applicant to undertake a predictive or diagnostic genetic test.⁴⁷

Ubiquitous risks of a weak health system

Good health is the foundation for societal well-being and a dynamic and prosperous economy.⁴⁸ Health systems form part of countries' critical infrastructure: they are vital to security, resilience and growth. At the population level, health underpins productivity. Well-functioning health systems enable countries to respond to, and recover from, natural and human-made disruptions. Weak systems let pathogens and diseases spread because they fail to address fake news about healthcare and preventive care, psychological responses of fear and despair, and lack of compliance with health professionals' requests.⁴⁹

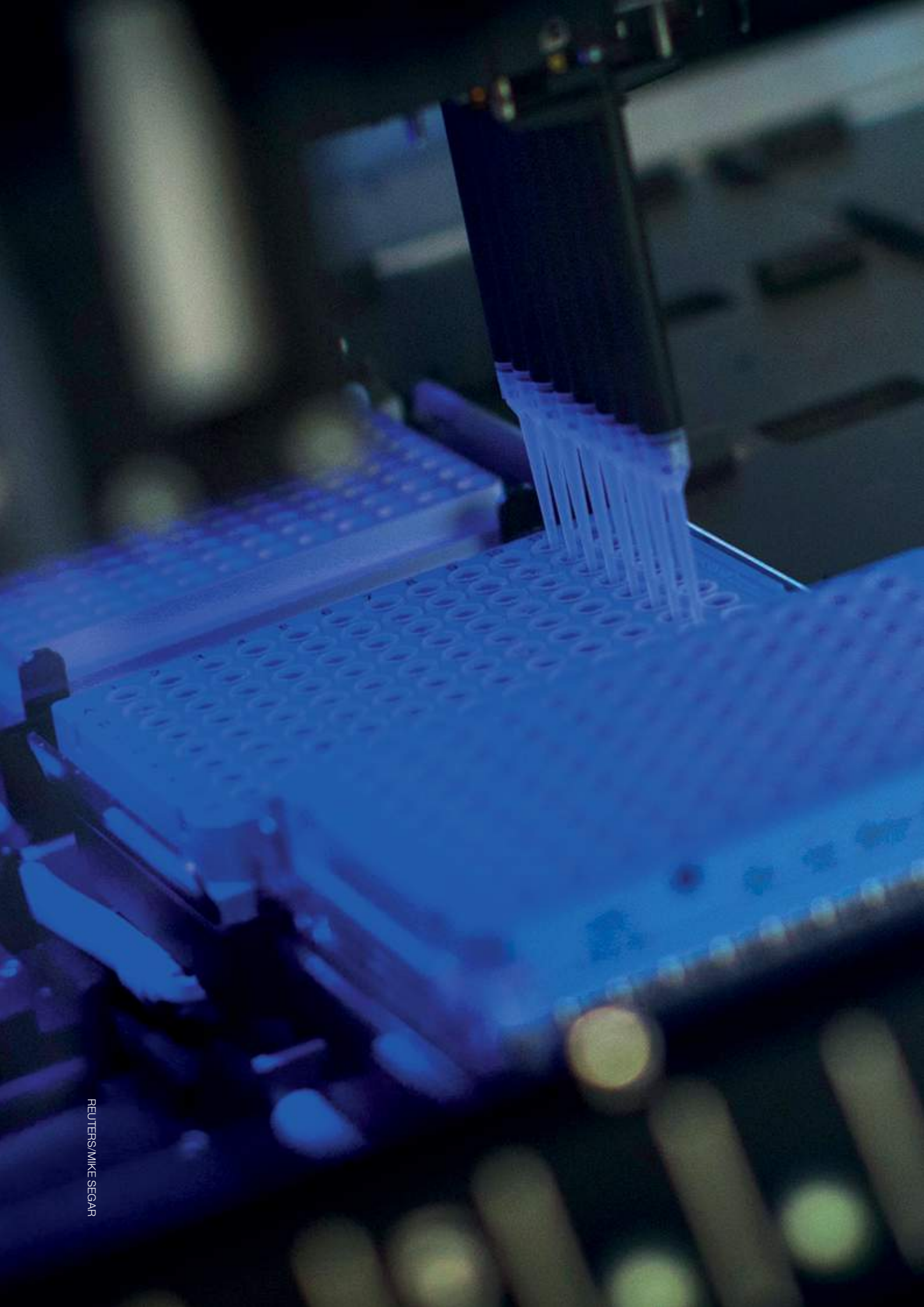
Like climate change, health risks pose an expensive and expanding transnational challenge. Around the world, health systems need to take a critical look at the fitness of their current approaches and institutions if we are to maintain the progress of the last century and tackle emerging threats. When health systems fail to mitigate vulnerabilities and adapt to changing contexts, they increase the likelihood of economic crises, political instability, social ruptures and state-on-state conflict.

Notes

- 1 WHO (World Health Organization). 2019. Global Health Observatory (GHO) Data: Life Expectancy. https://www.who.int/gho/mortality_burden_disease/life_tables/situation_trends/en/
- 2 WHO (World Health Organization). 2019. Global Health Observatory (GHO) Data: Healthy Life Expectancy (HALE) at Birth. https://www.who.int/gho/mortality_burden_disease/life_tables/hale_text/en/
- 3 WHO (World Health Organization). 2019. "The Power of Vaccines: Still Not Fully Utilized". <https://www.who.int/publications/10-year-review/vaccines/en/>
- 4 Cardona, C. and D. Bishai. 2018. "The Slowing Pace of Life Expectancy Gains since 1950". *BMC Public Health* (2018) 18:151. DOI 10.1186/s12889-018-5058-9. <https://bmcpublichealth.biomedcentral.com/track/pdf/10.1186/s12889-018-5058-9>
- 5 Murphy, S. L. B. S., J. Xu, K. D. Kochanek and E. Arias. 2018. "Mortality in the United States, 2017". Centers for Disease Control and Prevention, NCHS Data Brief No. 328, November 2018. <https://www.cdc.gov/nchs/products/databriefs/db328.htm>; Bernstein, L. 2018. "U.S. Life Expectancy Declines Again, a Dismal Trend Not Seen since World War I". *The Washington Post*. 29 November 2018. https://www.washingtonpost.com/national/health-science/us-life-expectancy-declines-again-a-dismal-trend-not-seen-since-world-war-i/2018/11/28/ae58bc8c-f28c-11e8-bc79-68604ed88993_story.html
- 6 Lim, J. 2018. 2019. "Singaporeans Living Longer but Spending More Time in Ill Health: Study". *Today*. 20 June 2019. <https://www.todayonline.com/singapore/singaporeans-living-longer-spending-greater-proportion-time-ill-health-study>
- 7 World Bank Open Data. Life Expectancy at Birth. https://data.worldbank.org/indicator/SP.DYN.LE00.IN?most_recent_value_desc=false, accessed 01 December 2019.
- 8 Public Health England, Gov.UK. 2018. "Health Profile for England 2018. Chapter 5: Inequalities in Health". <https://www.gov.uk/government/publications/health-profile-for-england-2018/chapter-5-inequalities-in-health>; Bleich, S. N., M. P. Jarlenski, C. N. Bell and T. A. LaVeist. 2012. "Health Inequalities: Trends, Progress, and Policy". *Annual Review of Public Health*. 33 (1): 7–40. <https://www.annualreviews.org/doi/full/10.1146/annurev-publhealth-031811-124658>
- 9 WHO (World Health Organization). 2018. *Review of Polio Endemic Countries*. Report of the Independent Monitoring Board of the Global Polio Eradication Initiative on Progress in Afghanistan, Nigeria and Pakistan. September 2018. https://www.who.int/immunization/sage/meetings/2018/october/4_Review_Polio_Endemic_Countires_Report_IMB_Final_revised.pdf
- 10 WHO (World Health Organization). 2019. Proposed programme budget 2020–2021. 13 May 2019. https://apps.who.int/gb/ebwha/pdf_files/WHA72/A72_INF3-en.pdf
- 11 Razum, O., D. Sridhar, A. Jahn, S. Zaidi, G. Ooms and O. Müller. 2019. "Polio: From Eradication to Systematic, Sustained Control". *BMJ Global Health* 2019; 4:e001633. <https://gh.bmj.com/content/4/4/e001633>
- 12 The Global Fund. 2019. "Global Fund Donors Pledge US\$14 Billion in Fight to End Epidemics". Press Release, 10 October 2019. <https://www.theglobalfund.org/en/news/2019-10-10-global-fund-donors-pledge-usd14-billion-in-fight-to-end-epidemics/>
- 13 WHO (World Health Organization). 2019. "Ten Threats to Global Health in 2019". <https://www.who.int/emergencies/ten-threats-to-global-health-in-2019>
- 14 CDC (Centers for Disease Control and Prevention). 2019. "Global Health: Global Measles Outbreaks". <https://www.cdc.gov/global-health/measles/globalmeaslesoutbreaks.htm>
- 15 Soucheray, S. 2019. "US Measles Cases Hit 1,234 as Brooklyn Outbreak Called Over". *CIDRAP News*. 03 September 2019. <http://www.cidrap.umn.edu/news-perspective/2019/09/us-measles-cases-hit-1234-brooklyn-outbreak-called-over>
- 16 UNICEF. 2019. "As Measles Deaths in the Democratic Republic of the Congo Top 4,000, UNICEF Rushes Medical Kits to Health Centers and Vaccinates Thousands More Children". Press Release, 09 October 2019. <https://www.unicef.org/press-releases/measles-deaths-democratic-republic-congo-top-4000-unicef-rushes-medical-kits-health>
- 17 Wellcome. 2019. "Q&A: What Are Drug-Resistant Infections?" *Wellcome News*. 09 September 2019. <https://wellcome.ac.uk/news/what-are-drug-resistant-infections>
- 18 Review on Antimicrobial Resistance. 2016. *Tackling Drug-Resistant Infections Globally: Final Report and Recommendations*. May 2016. Wellcome Trust and UK Government. https://amr-review.org/sites/default/files/160525_Final%20paper_with%20cover.pdf

- 19 NTI (Nuclear Threat Initiative). 2019. “Global Health Security Index: Inaugural Global Health Security Index Finds No Country Is Prepared for Epidemics or Pandemics”. NTI. Press Release, 24 October 2019. <https://www.nti.org/newsroom/news/inaugural-global-health-security-index-finds-no-country-prepared-epidemics-or-pandemics/>
- 20 World Economic Forum. 2019. “Outbreak Readiness and Business Impact Protecting Lives and Livelihoods across the Global Economy”. White Paper, in collaboration with Harvard Global Health Institute. <https://www.weforum.org/whitepapers/outbreak-readiness-and-business-impact-protecting-lives-and-livelihoods-across-the-global-economy>
- 21 WHO (World Health Organization). 2018. Fact Sheet on Noncommunicable Diseases. 1 June 2018. <https://www.who.int/news-room/fact-sheets/detail/noncommunicable-diseases>; Ha, B., S.H. Lee, and D. Park. 2019. “Will Asia Grow Old Before Becoming Rich?” *BRINK News*. 03 July 2018. <https://www.brinknews.com/will-asia-grow-old-before-becoming-rich/>
- 22 WHO (World Health Organization). 2011. *Global Status Report on Noncommunicable Diseases 2010*. https://www.who.int/nmh/publications/ncd_report2010/en/
- 23 Mnookin, S. 2016. “Out of the Shadows: Making Mental Health a Global Development Priority”. World Bank and World Health Organization background paper. http://www.who.int/mental_health/advocacy/wb_background_paper.pdf
- 24 Patel, V. and S. Saxena. 2014. “Transforming Lives, Enhancing Communities—Innovations in Global Mental Health”. *New England Journal of Medicine* 370 (6): 498–501.
- 25 Bloom, D. E., E. T. Cafiero, E. Jané-Llopis, A. Abrahams-Gessel, L. R. Bloom, S. Fathima, A. B. Feigl, T. Gaziano, M. Mowafi, A. Pandya, K. Prettnner, L. Rosenberg, B. Seligman, A. Z. Stein and C. Weinstein. 2011. *The Global Economic Burden of Noncommunicable Diseases*. A Report by the World Economic Forum and the Harvard School of Public Health. Geneva: World Economic Forum. <https://www.weforum.org/reports/global-economic-burden-non-communicable-diseases>
- 26 ADI (Alzheimer’s Disease International). 2018. *World Alzheimer Report 2018. The State of the Art of Dementia Research: New Frontiers*. London: ADI. <https://www.alz.co.uk/research/WorldAlzheimerReport2018.pdf>
- 27 WHO (World Health Organization). 2019. Fact Sheet on Dementia. <https://www.who.int/news-room/fact-sheets/detail/dementia>
- 28 WHO (World Health Organization). 2019. “WHO Calls for Urgent Action to Protect Health from Climate Change – Sign the Call”. <https://www.who.int/globalchange/global-campaign/cop21/en/>
- 29 Watts, N., et al. 2019. “The 2019 Report of *The Lancet* Countdown on Health and Climate Change: Ensuring that the Health of a Child Born Today Is Not Defined by a Changing Climate”. *The Lancet* 394 (10211): P1836–78. 13 November 2019. [https://www.thelancet.com/journals/lancet/article/PIIS0140-6736\(19\)32596-6/fulltext](https://www.thelancet.com/journals/lancet/article/PIIS0140-6736(19)32596-6/fulltext)
- 30 World Bank and Institute for Health Metrics and Evaluation (IHME). 2016. *The Cost of Air Pollution: Strengthening the Economic Case for Action*. Washington, DC: World Bank. <http://documents.worldbank.org/curated/en/781521473177013155/pdf/108141-REVISED-Cost-of-PollutionWebCORRECTEDfile.pdf>
- 31 Watts et al. 2019. Op. cit.
- 32 Caminade, C., K. M. McIntyre, and A. E. Jones. 2019. “Impact of Recent and Future Climate Change on Vector-Borne Diseases”. *Annals of the New York Academy of Sciences* 1436 (1): 157–73. <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6378404/>
- 33 Scheer, R. and D. Moss. 2013. “Mosquito-Borne Diseases on the Uptick—Thanks to Global Warming”. *Scientific American, EarthTalk*. <https://www.scientificamerican.com/article/mosquito-borne-diseases-on-the-uptick-thanks-to-global-warming/>
- 34 Dunne, D. 2019. “Mosquito-Borne Diseases Could Reach Extra ‘One Billion People’ as Climate Warms”. *Carbon Brief*. 28 March 2019. <https://www.carbonbrief.org/mosquito-borne-diseases-could-reach-extra-one-billion-people-as-climate-warms>
- 35 Mercer Marsh Benefits. 2019. “Health and Benefits: Health Insurance Costs – Insights & Implications. Results of the 2019 Medical Trends around the World Survey”. <https://www.mercermarshbenefits.com/en/intellectual-capital/2019-medical-trends-around-the-world1.html>
- 36 U.S. Centers for Medicare & Medicaid Services. 2018. *National Health Expenditure Accounts (2018)*. <https://www.cms.gov/Research-Statistics-Data-and-Systems/Statistics-Trends-and-Reports/NationalHealthExpendData/NationalHealthAccountsHistorical.html>, accessed 01 December 2019.

- 37 NHS Digital. 2019. NHS Vacancy Statistics England - February 2015 - September 2018, Provisional Experimental Statistics. Part of NHS Vacancy Statistics (and previous NHS Vacancies Survey), 24 January 2019. <https://digital.nhs.uk/data-and-information/publications/statistical/nhs-vacancies-survey/february-2015---september-2018-provisional-experimental-statistics>; NHS Digital. 2019. NHS Workforce Statistics - July 2019. Part of NHS Workforce Statistics, 24 October 2019. <https://digital.nhs.uk/data-and-information/publications/statistical/nhs-workforce-statistics/july-2019>
- 38 General Medical Council. 2018. *The State of Medical Education and Practice in the UK*. London: General Medical Council. <https://www.gmc-uk.org/about/what-we-do-and-why/data-and-research/the-state-of-medical-education-and-practice-in-the-uk>
- 39 WHO (World Health Organization). 2015. *Mental Health Atlas 2014*. Geneva: World Health Organization. https://www.who.int/mental_health/evidence/atlas/mental_health_atlas_2014/en/
- 40 AMA (American Medical Association). *AMA Physician Masterfile* database. <https://www.ama-assn.org/topics/ama-physician-masterfile>
- 41 Babylon GP at Hand application. <https://www.gpathand.nhs.uk/>
- 42 Davis, N. 2019. "AI Equal with Human Experts in Medical Diagnosis, Study Finds". *The Guardian*. 24 September 2019. <https://www.theguardian.com/technology/2019/sep/24/ai-equal-with-human-experts-in-medical-diagnosis-study-finds>
- 43 Wels-Maug, C. 2019. "HUG to Become First University Hospital Using IBM's AI Tool to Personalise Cancer Treatment". *Healthcare IT News*. 12 September 2019. <https://www.healthcareitnews.com/news/europe/hug-become-first-university-hospital-using-ibm-s-ai-tool-personalise-cancer-treatment>
- 44 Gershgorn, D. 2018. "If AI Is Going to Be the World's Doctor, It Needs Better Textbooks". *Quartz*. 06 September 2018. <https://qz.com/1367177/if-ai-is-going-to-be-the-worlds-doctor-it-needs-better-textbooks/>
- 45 Lee, K., J. P. Raman, W. Hedrich, R. Lam and P. Daga. 2018. *Holding Healthcare to Ransom: Industry Perspectives on Cyber Risks*. Marsh & McLennan Companies. <http://www.mmc.com/insights/publications/2018/jul/holding-healthcare-to-ransom-industry-perspectives-on-cyber-risks.html>
- 46 MIT NEWDIGS. 2018. "Projections from the Existing Pipeline of Cell and Gene Therapies: Launches and Patent Numbers". Research Brief 2018F210-v027-Launches. <https://newdigs.mit.edu/sites/default/files/FoCUS%20Research%20Brief%202018F210v027.pdf>
- 47 ABI (Association of British Insurers). 2018. *Code on Genetic Testing and Insurance*. <https://www.abi.org.uk/data-and-resources/tools-and-resources/genetics/code-on-genetic-testing-and-insurance/>
- 48 Kagame, P. and T. A. Ghebreyesus. 2019. "History Shows Health Is the Foundation of African Prosperity". *Financial Times* 23 September 2019. <https://www.ft.com/content/e61cc58c-cfc7-11e9-b018-ca4456540ea6>
- 49 WHO (World Health Organization). 2015. "Chapter 3: Factors that Contributed to Undetected Spread of the Ebola Virus and Impeded Rapid Containment". *Emergencies Preparedness, Response*. <https://www.who.int/csr/disease/ebola/one-year-report/factors/en/>





Appendices



Appendix A:

Descriptions of Global Risks 2020

Global Risks

A “global risk” is defined as an uncertain event or condition that, if it occurs, can cause significant negative impact for several countries or industries within the next 10 years.

To ensure legibility, the names of the global risks have been abbreviated in the figures. The portion of the full name used in the abbreviation is in bold.

	Global Risk	Description
Economic	Asset bubbles in a major economy	Unsustainably overpriced assets such as commodities, housing, shares etc. in a major economy or region
	Deflation in a major economy	Prolonged near-zero inflation or deflation in a major economy or region
	Failure of a major financial mechanism or institution	Collapse of a financial institution and/or malfunctioning of a financial system that impacts the global economy
	Failure/shortfall of critical infrastructure	Failure to adequately invest in, upgrade and/or secure infrastructure networks (e.g. energy, transportation and communications), leading to pressure or a breakdown with system-wide implications
	Fiscal crises in key economies	Excessive debt burdens that generate sovereign debt crises and/or liquidity crises
	High structural unemployment or underemployment	A sustained high level of unemployment or underutilization of the productive capacity of the employed population
	Illicit trade (e.g. illicit financial flows, tax evasion, human trafficking, organized crime)	Large-scale activities outside the legal framework such as illicit financial flows, tax evasion, human trafficking, counterfeiting and/or organized crime that undermine social interactions, regional or international collaboration, and global growth
	Severe energy price shock (increase or decrease)	Significant energy price increases or decreases that place further economic pressures on highly energy-dependent industries and consumers
Environmental	Unmanageable inflation	Unmanageable increases in the general price levels of goods and services in key economies
	Extreme weather events (e.g. floods, storms)	Major property, infrastructure, and/or environmental damage as well as loss of human life caused by extreme weather events
	Failure of climate-change mitigation and adaptation	The failure of governments and businesses to enforce or enact effective measures to mitigate climate change, protect populations and help businesses impacted by climate change to adapt
	Major biodiversity loss and ecosystem collapse (terrestrial or marine)	Irreversible consequences for the environment, resulting in severely depleted resources for humankind as well as industries
	Major natural disasters (e.g. earthquakes, tsunamis, volcanic eruptions, geomagnetic storms)	Major property, infrastructure, and/or environmental damage as well as loss of human life caused by geophysical disasters such as earthquakes, volcanic activity, landslides, tsunamis or geomagnetic storms
Human-made environmental damage and disasters (e.g. oil spills, radioactive contamination)	Failure to prevent major human-made damage and disasters, including environmental crime, causing harm to human lives and health, infrastructure, property, economic activity or the environment	

Geopolitical	Failure of national governance (e.g. failure of rule of law, corruption, political deadlock)	Inability to govern a nation of geopolitical importance as a result of weak rule of law, corruption or political deadlock
	Failure of regional or global governance	Inability of regional or global institutions to resolve issues of economic, geopolitical or environmental importance
	Interstate conflict with regional consequences	A bilateral or multilateral dispute between states that escalates into economic (e.g. trade/currency wars, resource nationalization), military, cyber, societal or other conflict
	Large-scale terrorist attacks	Individuals or non-state groups with political or religious goals that successfully inflict large-scale human or material damage
	State collapse or crisis (e.g. civil conflict, military coup, failed states)	State collapse of geopolitical importance due to internal violence, regional or global instability, military coup, civil conflict, failed states etc.
	Weapons of mass destruction	The deployment of nuclear, chemical, biological, and radiological technologies and materials, creating international crises and potential for significant destruction
Societal	Failure of urban planning	Poorly planned cities, urban sprawl and associated infrastructure that create social, environmental and health challenges
	Food crises	Inadequate, unaffordable or unreliable access to appropriate quantities and quality of food and nutrition on a major scale
	Large-scale involuntary migration	Large-scale involuntary migration induced by conflict, disasters, environmental or economic reasons
	Profound social instability	Major social movements or protests (e.g. street riots, social unrest) that disrupt political or social stability, negatively impacting populations and economic activity
	Rapid and massive spread of infectious diseases	Bacteria, viruses, parasites or fungi that cause uncontrolled spread of infectious diseases (for instance as a result of resistance to antibiotics, antivirals and other treatments) leading to widespread fatalities and economic disruption
	Water crises	A significant decline in the available quality and quantity of fresh water, resulting in harmful effects on human health and/or economic activity
Technological	Adverse consequences of technological advances	Intended or unintended adverse consequences of technological advances such as artificial intelligence, geo-engineering and synthetic biology causing human, environmental and economic damage
	Breakdown of critical information infrastructure and networks	Cyber dependency that increases vulnerability to outage of critical information infrastructure (e.g. internet, satellites) and networks, causing widespread disruption
	Large-scale cyberattacks	Large-scale cyberattacks or malware causing large economic damage, geopolitical tensions or widespread loss of trust in the internet
	Massive incident of data fraud or theft	Wrongful exploitation of private or official data that takes place on an unprecedented scale

Appendix B:

Global Risks Perception Survey

The Global Risks Perception Survey (GRPS) is the World Economic Forum's source of original risks data, harnessing the expertise of the Forum's extensive network of business, government, civil society and thought leaders. The survey was conducted from 5 September to 22 October 2019 among the World Economic Forum's multistakeholder communities (including the Global Shapers Community), the professional networks of its Advisory Board, and members of the Institute of Risk Management. The results of the GRPS are used to create the Global Risks Landscape and Interconnections Map presented at the beginning of the report, and to offer insights used throughout.

Both the GRPS and the *Global Risks Report* adopt the following definition of global risk:

Global risk: A “global risk” is an uncertain event or condition that, if it occurs, can cause significant negative impact for several countries or industries within the next 10 years.

Methodology

The world in 2020

In the first section of the GRPS, respondents were asked to assess whether the risks associated with 40 current issues would increase or decrease in 2020 compared to 2019 (see Table B.1 below for full results). Respondents were also given the option to name any other issue(s), not included in the 40 risks listed that they expect to be a source of increased risk in 2020. We use these open responses to assess the need to update our list of risks from year to year.

The possible answers to survey questions ranged from “significantly decrease” to “significantly increase” on a scale from 1 to 5, with 1 representing “significantly

decrease” and 5 representing “significantly increase”. To reduce framing bias, the values between this range were not assigned specific wording. For each risk, the share for each answer was obtained by dividing the number of respondents who selected that answer by the total number of answers.

Respondents were asked to base their answers to each of these 40 risks on a global level. They were asked the following question: “On a global level, do you think that in 2020 the risks presented by the following issues will increase or decrease compared to 2019?”

TABLE B.1:

Percent of respondents who think a risk will increase in 2020 compared to 2019.

Economic confrontations between major powers	78.5%	Foreign interference in domestic politics	60.5%
Domestic political polarization	78.4%	Civil unrest (including strikes and riots)	60.2%
Extreme heat waves	77.1%	Hostility against minorities	57.5%
Destruction of natural ecosystems	76.2%	Loss of confidence in collective security alliances	57.4%
Cyberattacks: disruption of operations and infrastructure	76.1%	Criminal use of cryptocurrencies	56.3%
Protectionism regarding trade and investment	76.0%	Involuntary climate-related migration	53.8%
Populist and nativist agendas	75.7%	Erosion of global policy coordination on climate change	53.0%
Cyberattacks: theft of data/money	75.0%	High levels of crisis-driven or economic migration	53.0%
Recession in a major economy	72.8%	Job losses due to technology	47.3%
Uncontrolled fires	70.7%	Corrupt leadership	46.6%
Water crises	69.3%	Debt defaults (public or private)	44.7%
Loss of privacy (to companies)	69.1%	Military actions short of war	44.3%
Loss of trust in media/information sources	68.4%	Erosion of global supply chains	43.7%
Loss of privacy (to governments)	67.4%	High levels of youth unemployment	42.9%
Human health impacted by air, plastic and water pollution	67.1%	Ineffective monetary stimuli	42.8%
Public anger against elites	66.3%	Market collapse of stock or other assets	40.9%
Protectionism against foreign workers	65.7%	Currency crises	40.6%
Inequality (within countries)	65.0%	Deep or widespread poverty	36.5%
Personal identity theft	63.8%	State-on-state military conflict	27.3%
Authoritarian leadership	62.9%	Terrorist attacks	23.1%

■ Economic
 ■ Environmental
 ■ Geopolitical
 ■ Societal
 ■ Technological

The global risks landscape

For each of the 30 global risks listed in Appendix A, respondents were asked to assess: (1) the likelihood of each global risk occurring over the course of the next 10 years, and (2) the severity of its impact at a global level if it were to occur, both on a scale from 1 to 5 as follows:

- Likelihood: a value of 1 for “very unlikely” and 5 for “very likely”
- Impact: a value of 1 for “minimal” impact and 5 for “catastrophic” impact

To reduce timing bias, respondents were reminded to assess the 30 risks over a 10-year period, as opposed to a time horizon of one year for the previous 40 risks. Again, to reduce framing bias, the values within the 1–5 scale were not assigned specific wording. Respondents could leave the question completely blank. Partial responses for any risk—those assessing only the likelihood of occurrence or only the negative impact—were not included in the results.

A simple average for both likelihood and impact for each of the 30 global risks was calculated on this basis. The results are illustrated in the Global Risks Landscape 2020 (Figure II).

Formally, for any given risk i , its likelihood and impact—denoted respectively likelihood_i and impact_i —are:

$$\text{likelihood}_i = \frac{1}{N_i} \sum_{n=1}^{N_i} \text{likelihood}_{i,n}$$

$$\text{impact}_i = \frac{1}{N_i} \sum_{n=1}^{N_i} \text{impact}_{i,n}$$

where N_i is the number of respondents for risk i , and $\text{likelihood}_{i,n}$ and $\text{impact}_{i,n}$ are, respectively, the likelihood and impact assigned by respondent n to risk i . The likelihood is measured on a scale of 1–5 and the impact on a scale of 1–5. N_i is the number of respondents for risk i who assessed both the likelihood and impact of that specific risk.

Global risks interconnections

Part 3 of the GRPS assesses interconnections between pairs of global risks.

For the interconnections between pairs of risks, survey respondents were asked the following question: “Global risks are not isolated, and it is important to assess their interconnections. In your view, which are the most **strongly connected** global risks? Please select three to six pairs of global risks, from the 30

global risks below (one risk can be connected to any one of the other 29 global risks).” The results are illustrated in the Global Risks Interconnections Map 2020 (Figure IV). A tally was made of the number of times each pair was cited.

In the Global Risks Landscape and the Interconnections Map, the size of each risk is scaled according to the weight of that node in the system.

Completion thresholds

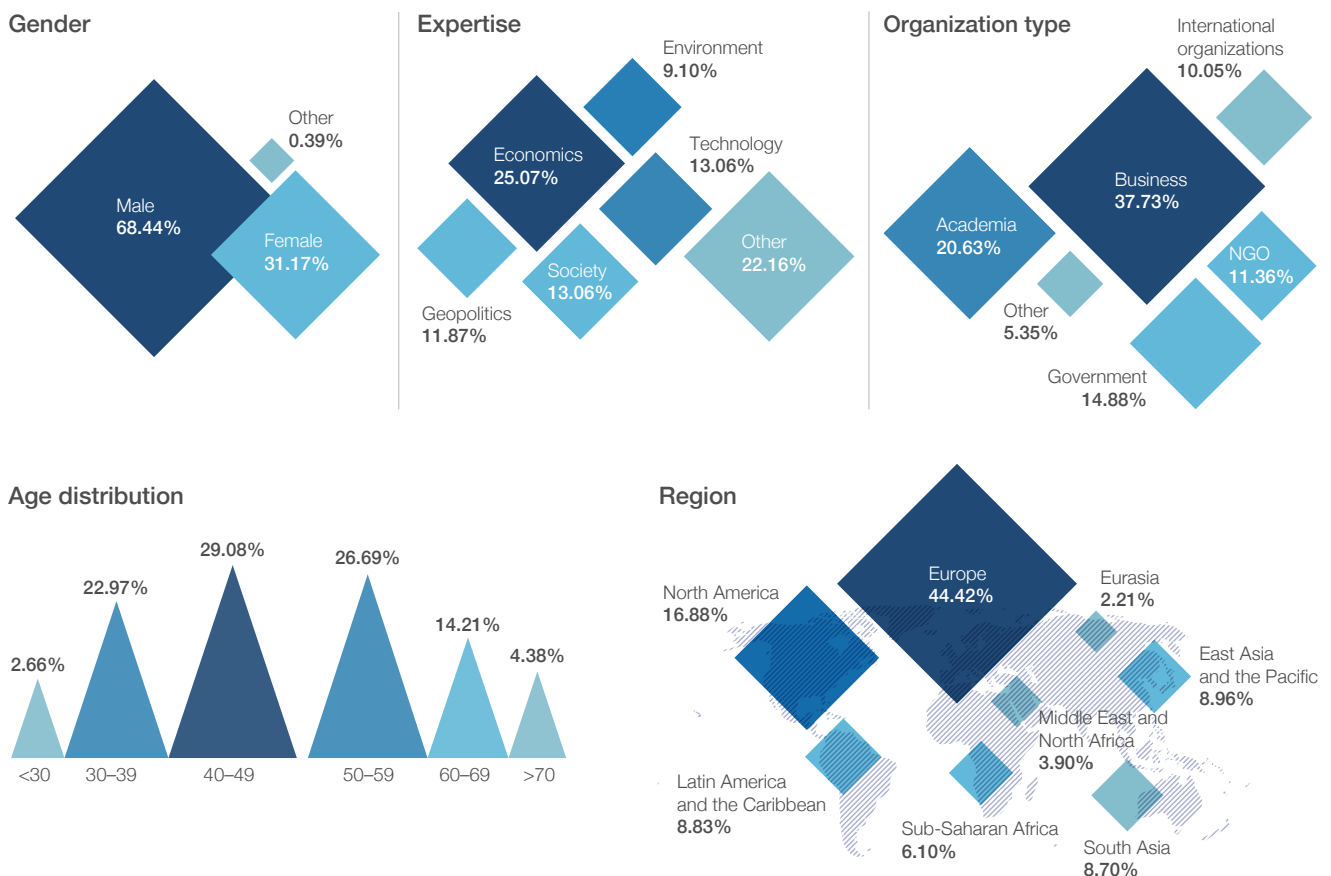
We received 1,047 total responses to the GRPS to which we applied an overall standard deviation check, as well as specific completion thresholds for each section of the survey:

- **Overall:** nine responses yielded a standard deviation of zero in the increase/decrease scores for Part 1 of the survey, as well as the likelihood and impact scores for Part 2. These responses were not included in the survey results.
- **Part 1 “The World in 2020”:** The answers from the 777 respondents who assessed at least four of the risks listed in this question were used to compute the results.

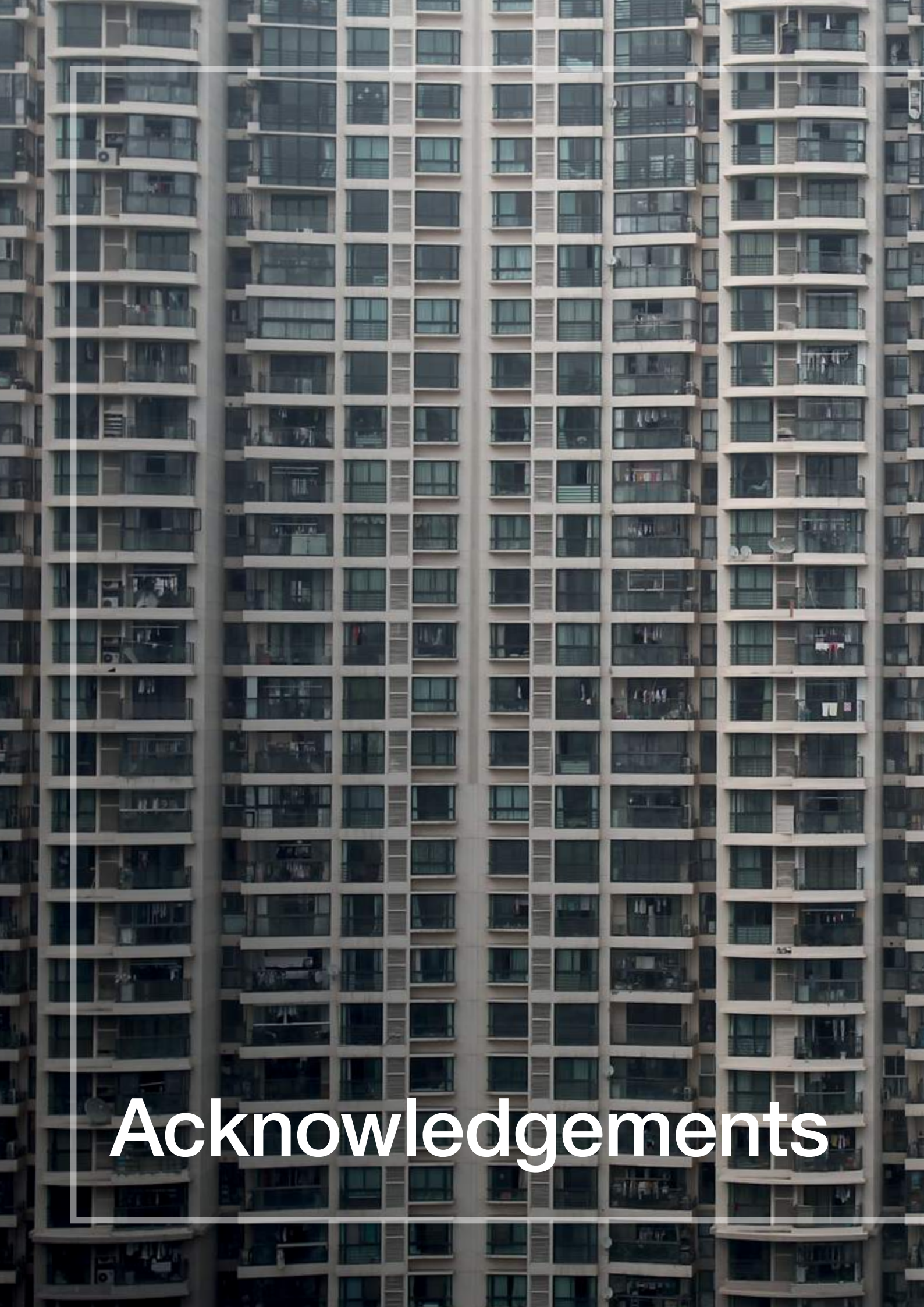
- **Part 2 “Assessment of Global Risks”:** The answers from the 718 respondents who assessed the impact and likelihood of at least one risk were used to compute the results (leaving the question entirely blank was not considered a valid answer).
- **Part 3 “Global Risk Interconnections”:** The answers from the 628 respondents who selected at least one valid pair of risks were used to compute the results.

Figure B.1 presents some key descriptive statistics and information about the profiles of the respondents.

FIGURE B.1
Survey Sample Composition



Source: Global Risks Perception Survey 2019-2020.



Acknowledgements

The lead author of *The Global Risks Report 2020* is Emilio Granados Franco, Head of Global Risks and Geopolitical Agenda.

At the World Economic Forum, a debt of gratitude is owed to Professor Klaus Schwab (Founder and Executive Chairman), Børge Brende (President) and Mirek Dusek (Deputy Head, Centre for Regional and Geopolitical Affairs), under whose guidance this report has been produced. Lee Howell (Head of Global Programming) has been an important mentor.

This report has relied heavily on the dedication and expertise of the Global Risks and Geopolitics team: Ariel Kastner, Melinda Kuritzky, Richard Lukacs and Philip Shetler-Jones. Thanks also to the other members of *The Global Risks Report 2020* team: Oliver Cann, Aylin Elçi, Emily Farnworth, Maxwell Hall and Yann Zopf.

A special thanks goes to our partners across World Economic Forum teams as well as external experts who have contributed to specific chapters of this report:

Chapter 2, The Fraying Fundamentals. Sheikh Tanjeb Islam.

Chapter 3, A Decade Left. Dominik Breiting, Emily Farnworth, Andrew Pickens and Jahda Swanborough.

Chapter 4, Save the Axolotl. Marco Albani, Akanksha Khatri, Marie Quinney and Kimberly Nicole Pope.

Chapter 5, Wild Wide Web. Francesca Bosco, Amy Jordan, Zvika Krieger, Rebekah Lewis, Adrien Ogée, Thomas Philbeck, Algirde Pipikaite and Anelia Uzunova.

Chapter 6, False Positive. Ryan Morhard.

Thanks also go to members of the Club of Rome (George Biesmans, Sandrine Dixson-Declève, Gail Whiteman) for their contributions.

We would like to thank our **Strategic Partners**, Marsh & McLennan (MMC) and Zurich Insurance Group, and in particular Daniel Glaser (Chief Executive Officer, MMC) and Mario Greco (Chief Executive Officer, Zurich Insurance Group). Thanks also to John Drzik (President, Global Risk and Digital, MMC) and Peter Giger (Group Chief Risk Officer, Zurich Insurance Group).

Special gratitude is due to John Scott (Head of Sustainability Risks, Zurich Insurance Group) and Richard

Smith-Bingham (Executive Director, Marsh & McLennan Advantage Insights) for their contributions throughout the planning and drafting of the report.

We are also grateful to our three **Academic Advisers**: the National University of Singapore, the Oxford Martin School at the University of Oxford and the Wharton Risk Management and Decision Processes Center at the University of Pennsylvania.

The report has greatly benefited from the insight and expertise of the members of the Global Risks Report **Advisory Board**: Rolf Alter (Hertie School of Governance), Sharan Burrow (International Trade Union Confederation), Winnie Byanyima (Oxfam International, through August 2019), Marie-Valentine Florin (International Risk Governance Center), Al Gore (Generation Investment Management), Carolyn Kousky (Wharton Risk Management and Decision Processes Center), Kok Kwang Phoon (National University of Singapore), Julian Laird (Oxford Martin School), Pascal Lamy (Jacque Delors Institute), Maleeha Lodhi (Government of Pakistan), Gary Marchant (Arizona State University), Robert Muggah (Igarapé Institute), Moisés Naím (Carnegie Endowment for International Peace), Naomi Oreskes (Harvard University), Jonathan Ostry (International Monetary Fund), Carol Ouko-Misiko (Institute of Risk Management), Eduardo Pedrosa (Pacific Economic Cooperation Council), Daniel Ralph (Cambridge Centre for Risks Studies), Nouriel Roubini (New York University), John Scott (Zurich Insurance Group), Carsten Schrehardt (Federal Ministry of Defence of Germany), Richard Smith-Bingham (Marsh & McLennan), Ursula von der Leyen (Government of Germany, through July 2019), Ngaire Woods (University of Oxford) and Alexandra Zapata (Mexican Institute for Competitiveness).

We are grateful to the following individuals from our Strategic Partners and Academic Advisors.

Marsh & McLennan: Rob Bailey, Alex Bernhardt, Helga Birgden, Leslie Chacko, Blair Chalmers, John Colas, Lorna Friedman, Jason Groves, Kavitha Hariharan, Rachel Lam, Jordan Parker, Hilary Pereira, Lily Phan, Viet Hoang Phan, Tom Quigley, Stephen Szaraz, Alex Wittenberg and Amelia Woltering.

Zurich Insurance Group: Paige Adams, Lori Bailey, Francis Bouchard, Matteo Capolei, Laura Castellano, Anette Dahl-Hiscott, Daniel Eherer, Lillian Labbat, Wen Lin, Alison Martin, Jessica McLellan, Guy Miller, Eugenie Molyneux, Pavel Osipyants, Marc Radice, Gregory Renand, Jennifer Schneider and Angel Serna.

National University of Singapore: Tan Eng Chye and Ho Teck Hua.

Oxford Martin School: Charles Godfray.

Wharton: Howard Kunreuther.

We would like to thank the respondents who completed the **Global Risks Perception Survey**. Thanks also go to the participants in our **Global Risks Workshops** in Geneva on 11 September 2019, in New York City on 15 October 2019 and in Washington, DC on 16 October 2019:

Geneva: Heba Aly (The New Humanitarian), Alison Bewick (Nestlé), Walter Bohmayr (Boston Consulting Group), Sebastian Brack (Kofi Annan Foundation), Vincent Chetail (The Graduate Institute of International and Development Studies), Marie-Valentine Florin (International Risk Governance Center at Ecole Polytechnique de Lausanne), Maya Horowitz (Check Point Software Technologies, Ltd.), Michael Ineichen (International Service for Human Rights), Hichem Khadhraoui (Geneva Call), Jovan Kurbalija (Geneva Internet Platform & Secretariat of the UN High-level Panel on Digital Cooperation), Esther Lynch (European Trade Union), Robert Marinkovic (International Organization of Employers), Tim Noonan (International Trade Union Confederation), Danny Quah (National University of Singapore), Jean-Marc Rickli (Geneva Centre for Security Policy), Carsten Schrehardt (Federal Ministry of Defence of Germany), John Scott (Zurich Insurance Group), Lutfey Siddiqi (London School of Economics and Political Science), Richard Smith-Bingham (Marsh & McLennan Companies), Michael Sparrow (World Climate Research Programme), Elisabeth Tuerk (United Nations Conference on Trade and Development), Jacob van der Blij (GAVI), Charlotte Warakaulle (CERN – European Organization for Nuclear Research), Gail Whiteman (Lancaster University Management School), Susan Wilding (CIVICUS: World Alliance for Citizen Participation), Carolyn Williams (Institute of Risk Management), Irina Zodrow (United Nations International Strategy for Disaster Reduction).

New York City: Jasmina Byrne (United Nations Children's Fund), Alexis Crow (PwC), Barry Franklin (Zurich Insurance Group), Jean-Marie Guéhenno (Center for Humanitarian Dialogue), Nancy J. Luquette (S&P Global), Oliver Money (International Rescue Committee), Robert Muggah (Igarapé Institute), Susan Myers (UN Foundation), Alexandra Pichler Fong (UN Department of Political Affairs), Reid Sawyer (Marsh & McLennan Companies), Steven Siqueira (United Nations Office of Counter Terrorism and UN Counter-Terrorism Center), Adam Tooze (Columbia University).

Washington, DC: Samuel Brannen (Center for Strategic and International Studies), Kaysie Brown (United Nations Foundation), Amir Eftekhari (Jacobs Engineering Group Inc.), Sherri Goodman (Wilson Center), Ryan Greer (Anti-Defamation League), Jane Harman (Wilson Center), Meg King (Wilson Center), Robert Litwak (Wilson Center), King Mallory (Rand Corporation), Crystal Patterson (Facebook), Lauren Herzer Risi (Wilson Center), Robert Sheldon (CrowdStrike), Paul Stares (Council on Foreign Relations).

A special thanks goes to the **Wilson Center** for co-hosting the Washington, DC workshop. We owe particular gratitude to Jane Harman, Robert Litwak, Meg King and Matthew Silberman for their support and contributions to our efforts.

In addition to those mentioned above, we extend our thanks to the following individuals for their time and help: David Aikman, Marisol Argueta, Daniela Barat, Nayia Barmapaliou, Teresa Belardo, Micael Bermudez, Sakshi Bhatnagar, Monika Boerlin, Anna Bruce-Lockhart, Pablo Burkolter, Denise Burnet, Diego Bustamante, Angélique Cado, Elizabeth Caputo, Andrew Caruana Galizia, Gill Cassar, Abhinav Chugh, Jennifer Clauzure, Arnaud Colin, Adeline Colonimos, Victoria Crawford, Roberto Crotti, Alexander Crueger, Nicholas Davis, Attilio di Battista, Beatrice Di Caro, William Dixon, Makiko Eda, Jaci Eisenberg, Nima Elmi, Anne Marie Engcroft Larsen, Gaia Felber, Cody Feldman, Jennifer Francis, Thierry Geiger, Fernando Gomez, Wadia Ait Hamza, Teresa Hartmann, Audrey Helstroffer, Kiriko Honda, Jeremy Jurgens, Mark Jones, Maroun Kairouz, Nikhil Kamath, Elsie Kanza, Nadège Kehri, Andrej Kirn, David Knowles, Patrice Kreidi, Tarika Lall, James Landale, Martina Larkin, Sam Leakey, Sarah Leboulanger, Joo-Ok Lee, Mariah Levin, Silvia Magnoni, Gayle Markovitz, Maryne Leboindre, Viraj Mehta, Stephan Mergenthaler, Adrian Monck, Fulvia Montresor, Marie Sophie Müller, Jamie Palter, Ceri Parker, Gemma Parkes, Robin Pomeroy, Arturo Rago, Nadia Raquillet, Katja Rouru, Eeva Salvik, Richard Samans, Pierre Saouter, Miriam Schive, Olivier Schwab, Sarah Shakour, Paul Smyke, Ahmed Soliman, Callie Stinson, Henry Taylor, Terri Toyota, Jean-François Trinh Tan, Dominic Waughray, Justin Wood, Pim Valdre, Carida Zafiropoulou-Guignard and Saadia Zahidi.

Design and Production: Thank you to all those involved in the design and production of this year's report. At the World Economic Forum: Javier Gesto, Floris Landi, Jordynn McKnight, Liam Ó Cathasaigh and Jean Philippe Stanway. And our external collaborators: Robert Gale, Travis Hensgen, and Moritz Stefaner (data visualization); Hope Steele (editing); Patrik Svensson (cover artwork); and Andrew Wright (writing and editing).



WORLD
ECONOMIC
FORUM

50
YEARS

COMMITTED TO
IMPROVING THE STATE
OF THE WORLD

The World Economic Forum, committed to improving the state of the world, is the International Organization for Public-Private Cooperation.

The Forum engages the foremost political, business and other leaders of society to shape global, regional and industry agendas.

World Economic Forum
91-93 route de la Capite
CH-1223 Cologny/Geneva
Switzerland

Tel.: +41 (0) 22 869 1212
Fax: +41 (0) 22 786 2744

contact@weforum.org
www.weforum.org