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Strategic Partner of the Global Risks 2015 report

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Insight Report

# Global Risks 2015
## 10th Edition

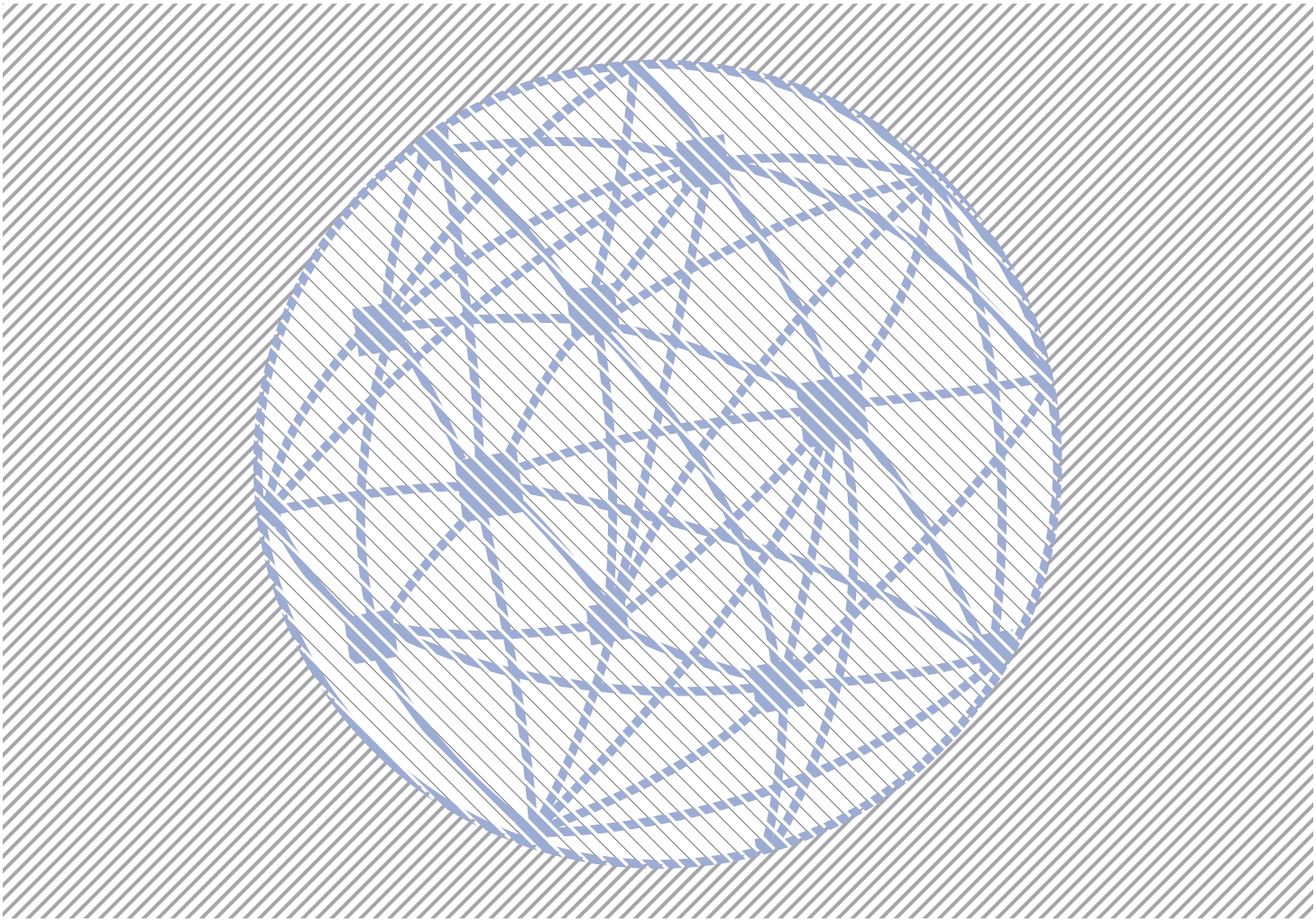

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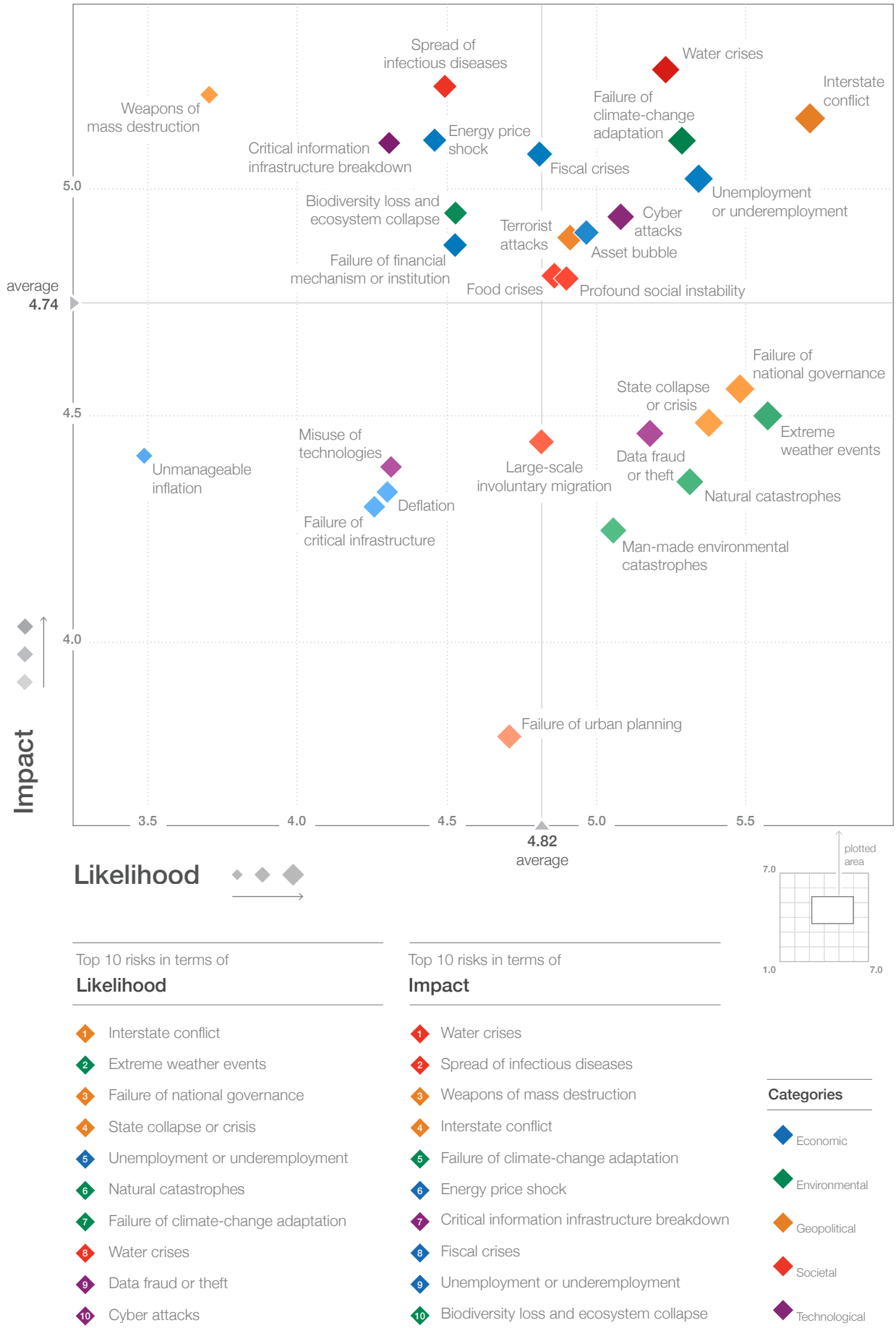
**Figure 1:** The Global Risks Landscape 2015




Top 10 risks in terms of **Likelihood**

1. Interstate conflict
2. Extreme weather events
3. Failure of national governance
4. State collapse or crisis
5. Unemployment or underemployment
6. Natural catastrophes
7. Failure of climate-change adaptation
8. Water crises
9. Data fraud or theft
10. Cyber attacks

Top 10 risks in terms of **Impact**

1. Water crises
2. Spread of infectious diseases
3. Weapons of mass destruction
4. Interstate conflict
5. Failure of climate-change adaptation
6. Energy price shock
7. Critical information infrastructure breakdown
8. Fiscal crises
9. Unemployment or underemployment
10. Biodiversity loss and ecosystem collapse

**Categories**

- Economic
- Environmental
- Geopolitical
- Societal
- Technological

Source: Global Risks Perception Survey 2014.
Note: Survey respondents were asked to assess the likelihood and impact of the individual risks on a scale of 1 to 7, 1 representing a risk that is not likely to happen or have impact, and 7 a risk very likely to occur and with massive and devastating impacts. See Appendix B for more details. To ensure legibility, the names of the global risks are abbreviated. Also see Appendix A for the full name and description.

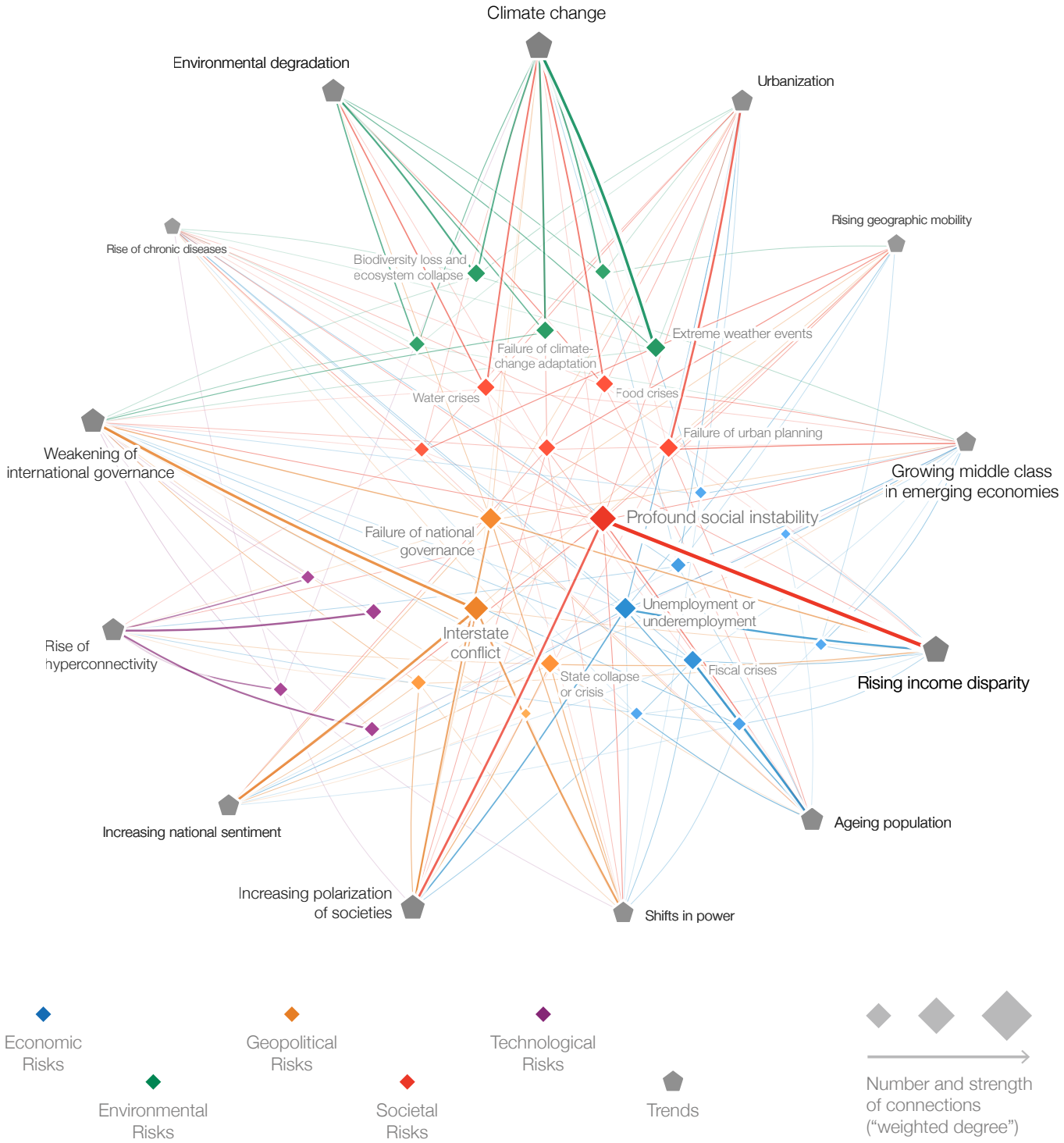
**Table A:** Global Risks 2015

| | |
|---|---|
| Economic | Asset bubble in a major economy |
| | Deflation in a major economy |
| | Energy price shock to the global economy |
| | Failure of a major financial mechanism or institution |
| | Failure/shortfall of critical infrastructure |
| | Fiscal crises in key economies |
| | High structural unemployment or underemployment |
| | Unmanageable inflation |
| Environmental | Extreme weather events (e.g. floods, storms, etc.) |
| | Failure of climate-change adaptation |
| | Major biodiversity loss and ecosystem collapse (land or ocean) |
| | Major natural catastrophes (e.g. earthquake, tsunami, volcanic eruption, geomagnetic storms) |
| | Man-made environmental catastrophes (e.g. oil spill, radioactive contamination, etc.) |
| Geopolitical | Failure of national governance (e.g. corruption, illicit trade, organized crime, impunity, political deadlock, etc.) |
| | Interstate conflict with regional consequences |
| | Large-scale terrorist attacks |
| | State collapse or crisis (e.g. civil conflict, military coup, failed states, etc.) |
| | Weapons of mass destruction |
| Societal | Failure of urban planning |
| | Food crises |
| | Large-scale involuntary migration |
| | Profound social instability |
| | Rapid and massive spread of infectious diseases |
| | Water crises |
| Technological | Breakdown of critical information infrastructure and networks |
| | Large-scale cyber attacks |
| | Massive incident of data fraud/theft |
| | Massive and widespread misuse of technologies (e.g. 3D printing, artificial intelligence, geo-engineering, synthetic biology, etc.) |

**Table B:** Trends 2015

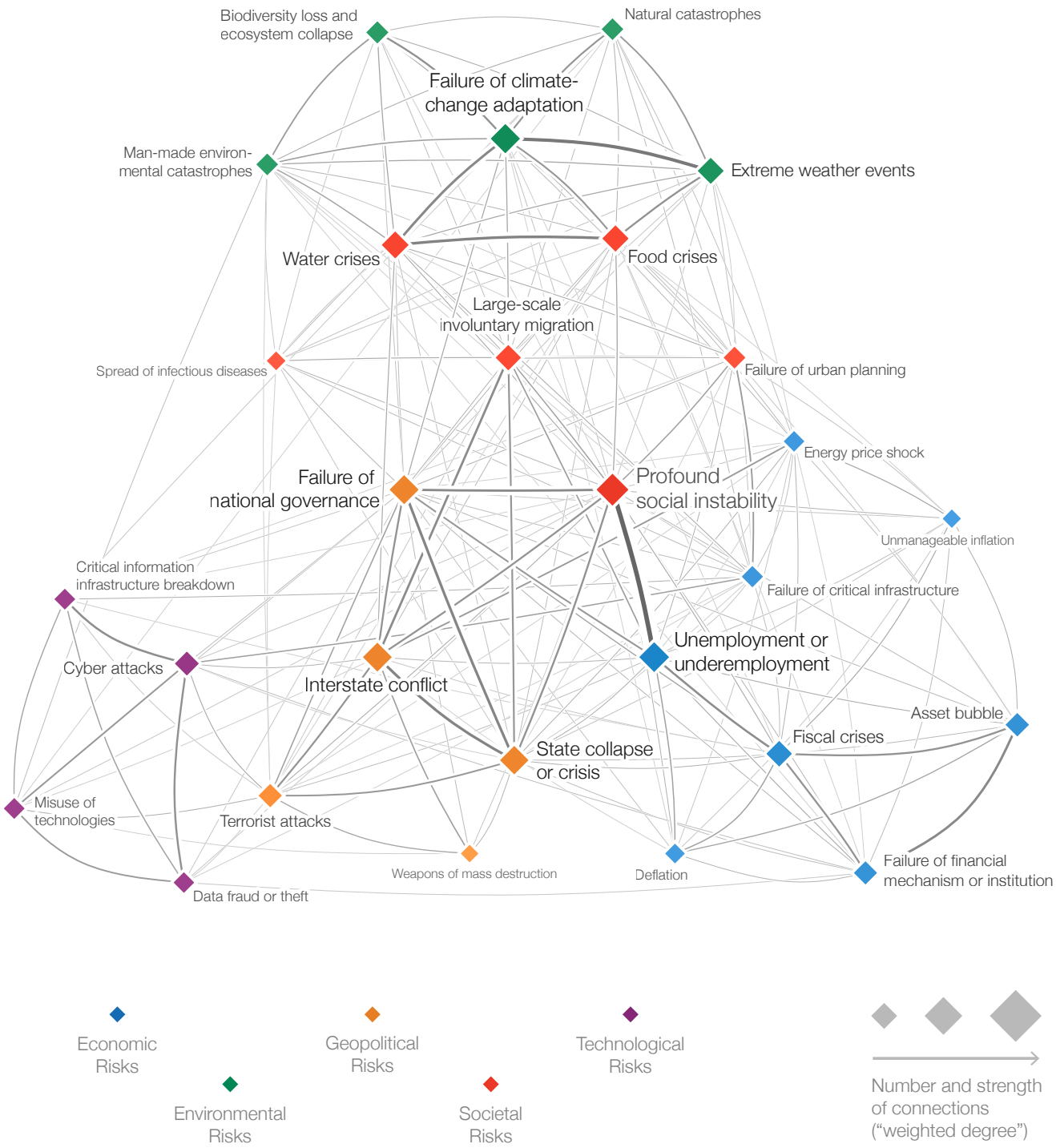
| |
|---|
| Ageing population |
| Climate change |
| Environmental degradation |
| Growing middle class in emerging economies |
| Increasing national sentiment |
| Increasing polarization of societies |
| Rise of chronic diseases |
| Rise of hyperconnectivity |
| Rising geographic mobility |
| Rising income disparity |
| Shifts in power |
| Urbanization |
| Weakening of international governance |

**Figure 3:** The Risks-Trends 2015 Interconnections Map




Source: Global Risks Perception Survey 2014.
Note: Survey respondents were asked to select between three and six trends and to identify for each the risk they believe is most interconnected. See Appendix B for more details. To ensure legibility, the names of the global risks are abbreviated. Also see Appendix A for the full name and description.

**Figure 2:** The Global Risks 2015 Interconnections Map




Source: Global Risks Perception Survey 2014.
Note: Survey respondents were asked to identify between three and six pairs of global risks they believe to be most interconnected. See Appendix B for more details. To ensure legibility, the names of the global risks are abbreviated. Also see Appendix A for the full name and description.

# Global Risks 2015
## 10th Edition

**Strategic Partners**
Marsh & McLennan Companies
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

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# Preface

This 10th edition of the *Global Risks* report is published at a time of profound transformations to our global context. Ongoing political, economic, social, environmental and technological developments are challenging many of our underlying assumptions. Across every sector of society, decision-makers are struggling to cope with heightened complexity and uncertainty resulting from the world's highly interconnected nature and the increasing speed of change.

Faster communication systems, closer trade and investment links, increasing physical mobility and enhanced access to information have combined to bind countries, economies and businesses more tightly together. In the coming decade – the time horizon of this report – our lives will be even more intensely shaped by transformative forces that are under way already. The effects of climate change are accelerating and the uncertainty about the global geopolitical context and the effects it will have on international collaboration will remain. At the same time, societies are increasingly under pressure from economic, political and social developments including rising income inequality, but also increasing national sentiment. Last but not least, new technologies, such as the Internet or emerging innovations will not bear fruit if regulatory mechanisms at the international and national levels cannot be agreed upon.

In a world where risks transcend borders and sectors, the motivations underlying the Global Risks report at its inception in 2005 – to shed light on global risks and help create a shared understanding of the most pressing issues, the ways they interconnect and their potential negative impacts – are more relevant than ever. The shared understanding of challenges is needed as a base for multistakeholder collaboration, which has seen increasing recognition as the most effective way to address global risks and build resilience against them. To further inspire action, in this year's report we include a new section sharing examples of risk mitigation and resilience practices.

As in previous years, the report is based on the annual Global Risks Perception Survey, completed by almost 900 members of the World Economic Forum's global multistakeholder community. This year's report introduces a new distinction between risks and trends, which allows the highlighting of trends as an enlarged solution space to many possible risks. The report also presents deep-dive discussions of the risks posed by a resurgence of interlinked economic and geopolitical power plays, the rapid urbanization of the developing world and the exciting realm of emerging technologies, from synthetic biology to artificial intelligence.

The coming year offers unprecedented opportunities for much-needed collective action to address key global risks, such as the Sendai world conference on disaster risk reduction and the 2015 United Nations Climate Change Conference in Paris. As we mark the 10th anniversary of the report and highlight progress that has been achieved over the past decade, my hope remains that this work will contribute to the debate on how we think about global risks, mitigate them and strengthen resilience.

Klaus Schwab
Founder and Executive Chairman
World Economic Forum

# Foreword

Collaboration across countries, areas of expertise and stakeholder groups is necessary to effectively address global risks. As one of the flagship reports of the World Economic Forum, the Global Risks report has been a collaborative effort since its first edition in 2006. Produced within the World Economic Forum's forward looking networked think tank, the Centre for Global Strategies, the report is able to draw on unique expertise available within the different communities and the knowledge networks of the World Economic Forum as well as within the organization as a whole.

The 2015 edition has established a Steering Board to provide strategic guidance as well as a high-level multistakeholder Advisory Board for advising on the methodology and the content of the report. The report's corporate partners, academic advisors, and members of the Advisory Board contributed greatly to this endeavour. It also strongly builds on ongoing research, projects, debates and initiatives within the World Economic Forum. The insights presented here are the result of numerous discussions, consultations, and workshops and reflect the views of leaders from our various communities through the Global Risks Perception Survey.

With this in mind, I would like to thank our corporate report partners, Marsh & McLennan Companies and Zurich Insurance Group, represented on the Steering Board by John Drzik, President, Global Risk and Specialties, Marsh, and Axel Lehmann, Member, Group Chief Risk Officer, Zurich Insurance Group. Further, I am grateful to our academic advisers the National University of Singapore, 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 also greatly benefited from the dedication and valuable guidance of the members of the Global Risks 2015 Advisory Board. Members are Rolf Alter, Organisation for Economic Co-operation and Development; Mario Blejer, Banco Hipotecario; Oliver Chen, Global Valuation, who represents the National University of Singapore; Megan Clark, Commonwealth Scientific and Industrial Research Organization; Marie-Valentine Florin, International Risk Governance Council; Julian Laird, Oxford Martin School; Pascal Lamy, Notre Europe – Jacques Delors Institute; Ursula von der Leyen, Federal Minister of Defence of Germany; Erwann Michel-Kerjan, the Wharton School, University of Pennsylvania; Moisés Naím, Carnegie Endowment for International Peace; Jonathan Ostry, International Monetary Fund; Manuel Pulgar-Vidal Otalora, Minister of Environment of Peru; Nouriel Roubini, New York University; Anders Sandberg, University of Oxford; Richard Smith-Bingham, Marsh & McLennan Companies; Michelle Tuveson, University of Cambridge; Margareta Wahlström, United Nations International Strategy for Disaster Reduction; and Steve Wilson, Zurich Insurance Group.

I am also grateful to Margareta Drzeniek Hanouz, Lead Economist and Head, Global Competitiveness and Risks, and the Global Risks 2015 project team members Ciara Browne, Jonathon Cini, Roberto Crotti, Attilio Di Battista, Gaëlle Dreyer, Caroline Galvan, Thierry Geiger, Tania Gutknecht and Cecilia Serin for their contributions to the report.

Last but not least, I would like to thank the respondents that completed the Global Risks Perception Survey.

Espen Barth Eide
Managing Director
and Member of the Managing Board
World Economic Forum

# Executive Summary

The 2015 edition of the *Global Risks* report completes a decade of highlighting the most significant long-term risks worldwide, drawing on the perspectives of experts and global decision-makers. Over that time, analysis has moved from risk identification to thinking through risk interconnections and the potentially cascading effects that result. Taking this effort one step further, this year's report underscores potential causes as well as solutions to global risks. Not only do we set out a view on 28 global risks in the report's traditional categories (economic, environmental, societal, geopolitical and technological) but also we consider the drivers of those risks in the form of 13 trends. In addition, we have selected initiatives for addressing significant challenges, which we hope will inspire collaboration among business, government and civil society communities.

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.*

A trend is defined as *a long-term pattern that is currently taking place and that could amplify global risks and/or alter the relationship between them.*

## Mapping Global Risks in 2015

The Global Risks Landscape, a map of the most likely and impactful global risks, puts forward that, 25 years after the fall of the Berlin Wall, "interstate conflict" is once again a foremost concern (see Table 1). However, 2015 differs markedly from the past, with rising technological risks, notably cyber attacks, and new economic realities, which remind us that geopolitical tensions present themselves in a very different world from before. Information flows instantly around the globe and emerging technologies have boosted the influence of new players and new types of warfare. At the same time, past warnings of potential environmental catastrophes have begun to be borne out, yet insufficient progress has been made – as reflected in the high concerns about failure of climate-change adaptation and looming water crises in this year's report.

These multiple cross-cutting challenges can threaten social stability, perceived to be the issue most interconnected with other risks in 2015, and additionally aggravated by the legacy of the global economic crisis in the form of strained public finances and persistent unemployment. The central theme of profound social instability highlights an important paradox that has been smouldering since the crisis but surfaces prominently in this year's report. Global risks transcend borders and spheres of influence and require stakeholders to work together, yet these risks also threaten to undermine the trust and collaboration needed to adapt to the challenges of the new global context.

The world is, however, insufficiently prepared for an increasingly complex risk environment. For the first time, the report provides insights on this at the regional level: social instability features among the three global risks that Europe, Latin America and the Caribbean, and the Middle East and North Africa are least prepared for. Other societal risks, ranging from the failure of urban planning in South Asia to water crises in the Middle East and North Africa, are also prominent. And capacity to tackle persistent unemployment – an important risk connected with social instability – is a major concern in Europe and sub-Saharan Africa.

As in previous years, Part 2 explores three risk constellations that bear on the survey findings. In 2015, these are:

**Interplay between geopolitics and economics:** The interconnections between geopolitics and economics are intensifying because states are making greater use of economic tools, from regional integration and trade treaties to protectionist policies and

**Table 1:** The Ten Global Risks in Terms of Likelihood and Impact

| Top 10 global risks in terms of **Likelihood** | Top 10 global risks in terms of **Impact** |
|---|---|
| 1 Interstate conflict | 1 Water crises |
| 2 Extreme weather events | 2 Spread of infectious diseases |
| 3 Failure of national governance | 3 Weapons of mass destruction |
| 4 State collapse or crisis | 4 Interstate conflict |
| 5 Unemployment or underemployment | 5 Failure of climate-change adaptation |
| 6 Natural catastrophes | 6 Energy price shock |
| 7 Failure of climate-change adaptation | 7 Critical information infrastructure breakdown |
| 8 Water crises | 8 Fiscal crises |
| 9 Data fraud or theft | 9 Unemployment or underemployment |
| 10 Cyber attacks | 10 Biodiversity loss and ecosystem collapse |

**Categories**

- Economic
- Environmental
- Geopolitical
- Societal
- Technological

Source: Global Risks Perception Survey 2014, World Economic Forum.

cross-border investments, to establish relative geopolitical power. This threatens to undermine the logic of global economic cooperation and potentially the entire international rule-based system.

**Urbanization in developing countries:** The world is in the middle of a major transition from predominantly rural to urban living, with cities growing most rapidly in Asia and Africa. If managed well, this will help to incubate innovation and drive economic growth. However, our ability to address a range of global risks – including climate change, pandemics, social unrest, cyber threats and infrastructure development – will largely be determined by how well cities are governed.

**Governance of emerging technologies:** The pace of technological change is faster than ever. Disciplines such as synthetic biology and artificial intelligence are creating new fundamental capabilities, which offer tremendous potential for solving the world's most pressing problems. At the same time, they present hard-to-foresee risks. Oversight mechanisms need to more effectively balance likely benefits and commercial demands with a deeper consideration of ethical questions and medium to long-term risks – ranging from economic to environmental and societal.

The Global Risks Perception Survey 2014 gathered the perceptions of almost 900 members of the World Economic Forum's multistakeholder community between July and September 2014.

Mitigating, preparing for and building resilience against global risks is long and complex, something often recognized in theory but difficult in practice. Against this backdrop, Part 3 features three proven or promising initiatives that were instituted in response to extreme weather events and climate-change adaptation. The modelling of the **Murray-Darling Basin** river system in Australia has pioneered innovative methods of water management that are now being adapted for use elsewhere in the world. The **Resilient America Roundtable** is currently helping selected local communities across the United States to understand how they might be affected by different risks and then design resilience strategies. **ZÜRS Public**, part of an extensive flood management programme in Germany, is a public-private collaboration that for several years now has been a tool for communicating with homeowners and businesses about their exposure to flood risk.

Over the past 10 years, the *Global Risks* report has raised awareness of the dangers from the interconnected nature of global risks and has persistently called for multistakeholder collaboration to address them. By offering a broad-ranging overview from risk identification and evaluation to practices – from the "what" to the "how" – this year's report aims to provide the most comprehensive set of insights yet for decision-makers in its decade-long history.

# Introduction

For the past decade, the Global Risks report – now in its 10th edition – has been calling attention to global risks and providing tools to support decision-makers in their efforts to mitigate or prevent global risks or strengthen resilience against them.

Since its inception, the report has raised awareness that the world is increasingly interconnected and that global risks cannot be seen in isolation. On the contrary, they can have far-reaching cascading effects as demonstrated by the financial crisis in 2008 and its socio-economic consequences. The year 2014 alone witnessed several such risks with potentially broad implications in the years to come if history serves as a benchmark: the frozen relationship between Russia and the West – unfathomable to most just one year ago – seems to be transporting the world back to a time when geopolitics took primacy. The conflict in Syria and the spread of the Islamic State in the region have set off unprecedented migration flows into neighbouring countries and Europe, which could impact social cohesion if poorly managed. Revelations about data fraud and leaks and cyber espionage have critically undermined global trust, running the risk of complicating the search for solutions to other global governance challenges as well. Successfully addressing these complex and interconnected issues necessitates greater multistakeholder cooperation to increase the capacity to foresee, manage and mitigate global risks and to strengthen society's preparedness and resilience to them. The report takes the first step towards establishing comprehensive collaboration by fostering a shared understanding of the issues at hand.

## 10 Years of Risk Awareness Building

Over the past decade, the *Global Risks* report has seen both its readership and its impact increase significantly. The report has become a useful tool for many governments and businesses to assess their exposure to global risks (see Box 1). It has also successfully raised awareness on key risks, such as the threat of increasing resistance to

antibiotics, which was featured in 2013, or important IT-related risks, which are now at the forefront of business concerns.

After 10 years, the World Economic Forum is now also in a position to revisit the first *Global Risks* report, an endeavour that illustrates both the difficulty and the necessity of attempting to think 10 years ahead. The economic risk given most attention in 2007 was the possibility of an asset price bubble, which set off a major financial crisis in the same year. The subsequent years were primarily defined by potential risks related to the stability of financial systems in many countries and the threat of sovereign default, resulting in an economic meltdown the world is still recovering from. The interconnected nature of the global economy today and the scale of the global financial crisis show the need to look beyond the obvious for risk interconnections.

Importantly, this 10th edition also reflects a decade of learning and methodological improvements. Fundamentally, the report's approach remains the same – to identify global risks and their interactions, and to assess them on two dimensions: their perceived likelihood and impact. However, over the years, a number of refinements have been made to the methodology, reflecting the lessons learned from 10 years' experience in this field. This year's edition features an updated methodology based on input from the members of the newly established Advisory Board (the list of members appears in the Acknowledgements section at the end of this report).

The uncertainty associated with risks, their interconnected nature and often the absence of data make it difficult to accurately quantify a range of risks – for example social unrest, cyber attacks or oil price shocks. A survey is therefore a suitable tool to get a sense of the order of magnitude of the impact and likelihood of risks. The qualitative, perceptions-based approach embodied in the Global Risks Perception Survey has been the base of the World Economic Forum's work in this area since 2011, capturing the views of decision-makers from the Forum's multistakeholder constituencies on the perceived impact and probability of risks and the interconnections between them. Perceptions allow us to better understand decision-makers' priorities, which in turn influence their decisions.

Over the years, the reports have put increasing emphasis on the interconnected nature of global risks and the potential spillover effects of systemic risks, putting this aspect of risks on the agenda. The resulting complexities underscore the difficulties stakeholders face when addressing risks and are reflected in this edition's introduction of trends as drivers of risks. As a result, there is increased emphasis on going beyond the analysis of global risks to include suggestions on what stakeholder alliances can do about them. The focus on solutions in this edition is the strongest yet, with a new section on practices and a stronger focus in the survey on preparedness and progress.

### Box 1: How has the *Global Risks* report been used?

A range of stakeholders were asked how they used the Global Risks report series over the last 10 years. The most common answers were to:

- develop scenarios;
- prepare crisis exercises;
- assess vulnerabilities and their potential for cascade effects;
- inform "sense making" exercises in crisis situations;
- train top decision-makers;
- model risks external to the direct business environment.

## The Structure of this Report

Part 1 of this report explores the results of the Global Risks Perception Survey 2014. It explains the distinction between risks and trends, visualizes the likelihood of interconnections between risks, and analyses the difference in risk perceptions over different time horizons. Figures 1, 2 and 3 are shown on the inside cover flaps.

Part 2 deep-dives into three topics that emerged strongly from the interconnections between risks and trends: the interplay between geopolitics and economics, rapid urbanization in developing countries, and emerging technologies.

Part 3 discusses risk management and risk resilience: it presents survey respondents' views on which risks have most successfully been addressed over the past 10 years, and shares practices from the public and private sectors that offer ways forward to address global risks. The full methodology for the survey is shared in Appendix B. The complete set of data can be explored online at: www.weforum.org/risks.

# Part 1: Global Risks 2015

## Introduction

The *Global Risks 2015* report comes at a time when various manifestations of global risks brought into sharp relief that the world is not equipped to deal with these events or similar occurrences in the future. For the past decade, the *Global Risks* report has been calling attention to global risks and providing a base for multistakeholder action. Over this period, the evolution in understanding how global risks are thought about and assessed has been significant. This has led the Forum to update the methodology it has used to assess global risks for the 10th edition of the report, based on input from the members of the newly established Advisory Board.

Building on this evolution, in this report 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*. Based on this refined definition, 28 global risks were identified and grouped into the five customary categories: economic risks, environmental risks, geopolitical risks, societal risks and technological risks. A description of the risks and the methodology employed can be found in Appendix A and Appendix B.

A further development in the 2015 report is the delineation of risks and trends. This distinction allows a better understanding of the underlying drivers of global risks. A trend is defined as *a long-term pattern that is currently taking place and that could contribute to amplifying global risks and/or altering the relationship between them*. The focus on trends can contribute to risk mitigation; for example, better planned urbanization can help alleviate certain risks that concentrate in urban areas. Moreover, the differentiation between trends and risks emphasizes the fact that trends, unlike risks, are occurring with certainty and can have both positive and negative consequences. Trends are long-term, ongoing processes that can alter the future evolution of risks or the interrelations among them, without necessarily becoming risks themselves.

As in previous years, risks are assessed based on the perception of leaders and decision-makers obtained through the Global Risks Perception Survey. The survey captures the views of the World Economic Forum's multistakeholder communities across different areas of expertise, geographies and age groups. It was conducted between July and September 2014 and gathered the perceptions of almost 900 leading decision-makers from business, academia and the public sector. A more detailed description of the sample and the survey's methodology is presented in Appendix B. Complementary to the Global Risks Perception Survey data, the views of business executives were also collected on the risks of highest concern for doing business in their country, presented in more detail in Appendix C.

The results provide a snapshot of current perceptions on global risks and highlight priorities for action from three complementary angles: (1) the Global Risks Landscape, in which risks are assessed according to likelihood and impact, allowing a comparison of how perceptions have evolved over the years (Figure 1); (2) the Interconnections Maps of Risks (Figure 2) and of Risks and Trends (Figure 3); and (3) the level of concern in the short and long terms (Figure 1.1).

The Global Risks Landscape, as defined by the survey, highlights five global risks that stand out as both highly likely and highly potentially impactful (upper right quadrant of Figure 1). **Interstate conflict** has significantly leaped up both dimensions since 2014, arguably reflecting recent geopolitical conflicts that are fuelling geopolitical and social instability. As last year, concerns about environmental and economic risks remain, in particular around **failure of climate-change adaptation, water crises**[1] and **unemployment and underemployment** reflecting concern about how little tangible action has been taken to address them. At the same time, **cyber attacks** remain among the most likely high-impact risks.

Respondents also underscored the potentially devastating impact of the **rapid and massive spread of infectious diseases**, which reflects the need for a higher level of preparedness for major pandemics at both the country and international levels to address this important risk (see Box 2.4 in Part 2).

In the geopolitical risks category, respondents identified **weapons of mass destruction** (WMDs), which include weapons containing nuclear, chemical, biological and radiological technologies, as the third most impactful risk, albeit as the second least likely risk. If deployed, they would create an international crisis with huge human and economic costs. In the coming decades, technological advancements, greater access to scientific knowledge and the increased vulnerability of classified information to cyber threats enhance the risk of WMDs proliferation, particularly in fragile areas. This highlights the need for greater international collaboration to control the proliferation of WMDs.

Among the economic risks, **fiscal crises** and unemployment are perceived as close to equally impactful and likely as in last year's report, yet other risk categories take centre stage this year (see Figure 1.4). While the world has made progress in addressing and preventing financial crises, and small improvements in fiscal issues and unemployment have been achieved, the danger of complacency compared to other risks exists: experts remain concerned about significant residual risks, which may have been overshadowed by other risks in the survey.[2]

The prominence of risks dominating recent headlines in our assessments raises questions about the role of the "availability heuristic" – risks that have manifested themselves recently may be uppermost in people's minds, even if their recent occurrence does not necessarily increase their impact or likelihood over a 10-year time horizon. To reveal more about the psychology behind the responses, the survey this year asked respondents to nominate risks of highest concern over two time horizons: 10 years, as usual, and 18 months. The results are shown in Figure 1.1. In the short term, respondents are more concerned about global risks related to recent events and human action, including interstate conflict, **state collapse**, **failure of national governance** and **large-scale terrorist attacks**. The list for the longer term is dominated by risks related to physical and environmental trends that have been less prominent in recent headlines, such as water crises, failure of climate-change adaptation and **food crises**.

Interestingly, the risk of **social instability** scores high in both the short and long term. This trend towards social fragility is one of five threads that stand out from the 2015 survey – along with growing concern about geopolitics, the possible overshadowing of economic risks by other more imminent risks, concern about unaddressed environmental risks, and persisting vulnerabilities in cyberspace – which are explored in more depth below.

## Box 1.1: The evolution of the risks of highest impact/likelihood

As the report's 10th anniversary approaches, the evolution of the perceived top five global risks can be viewed in terms of impact and likelihood as documented in the Global Risks reports from 2007 to 2015. As Table 1.1.1 shows, economic risks largely dominated from 2007 to 2014, with the risk of an asset-price collapse heading the list in the run-up to the financial crisis, giving way to concerns about the more immediate but slow-burning consequences of constrained fiscal finances, a major systemic financial failure in the immediate post-crisis years, and income disparity. This year features a radical departure from the past decade; for the first time in the report's history, economic risks feature only marginally in the top five. In the 25th year after the fall of the Berlin Wall, geopolitical risks are back on the agenda. The dispute over Crimea in March 2014 serves as a forceful reminder of the consequences of interstate conflicts with regional consequences that seemed long forgotten and unfathomable, as further explored in this report. Similarly, together with other events in 2014, such as the prominent rise of the Islamic State, it has brought state collapse and the failure of national governance back into public consciousness. At the same time, health-related risks, such as pandemics – last considered impactful in 2008 – have made it back into the unglamorous top, following the unprecedented spread of Ebola.

On a higher level, Table 1.1.1 also indicates a shift over past years away from economic risks in general to environmental risks – ranging from climate change to water crises. While this highlights a recognition of the importance of these slow-burning issues, strikingly little progress has been made to address them in light of their far-reaching and detrimental consequences for this and future generations.

**Table 1.1.1:** The Evolving Risks Landscape (2007-2015)

Top 5 Global Risks in Terms of Likelihood

| | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 |
|---|---|---|---|---|---|---|---|---|---|
| 1st | Breakdown of critical information infrastructure | Asset price collapse | Asset price collapse | Asset price collapse | Storms and cyclones | Severe income disparity | Severe income disparity | Income disparity | Interstate conflict with regional consequences |
| 2nd | Chronic disease in developed countries | Middle East instability | Slowing Chinese economy (<6%) | Slowing Chinese economy (<6%) | Flooding | Chronic fiscal imbalances | Chronic fiscal imbalances | Extreme weather events | Extreme weather events |
| 3rd | Oil price shock | Failed and failing states | Chronic disease | Chronic disease | Corruption | Rising greenhouse gas emissions | Rising greenhouse gas emissions | Unemployment and underemployment | Failure of national governance |
| 4th | China economic hard landing | Oil and gas price spike | Global governance gaps | Fiscal crises | Biodiversity loss | Cyber attacks | Water supply crises | Climate change | State collapse or crisis |
| 5th | Asset price collapse | Chronic disease, developed world | Retrenchment from globalization (emerging) | Global governance gaps | Climate change | Water supply crises | Mismanagement of population ageing | Cyber attacks | High structural unemployment or underemployment |

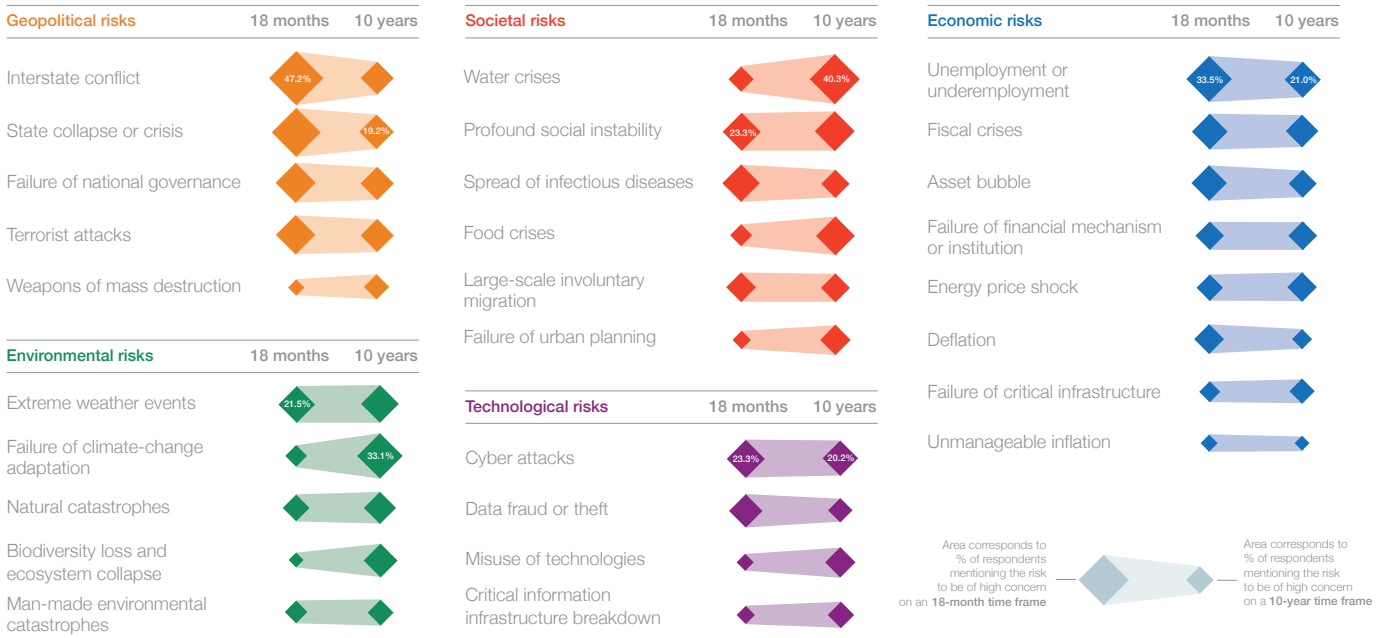
Top 5 Global Risks in Terms of Impact

| | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 |
|---|---|---|---|---|---|---|---|---|---|
| 1st | Asset price collapse | Asset price collapse | Asset price collapse | Asset price collapse | Fiscal crises | Major systemic financial failure | Major systemic financial failure | Fiscal crises | Water crises |
| 2nd | Retrenchment from globalization | Retrenchment from globalization (developed) | Retrenchment from globalization (developed) | Retrenchment from globalization (developed) | Climate change | Water supply crises | Water supply crises | Climate change | Rapid and massive spread of infectious diseases |
| 3rd | Interstate and civil wars | Slowing Chinese economy (<6%) | Oil and gas price spike | Oil price spikes | Geopolitical conflict | Food shortage crises | Chronic fiscal imbalances | Water crises | Weapons of mass destruction |
| 4th | Pandemics | Oil and gas price spike | Chronic disease | Chronic disease | Asset price collapse | Chronic fiscal imbalances | Diffusion of weapons of mass destruction | Unemployment and underemployment | Interstate conflict with regional consequences |
| 5th | Oil price shock | Pandemics | Fiscal crises | Fiscal crises | Extreme energy price volatility | Extreme volatility in energy and agriculture prices | Failure of climate change adaptation | Critical information infrastructure breakdown | Failure of climate-change adaptation |

Economic | Environmental | Geopolitical | Societal | Technological

Source: *Global Risks* reports 2007-2015, World Economic Forum.
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, cyber attacks, income disparity and unemployment entered the set of global risks in 2012. Some global risks were reclassified: water crises and rising income disparity were recategorized as societal risks and as a trend, respectively, in 2015. The 2006 edition of the Global Risks report did not have a risks landscape.

**Figure 1.1:** Global Risks of Highest Concern - for the Next 18 Months and 10 Years




Source: Global Risks Perception Survey 2014, World Economic Forum.
Note: Survey respondents were asked to select up to five risks of highest concern for each time frame. The percentage indicates the share of respondents who selected the specific global risk among the five risks of highest concern for each time frame. In each category, the risks are sorted by the total sum of mentions. See Appendix B for more details. To ensure legibility, the names of the global risks are abbreviated. See Appendix A for the full name and description.

## Fragile Societies under Pressure

The fragility of societies is of increasing concern, fuelled by underlying economic, societal and environmental developments (Figure 3 and Figure 1.2). A major driver of social fragility is **rising socio-economic inequality** within countries, although it is diminishing between countries. Among the members of the Organisation for Economic Co-operation and Development (OECD), the average income of the richest 10% has now grown to about nine times that of the poorest 10%. In other countries, the ratio is even higher: for example, more than 25 times in Mexico.[3]

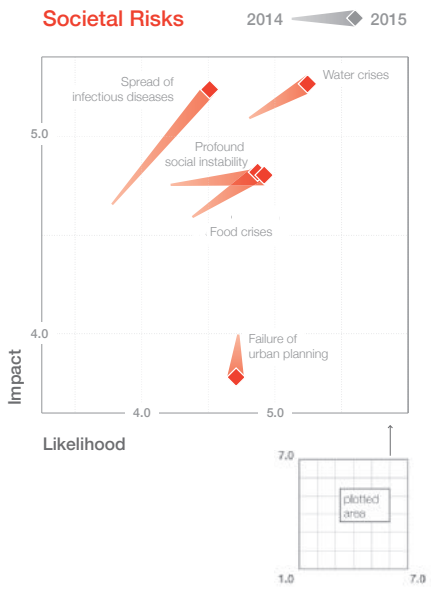
Income inequality is widening quickly in large emerging markets. The People's Republic of China has seen its Gini Index rise from about 30 in the 1980s to over 50 in 2010.[4,5] While extreme poverty (less than $1.25 per day) was reduced from afflicting over 50% of the world's population in 1990 to 22% in 2010, the same reduction did not take place in those earning under $3 per day.[6] The story is of people escaping extreme poverty, yet remaining poor. Widening income inequality is associated with lower and more fragile economic growth, which reduces the scope to meet rising social expectations in emerging markets.[7]

Rising **structural unemployment** drives both inequality and social pressures. Lower economic growth and technological change are likely to keep unemployment high in the future, also in developing countries. The spread of connectivity enables protest movements to mount more quickly, increasing the risk of unrest and violence that could easily spill over from individual countries to affect the global economy. While inequality and unemployment contribute to social instability, social instability in turn impacts negatively on equality, employment and wealth creation. The multidirectional cause-and-effect relationship makes it harder to address the related risks.

Underlying social fragility is also the accelerating pace of change, growing complexity and the deepening extent of global interdependence, which together reduce people's feeling of control over their immediate environment and hence their sense of stability and security. A common psychological response to insecurity and perceived loss of control is the desire to turn inwards towards smaller groups that have a stronger sense of identity. At the same time, increased global connectivity allows people to make their voices heard and to convene with like-minded individuals. The growing risks of social extremism and isolationism are brought to light through the rising influence of religious groups and in the separatist movements in Catalonia and Scotland.

The effects associated with **climate change** will put further pressure on societies. Its expected impact on the ability to grow food and access water could prompt sudden and uncontrolled population migrations, putting additional pressure on receiving countries.[8] Already in 2014, the number of refugees worldwide from environmental or conflict-related causes reached its highest level since World War II.[9]

**Figure 1.2:** The Changing Global Risks Landscape 2014-2015, Societal Risks




Source: Global Risks Perception Surveys 2013 and 2014, World Economic Forum.
Note: See endnote 25

As societies become less homogenous and less bound by common values, and more polarized into the haves and have-nots, they will become harder to govern effectively. This in turn increases the risk of prolonged economic stagnation, creating the potential for a self-reinforcing downward spiral into social chaos. States will need to mitigate this risk through policies to make growth more inclusive: providing public goods and services such as social protection, hospitals, schools, transport and telecommunications infrastructure.

## Growing Worries about Conflict

Having not featured prominently in previous editions of the report, interstate conflict is this year considered the most likely high-impact risk over the next 10 years, or indeed perhaps even sooner. As already discussed, respondents are even more concerned about geopolitical risks in the short term than in the long term (Figure 1.1)

Many observers believe that the world is entering a new era of strategic competition among global powers. Disillusion about globalization is leading to more self-interested foreign policies in combination with a rise in **national sentiment** (Figure 3) fuelled in part by the social pressures described above. Growing nationalism is evident around the world: in Russia, as seen in the Crimea crisis; in India, with the rising popularity of nationalist politicians; and in Europe, with the rise of far-right, nationalistic and Eurosceptic parties in a number of countries.

Growth and employment creation are currently expected to remain below pre-crisis levels in both emerging markets and advanced economies, suggesting that the drivers of nationalism will remain strong, and raising the possibility of more frequent and impactful conflicts among states. Importantly, as can be seen in Figure 2, interstate conflict is no longer physical but uses economic means and cyber warfare to attack people's privacy as well as intangible assets.

Geopolitical risks can have cascading impacts on other risks. As state structures are challenged by conflict, the risk of the failure of national governance and state collapse or crisis can increase in areas where current state boundaries do not necessarily reflect popular self-identification. A recent example is Iraq and Syria, where ISIS has claimed control of territory and attracted 20,000 to 30,000 fighters from a near standing start.[10] The rapid rise and brutality of ISIS as well as the response of the international community may underlie the increased likelihood and impact attributed by respondents to the risk of the deployment of weapons of mass destruction and the higher potential impact than in previous years associated with large-scale terrorist attacks (Figure 1.3).

Failure of national governance features strongly this year, as the third most likely risk across the global risks landscape. This risk area captures a number of important elements around the inability to efficiently govern as a result of corruption, illicit trade, organized crime, the presence of impunity and generally weak rule of law. Over past years, the links between many forms of global crime and corruption and their impact on global security, extremism, terrorism and fragile states have only grown stronger, and it is critical to acknowledge and address them through more effective policies that curb illegal financial flows, foster transparent governance and build capacity around anti-crime efforts at the national and local levels. Absent a stronger response from both the public and private sectors, the risk is of undoing hard-earned gains in economic and political stability, and further eroding trust in leadership. In a number of countries, such as India, Indonesia and Romania, new leaders have been elected in large part due to their public commitment to more transparent and corruption-free governance models, underscoring an ongoing shift in public expectations.

The growing interconnectedness of the global economy increases the economic effects of any geopolitical conflict. Supply chains that run across countries in conflict could be interrupted, leading to disruptions in the availability of goods or energy. Survey respondents considered the risk of an **energy price shock to the global economy** as more impactful and more likely than in previous years, despite the increasing availability of shale gas or alternative energy sources. The interplay between economic and geopolitical forces is further explored in Part 2 of this report.

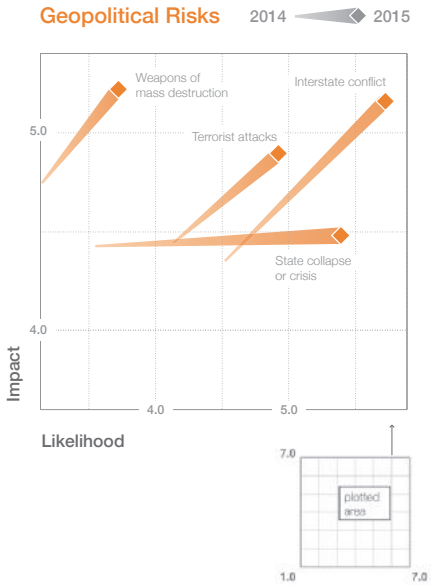
## Box 1.2: The rising threat from non-state actors

The group known as ISIS, ISIL or the Islamic State has gained global notoriety through its taste for video-recorded executions and large-scale atrocity, with a background of further human rights abuse that includes arbitrary imprisonment and sexual enslavement. While its thirst for violence, blood and misery – and especially the way it glories in these crimes – mark it out from other non-state armed forces of our age, this is really only a quantitative distinction. Other groups – many of them part of the global Al Qaeda franchise – do the same, only less. Al Nusra in Syria, Al Qaeda in the Islamic Maghreb and the Nigerian group known in the West as Boko Haram all do some of what ISIS does on a somewhat smaller scale.

But what really marks ISIS out is that it has claimed statehood and with that has established some of the machinery of state management. ISIS has not only proclaimed the new Caliphate, the rule of the successors of the Prophet Muhammad – not that it has any theological credibility to do so – but also administers the area of northern Iraq and eastern Syria where it holds sway. It handles law and order, some social services on a selective basis, and has an intelligence service and system of informers set up for it by former officials of the overthrown Ba'athist regime of Saddam Hussein. Adding to the lavish funds it has raised from the Gulf region, it has also taken over and emptied the central bank in Mosul, making it the richest non-state armed force in the world and equipping it to be a non-state state.

The phenomenon is not without precedent: the Provisional Revolutionary Government in South Vietnam did much the same in the late 1960s and early 1970s, without the self-glorification of atrocity and terror. And it is not without parallel today. The Taliban have effective control over parts of Afghanistan and was effectively the state in the late 1990s, until the US-led offensive overthrew it in October 2001. Among other examples, for a long time FARC has been in control of large areas of Colombia, while the Seleka militia is in charge of northern areas of Central African Republic. Having withdrawn from Bangui in January 2014 under heavy international pressure, they are recuperating by systematically taxing gold and diamond mining, livestock and other economic activities – behaving in part like a nascent state. Some groups have not based themselves outside the territory over which they are fighting, but have waged warfare that is not territorially limited. In the Al Qaeda mode, they have fought what they perceive to be a global enemy. Today, perhaps the trend is in the opposite direction: re-entry into an era of the non-state state.

**Figure 1.3:** The Changing Global Risks Landscape 2014-2015, Geopolitical Risks




Source: Global Risks Perception Surveys 2013 and 2014, World Economic Forum.
Note: See endnote 25

Rising nationalist sentiment and declining trust among global players are contributing to a **weakening of international governance**, undermining the international community's ability to act decisively on issues such as conflict resolution, Internet governance, climate change and the management of oceans. Failure to collaborate and implement common solutions in these areas could significantly undermine future global growth.

## Economic Risks: Out of the Spotlight?

The global economy is returning to growth, albeit sluggishly, and there is a feeling that significant progress has been made in reducing the likelihood of another financial crisis (as explored in Box 1.4). This may reflect a false sense of control, as history shows that people do not always learn from past failures and are often taken by surprise by the same risks.

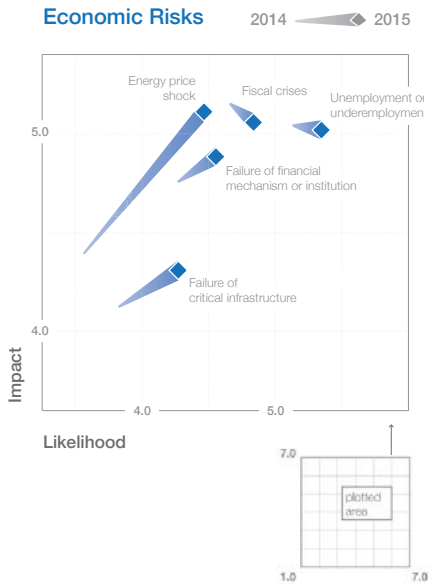
The global **unemployment** rate is expected to remain at current levels until 2018, reflecting a growing problem of structural unemployment in advanced economies.[11] This will likely keep wages low, maintaining deflationary pressures; in the Eurozone, **inflation** fell as low as 0.66% in 2014. As past years have seen a build-up of debt in many major economies – notably China, where the corporate debt-to-GDP ratio went from 92% in 2003-2007 to 110% in 2013 – the possible risk is that **deflation** could reduce debtors' ability to repay, threatening the future stability of the financial system.[12]

Conversely, low interest rates have also fuelled the risk of **asset bubbles**. Since the financial crisis, the use of expansionary monetary policy – such as quantitative easing and zero interest rates – has not had the expected impact of significantly increasing credit availability in the real economy, instead leading to a reflation of asset prices. Credit booms and asset bubbles have historically resulted in bank bailouts and recession in the real economy (see Box 1.3).

The risks of a **failure of a major financial mechanism or institution** and **fiscal crises** are perceived as equally impactful and likely as in last year's report (Figure 1.4), yet other risks, such as water crises, interstate conflict and the failure of climate-change adaptation, have taken centre stage. This runs the risk of diverting decision-makers' attention away from continuing economic reforms. Despite recent efforts (see Box 1.4), either deflationary pressures or the bursting of an asset-price bubble could still cause the failure of a major financial mechanism or institution – especially as the shadow banking sector is less regulated yet increasingly important.[13] Likewise, in many countries public debt levels are still worryingly high so that the related risks are likely to persist over many years.

Decision-makers' focus on other risks could lead to inaction at a time when continued progress in structural reform is most necessary; *The Global Competitiveness Report 2014-2015* outlines some priorities.[14] Maintaining the momentum of both financial and fiscal reforms will be crucial to avoid another major economic crisis.

**Figure 1.4:** The Changing Global Risks Landscape 2014-2015, Economic Risks




Source: Global Risks Perception Surveys 2013 and 2014, World Economic Forum.
Note: See endnote 25

### Box 1.3: Asset bubbles – a new old risk?

The evidence of frothiness is increasing in a number of housing markets in both advanced and emerging economies – including Canada, the United Kingdom, Switzerland, France, Sweden, Norway, China, Hong Kong SAR and Singapore – as well as in a number of credit and equity markets across the world.

The traditional goal of central banks has been economic stability: keeping inflation low while achieving robust growth. The current realization is that central banks must also seek to preserve financial stability – which means, among other things, avoiding risky bubbles. The current theory is that macro-prudential regulation and supervision of the financial system will avoid bubbles and achieve financial stability. However, bubbles are very hard to identify (price increases could also reflect market movements), and macro-prudential regulation has not historically been effective and excludes the unregulated shadow banking system.

If macro-prudential regulation fails again, central banks will be left with only one tool – monetary policy – to pursue both goals of economic and financial stability. This may prove impossible. Trying to prick bubbles by using monetary policy risks causing a bond market rout and a hard landing for the real economy. However, keeping monetary policy loose in a bid to help the real economy risks inflating asset bubbles that will, inevitably, eventually burst and also damage the real economy. Loose monetary policy is the mother of all bubbles. Attempting to walk this tightrope will be a difficult issue for central banks in both advanced and emerging markets in the years to come.

## Box 1.4: Recent advances in the global regulation of the financial system

The global financial system is undergoing massive structural change as a result not only of the crisis but of the regulatory changes in its wake. The very fact that the whole post-crisis regulatory overhaul has been spearheaded by the Financial Stability Board and G20, i.e. with explicit political backing by a global set of policy-makers, is very innovative and has not been the case in setting international regulatory standards before. The past five years have witnessed a profound change of international regulatory standards for banks and non-banks alike.

- Banks' regulatory rules have been revised (usually subsumed under the Basel III heading), resulting in stronger capital requirements, the first-ever globally agreed liquidity standards (for a short-term liquidity and a structural funding measure), and new standards for constraining large exposures and improving risk management. Also, supervisory standards are being raised and the international standard setter (Basel Committee) has launched a programme to assess national implementation, which exerts peer pressure on jurisdictions to implement the reforms in a consistent manner.
- Cross-border resolution difficulties witnessed in the crisis are reflected in the new set of expectations with regard to effective resolution regimes and a process of recovery and resolution planning for the largest banks, complete with setting up cross-border crisis management groups composed of authorities from the (most prominent) jurisdictions where these banks operate.
- Regarding non-banks, the international community is finalizing a basic solvency requirement for global insurers who are systemically important – to date there has been no global solvency standard; over-the-counter derivatives markets are undergoing major overhaul with measures aimed at mandating and/or incentivizing central clearing and trading on organized platforms with reporting to trade repositories of all contracts. In terms of insurance regulation, many countries in Europe, Latin America and Asia are adopting variants of the Solvency II regime. New insurance regulation has a strong emphasis on corporate governance, disclosure and accountability. These measures are relevant as they aim to change the broader corporate behaviour.
- International accounting standards are being changed, in particular to make loss recognition more forward-looking (newly issued IFRS9).
- Some supervisory authority over the financial sector has been relocated to central banks, most notably in Europe, where the European Central Bank has taken on additional responsibilities.

Still, of course, challenges remain. Addressing the issue of "too-big-to-fail" remains a key issue. Efforts are needed to: (i) finalize living wills and identify and remove barriers to firms' resolvability; (ii) reach consensus on banks' loss-absorbing capacity to ensure that they can be resolved; (iii) address obstacles to cross-border cooperation and recognition of resolution measures; (iv) ensure recovery and resolution of non-banks; and (v) promote better regulation of the shadow banking sector. Cross-border challenges persist also in over-the-counter derivatives reform. As regulatory regimes developed in parallel in the two largest markets (European Union and United States), they resulted in a framework that overlaps and is not completely consistent. Regulatory decisions allowing reliance on home regulatory regimes (known as "deference") are urgently needed. Trade reporting requirements have been adopted in key countries but legal barriers frustrate implementation. Progress on trading standardized contracts on exchanges and electronic trading platforms continues to slip. Political commitment is needed to advance reforms in all these areas.

Source: This box draws on the latest Global Financial Stability Report and related IMF work.
Note: In addition to the current regulatory reforms described above, some experts believe that profound changes in the corporate culture and incentive systems in the financial sector are needed to reduce excessive risk-taking.

### Box 1.5: Black Sky – risks to critical infrastructure

The world has more to lose than ever before from massive failure of critical infrastructure. To improve efficiency and lower cost, various systems have been allowed to become hyperdependent on one another. The failure of one weak link – whether from natural disaster, human error or terrorism – can create ripple effects across multiple systems and over wide geographical areas.

Large-scale power outages might be the most visible illustration. The initiating event in the August 2003 power failures in the United States occurred in Ohio but the worst consequences were felt by 55 million people in the north-eastern part of the United States and Canada. The July 2012 India blackout was the largest in history, affecting 670 million people, about 10% of the world population, and was partially triggered by high demand during a heat wave.

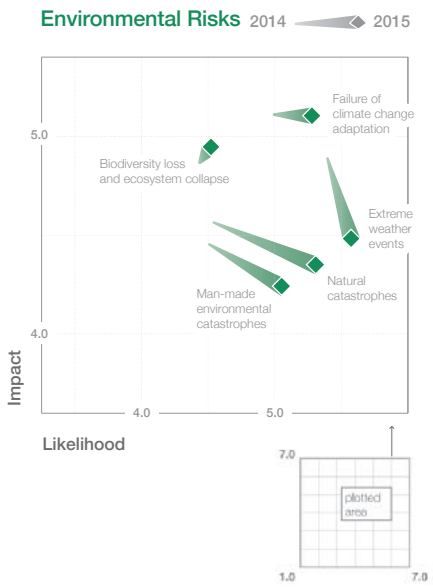
In many countries, infrastructure has not been maintained well enough to withstand the kinds of catastrophes that could spark such cascading effects. This is often the result of procrastination, the perception that the risk is so small that it is not worth considering or crowding out by other priorities, and the fact that investing in preparedness is rarely immediately rewarded in the electoral process. The challenge is financial, and incentives are misaligned. For example, in the United States, over 80% of infrastructure is owned or managed by private sector firms, which are not responsible for the negative externalities that failure of their part of the infrastructure could have elsewhere.[1] To increase investment in infrastructure, a coordinated, global, long-term and multistakeholder approach is required. Upgrading infrastructure is essential, in recognition that resilient infrastructure has become the backbone of a competitive economy.

Note:
[1] Auerswald, Branscomb, LaPorte and Michel-Kerjan, 2006.

## Environment – High Concern, Little Progress

Over the past decade, awareness has grown regarding the threats posed by environmental change to social, political and economic security. As the Global Risks Perception Survey 2014 highlights, three of the top 10 risks in terms of impact over the next 10 years are environmental risks: water crises, at the top of the table, and failure of climate-change adaptation as well as **biodiversity loss** (see Figure 1).[15]

**Figure 1.5:** The Changing Global Risks Landscape 2014-2015, Environmental Risks




Source: Global Risks Perception Surveys 2013 and 2014, World Economic Forum.
Note: See endnote 25

Both **water crises** and **failure of climate-change adaptation** are also perceived as more likely and impactful than average (upper right quadrant of Figure 1 and Figure 1.5). Global water requirements are projected to be pushed beyond sustainable water supplies by 40% by 2030.[16] Agriculture already accounts for on average 70% of total water consumption and, according to the World Bank, food production will need to increase by 50% by 2030 as the population grows and dietary habits change.[17,18] The International Energy Agency further projects water consumption to meet the needs of energy generation and production to increase by 85% by 2035.[19]

The Intergovernmental Panel on Climate Change notes that weather extremes in food-producing regions are already causing price increases and suggests that the impact of climate change on weather patterns and rainfall – causing either floods or droughts – could cut crop yields by up to 25%.[20]

The nexus of food, water, energy and climate change has been identified by the US National Intelligence Council as one of four overarching mega trends that will shape the world in 2030.[21] The risks interconnections map (see Figure 2) shows how survey respondents perceived this nexus to be related also to other risks, including **large-scale involuntary migration**.

Decision-makers will be forced to make tough choices about allocations of water that will impact users across the economy (Part 3 of this report highlights an approach developed in Australia's Murray-Darling Basin, for addressing this issue). The situation will worsen further if more **man-made environmental catastrophes** causing shocks to the system happen: more recent examples include the Fukushima power plant disaster threatening to contaminate both freshwater and seawater, or the Deepwater Horizon oil spill contaminating large sections of coast along the Gulf of Mexico.

Overfishing, deforestation and the inadequate management of sensitive ecosystems such as coral reefs are increasing the stress on food and water systems. Major biodiversity loss and ecosystem collapse was assessed as high impact by respondents, but below average in terms of likelihood (see Figure 1); the latter seems to reflect a misperception. The World Bank estimates that 75% of the world's poor, or 870 million people, make a living from ecosystems, including tourism and the goods they produce, while 350 million are affected by the loss of coral reefs.[22] Increasingly, decision-makers are realizing that biodiversity loss is not a second-order issue but is intricately linked to economic development, food challenges and water security.

The urgency of coordinated global action on climate change was reinforced in April and November 2014 by the Intergovernmental Panel on Climate Change's release of its Fifth Assessment Report and the associated update. It reconfirms that warming is unequivocally happening and it is "extremely likely" that human influence has been the dominant cause. Atmospheric concentrations of three major greenhouse gases (carbon dioxide, methane and nitrous oxide) are at their highest level in 800,000 years. Strong evidence of the effects of climate change is already apparent, in terms of sea level rise, shrinking glaciers, warmer oceans and the increasing frequency of weather extremes.

Even though all of these risks are well known, governments and businesses often remain woefully underprepared, as illustrated by respondents' perceptions that relatively little progress has been made on these risks in the last decade (see Figure 3.1). At the heart of the problem is a risk-management approach based on responsive measures that assume things go back to normal after a crisis – an approach that falls short with complex or slowly evolving environmental risks such as climate change. Stakeholders have been slow to address the underlying causes of environmental risks or to address their economic, social, political and humanitarian consequences.

### Box 1.6: The road to Paris – is 2015 make or break for climate change?

In 2015 the international community has a once-in-a-generation opportunity to align the climate change and development agenda. A series of global summits on climate change, disaster risk reduction, financing for development and sustainable development goals could embed into the post-2015 global governance architecture a coherent agenda for tackling interlocking environmental risks.

Convergence among governments on these decisions could kick-start the next generation of sustainable growth and poverty reduction – through catalysing private finance and scaling low-carbon, climate-resilient investment, especially but not only in developing countries. However, the opportunity will be missed if governments continue to value narrow short-term concerns above the prospect of longer-term global prosperity and environmental security. More vulnerable populations will be consigned to the negative spiral of poverty and environmental degradation.

Until recently, the expectation was that governments would struggle to finalize a strong global climate accord in time for the Paris climate conference in December 2015. But is the tide beginning to turn? At the United Nations Secretary-General's Climate Summit in September 2014, over 1,000 businesses and investors signalled their support for global carbon pricing. So did some 73 countries, covering 52% of global GDP and 54% of global emissions.

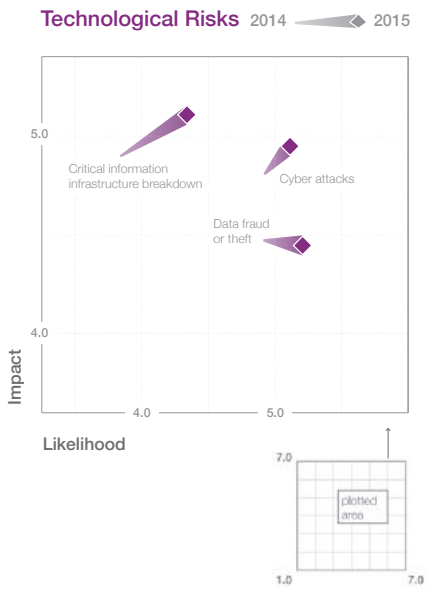
Major consumer companies and financial institutions see the need to reduce global climate risks and have mobilized action along their supply chains, for example through the New York Declaration on Forests and the move towards climate-friendly coolants. The Oil & Gas Climate Initiative signalled refreshed engagement from major energy producers.

The hope is that these coalitions of committed businesses could both inject concrete solutions and create a more positive global atmosphere for governments to collectively make decisions in 2015. A positive signal is the agreement between China and the United States in November 2014. A strong set of clear policy signals to the wider business community is needed from the world's governments on their ambition to tackle environmental risks. The year 2015 is not an opportunity the world can afford to miss.

## Technological Risks: Back to the Future

The risk of **large-scale cyber attacks** continues to be considered above average on both dimensions of impact and likelihood (see Figures 1 and 1.6) This reflects both the growing sophistication of cyber attacks and the **rise of hyperconnectivity**, with a growing number of physical objects connected to the Internet and more and more sensitive personal data – including about health and finances – being stored by companies in the cloud. In the United States alone, cyber crime already costs an estimated $100 billion each year.[23]

**Figure 1.6:** The Changing Global Risks Landscape 2014-2015, Technological Risks




Source: Global Risks Perception Surveys 2013 and 2014, World Economic Forum.
Note: See endnote 25

While the "Internet of Things" (IoT) will deliver innovations, it will also entail new risks. Analytics on large and disparate data sources can drive breakthrough insights but also raise questions about expectations of privacy and the fair and appropriate use of data about individuals. Security risks are also intensified. There are more devices to secure against hackers, and bigger downsides from failure: hacking the location data on a car is merely an invasion of privacy, whereas hacking the control system of a car would be a threat to life. The current Internet infrastructure was not developed with such security concerns in mind.

The IoT is likely to disrupt business models and ecosystems across a range of industries. While this will deliver innovation, the prospect of many large players across multiple industries being forced to change so radically at the same time raises potential systemic risks such as large-scale disruption in labour markets and volatility in financial markets. A major public security failure could also prevent the IoT from becoming truly widespread.

An important characteristic of global risks, which transpires across the cases included in this report, is their interconnectedness, shown in the Interconnections Map in Figure 2. It is important to stress that risks cannot be seen in isolation. The feedback loops between risks and the fact that they are also driven by underlying trends (Figure 3) raise their complexity and make it more difficult to control individual risks. Over past years, the speed of transmission and the strength of interconnections have increased.

The complexity of addressing risks, their likelihood and their potential consequences raise the question of preparedness, on the global, regional, national and local levels.

### Box 1.7: Governing the Internet — the need for mechanisms to maintain a unified and resilient network

The pace of innovation and the highly distributed nature of the Internet require a new approach to global Internet governance and cooperation. As more people rely on the Internet, the question of Internet governance becomes increasingly important. Two kinds of issues exist: technical matters, to make sure all the infrastructure and devices that constitute the Internet can talk to each other; and overarching matters, to address cyber crime, Net neutrality, privacy and freedom of expression.

Responsibility for the technical infrastructure of the Internet is dispersed among several organizations, including the Internet Engineering Task Force (IETF) and the World Wide Web Consortium (W3C), the Regional Internet Registries (RIRs), the root servers' operators, and the Internet Corporation for Assigned Names and Numbers (ICANN). The solutions they propose – policy models, standards, specifications or best practices – spread through voluntary adoption or ad hoc conventions, regulations, directives, contracts or other agreements.

No such systems exist for developing and implementing solutions to the overarching issues. Consequently, governments are feeling pressure to enact national measures to deal with their citizens' data and privacy concerns. While laws that force the "localization" of infrastructure may be easier short-term solutions than collaborating to define global mechanisms for addressing the issues, the risk is that "data nationalism" could endanger the network effects that underlie the Internet's ability to drive innovation and create social and economic value.

To advance the conversation, identify possible solutions and contribute to open, resilient and inclusive Internet governance, the World Economic Forum is embarking on a multiyear strategic initiative to bring together leaders from the public and private sectors with civil society leaders and the technical community to address these issues in an impartial, high-level dialogue. This effort will complement the expert-level discussions taking place at the Internet Governance Forum and various other grassroots and government-led initiatives.

## Preparedness at the Regional Level Is Different

As most efforts to address global risks are undertaken at the national and regional levels, it is important to look at preparedness from a disaggregated perspective. Figure 1.7 illustrates for each world region those risks for which survey respondents indicated their region is the least prepared. Preparedness reflects a combination of exposure to a risk and the measures that have already been taken to mitigate or prepare for it.

It is striking that every region presents a wholly different set of issues for which it is least prepared. For example:

- High structural unemployment or underemployment is seen as the risk for which **Europe** is least prepared, followed by large-scale involuntary migration and profound social instability. Both unemployment and migration flows into Europe are expected to remain high on the agenda going forward and are driving factors of social instability.[24]
- **North America** identifies failure/shortfall of critical infrastructure, large-scale cyber attacks and failure of climate-change adaptation as the three risks for which it is least prepared. Major breakdowns of infrastructure in the wake of Superstorm Sandy and the sheer number of cyber attacks illustrate the low level of preparedness.
- **Sub-Saharan Africa** is considered least prepared for infectious diseases and unemployment. Both are of key importance given recent events and the fact that strong population growth is expected to exacerbate unemployment in the coming years, despite expected economic growth.
- Many regions, including Europe, Latin America and the Caribbean, and the **Middle East and North Africa**, also include profound social instability among the risks they are least prepared for.
- **East Asia and the Pacific** is perceived as least prepared for interstate conflict and failure of urban planning. It is also the only region that reported being least prepared for man-made environmental catastrophes following the 2011 Fukushima incidence.
- Failure of urban planning is among the first three risks in East Asia and the Pacific, **Latin America and the Caribbean**, and **South Asia**. In such regions, urbanization is especially rapid and the failure of urban planning can lead to a wide range of catastrophic scenarios from social unrest to pandemic outbreak (Part 2).

**Figure 1.7:** For Which Global Risks Is Your Region Least Prepared?

Source: Global Risks Perception Survey 2014, World Economic Forum.
Note: Respondents were asked to select three global risks that they believe their region is least prepared for. For legibility reasons, the names of the global risks are abbreviated. Please see Appendix A for the full name and description. Oceania is not displayed because of the low number of respondents.

## Conclusion

Drawing on the perceptions of almost 900 survey respondents, this chapter focuses on the threats of social fragility and short-term worries about conflict. Rising socio-economic inequality, weak economic growth, food price volatility and food insecurity, unemployment, large-scale migration and the growing heterogeneity and interdependence of societies are among the key drivers of social fragility. Growing social polarization, isolationism and nationalism in turn have the potential to trigger geopolitical conflicts.

The section highlights the interconnections between global risks and trends. A better understanding of global risks and the interconnections between them is key to prompting discussion about how to prepare, mitigate and prevent them. Part 2 of this report analyses in detail selected clusters of interconnected risks and how they could evolve – the interplay between geopolitical and economic risks, challenges related to urbanization in developing countries and emerging technologies.

## Endnotes

[1] The risk of water crises is classified as a societal risk for the purpose of this report. However, it has an important environmental dimension.

[2] IMF, 2014a.

[3] OECD, 2011.

[4] Standardized World Income Inequality Database. See http://myweb.uiowa.edu/fsolt/swiid/swiid.html.

[5] The Gini index measures the extent to which the distribution of income among individuals or households within an economy deviates from a perfectly equal distribution on a scale from 0 (perfect equality) to 100 (perfect inequality).

[6] UN, 2014.

[7] Berg and Ostry, 2011. And Ostry, Berg and Tsangarides, 2014.

[8] IPCC, 2014, pp. 1-32.

[9] UNHCR, 2014.

[10] *"Islamic State fighter estimate triples – CIA"*, BBC, 12 September 2014; http://www.bbc.com/news/world-middle-east-29169914.

[11] ILO, 2014.

[12] IMF, 2014b.

[13] IMF, 2014c.

[14] World Economic Forum, 2014.

[15] As mentioned above, the risk of water crises is classified as a societal risk for the purpose of this report. However, it has an important environmental dimension.

[16] 2030 Water Resources Group, 2009.

[17] Food and Agriculture Organization of the United Nations, aquastat; http://www.fao.org/nr/water/aquastat/water_use/index.stm.

[18] World Bank, Food Security; http://www.worldbank.org/en/topic/foodsecurity/overview#1.

[19] IEA, 2012.

[20] Porter et al., 2014.

[21] NIC, 2012.

[22] World Bank, Biodiversity; http://www.worldbank.org/en/topic/biodiversity/overview.

[23] See *The Wall Street Journal*, "Annual U.S. Cybercrime Costs Estimated at $100 Billion", 22 July 2013; http://online.wsj.com/articles/SB10001424127887324328904578621880966242990.

[24] In the first nine months of 2014, the number of migrants crossing the Mediterranean Sea into Europe reached 160,000, twice the previous record from 2011. Integrating such a large number of migrants is a big challenge, which has the potential to destabilize societies if not properly addressed.

[25] Global risks may not be strictly comparable across years, as the names and description of the risks were revised between 2014 and 2015. The risks introduced in 2015 are not displayed in the figures and only the risks for which the name or the description were slightly revised between 2014 and 2015 are presented. Water crises was categorized as an environmental risk in 2014 but as a societal risk in 2015. To ensure legibility, the names of the global risks are abbreviated. Please see Appendix A for the full name and description.

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# Part 2: Risks in Focus

## 2.1 Introduction

This section of the *Global Risks 2015* report presents deep-dives into three "risks in focus" – the interplay between geopolitics and economics, rapid and unplanned urbanization in developing countries, and emerging technologies – that emerged from the Risks Interconnections Map and the Risks-Trends Interconnections Map (see Figures 2 and 3). These provide good illustrations of the links between different global risks. The analysis in the following pages is based on follow-up research and interviews with experts.

As discussed in Part 1, geopolitical risks are back, as evident from the central node of the failure of national governance in the interconnections maps, and the strong linkages to interstate conflict and profound social instability, among others. With economies tied together on an unprecedented scale by financial and trade flows, many analysts are concerned about the resurgence of the trend towards the **interplay between geopolitics and economics**. While national governments in the past also made use of economic tools to increase their relative power, today's strong economic ties arguably make this interplay more complex and therefore more difficult to navigate. This resurgence could have profound implications for the effectiveness of global governance mechanisms in other areas, from combating climate change to reaching an international solution for Internet governance.

Even as nation states step up their efforts to maintain or expand power, urbanization is slowly but surely rebalancing the locus of power from national to city governments. The data gathered for this report suggest that **urbanization** is a critical driver of profound social instability, failure of critical infrastructure, water crises, and the spread of infectious diseases (see Figure 3). This will only be further exacerbated by an unprecedented transition from rural to urban areas: by 2050, two-thirds of the world's population – an estimated 6.3 billion people – will live in cities, with 80% in less developed regions.[1] Rapid and unplanned urbanization in these regions has the potential to drive many risks. How effectively the world addresses global risks, ranging from climate

change to pandemics, will increasingly be determined by how well cities are governed. The concentration of a large number of people, assets, critical infrastructure and economic activities means that the risks materializing at the city level have the potential to disrupt society.

From artificial intelligence to synthetic biology, the need for governance on a global scale comes into focus when considering **emerging technologies**, given the many uncertainties about how emerging technologies evolve and their far-reaching economic, societal and environmental implications. The data also point to strong interconnections with man-made and natural environmental catastrophes (see Figure 2). The coming years are likely to see rapid advances in such fields as artificial intelligence and synthetic biology – and while many of their impacts are likely to be beneficial, negative effects will spread quickly in today's hyperconnected world. Some of those negative effects may be difficult to anticipate and safeguard against.

In many cases, by addressing the trends underlying most of the risks, the vulnerability to risks can be reduced significantly. In addition, understanding the context and possible trajectories of a significant nexus of risks and trends can help to clarify ways to address them and to capitalize on opportunities presented by the trends. That is the aim of the analysis that follows.

## 2.2 Global Risks Arising from the Accelerated Interplay between Geopolitics and Economics

Geopolitics traditionally focuses on military might, resources and demographics as measures of national influence, while economics focuses on growth, productivity and prosperity. However, geopolitics and economics have been intertwined through history – for example in the rise of British political power on the back of the "economic" Industrial Revolution, the era of British and French colonialism, or the Cold War, when a deep geopolitical divide separated economies. When the Cold War ended, an era of common norms ushered in a global economy; now, more than 25 years after the fall of the Berlin Wall, strategic competition is returning. The world is grappling with a seemingly accelerating dynamic between geopolitics and economics. Today's realpolitik is not ideologically driven, includes new players and takes place in the context of deep economic integration.

Will the global economy, the efficiency of the international system and the win-win logic of commerce be undermined by geopolitics? How will economic decisions and spheres of influence impact the global balance of power? What global risks could emerge when countries use economic rather than military tools to advance their ends? These questions have been brought into focus by trends including the recent heightened tensions in East Asia, the acceleration of regional integration in South-East Asia and the rise of preferential and regional trade agreements more generally, the shale gas and oil revolution in the United States, turbulence in the Middle East and Ukraine, competing integration mechanisms in Latin America, China's assertion of leadership in the global economy, and acts of terrorism and violent strife that are redrawing borders and sending economies backwards.

Global interconnectedness and the rising speed of information transmission have reinforced the interdependence between geopolitics and economics, with cyberspace representing an important new front in the geopolitical equation as cyber attacks have the growing potential to inflict economic damage. This makes it difficult for decision-makers to predict the development of such situations as sanctions and other instruments of economic coercion, thus raising the risk of unintended consequences. The interplay between geopolitics and economics can create, reinforce and alter the nature of the interconnections between global risks, affecting many areas of public policy and international cooperation.

Governments and businesses alike need to conduct "geopolitical due diligence" to not be caught off guard. The focus below is on three areas where direct effects are likely – disruptions to international trade, and threats to political cooperation and the international rules-based system.

### How Is this Situation Manifested?

In a retreat from the prevailing logic of globalization that characterized the 1990s and early 2000s, today's international environment is in large part marked by self-interested nation states trying to gain relative power over others, even at the expense of economic considerations. Rising unemployment and more difficult fiscal situations are contributing to the more inward orientation of economies. The growth of trade along global value chains and intensifying financial linkages have increased the economic cost of rising protectionist policies, such as tariffs, sanctions and trade wars, as described in Box 2.1.

As states turn inwards, their international economic policies tend to focus on collaboration with smaller groups of like-minded countries that would allow them to better pursue their economic goals. Countries have always sought to achieve both geopolitical and economic aims through regional economic integration – the European Economic Community, for example, was established to stabilize relations and raise the stakes in case of war as well as to increase market size and economic opportunities. Many regional groupings are established as they allow countries to gain relative power over others. This type of thinking is currently why the Association of Southeast Asian Nations (ASEAN) is seeking to create a unified market by

**Table 2.1:** East Asian-Pacific Free Trade Agreements

| Country | RCEP[1] | TPP[2] | FTAAP[3] | Korea, Rep. bilateral[4] |
|---|---|---|---|---|
| Australia | ● | ● | ● | ● |
| Brunei | ● | ● | ● | ● |
| Cambodia | ● | ● | ● | ● |
| China, People's Rep. | ● | ● | ● | ● |
| Indonesia | ● | ● | ● | ● |
| Japan | ● | ● | ● | ● |
| Korea, Rep. | ● | ● | ● | ● |
| Malaysia | ● | ● | ● | ● |
| New Zealand | ● | ● | ● | ● |
| Philippines | ● | ● | ● | ● |
| Singapore | ● | ● | ● | ● |
| Thailand | ● | ● | ● | ● |
| Vietnam | ● | ● | ● | ● |

● Part of the agreement ● Not part of the agreement

Source: ASEAN, Ministry of Foreign Affairs of the Republic of Korea, The Economist and Oliver Wyman analysis.
Notes: [1] RCEP, promoted by ASEAN, would also include Cambodia, India, Laos and Myanmar.
[2] TPP, promoted by the US, would also include Canada, Chile, Mexico and Peru as well as the US.
[3] FTAAP, promoted by China, would also include Hong Kong SAR, Papua New Guinea, Russian Fed. and Taiwan, China.
[4] Planned or achieved. Korea's free trade agreements (additionally with Brunei, Cambodia, Indonesia, Malaysia, Philippines, Singapore, Thailand and Vietnam) are through its agreement with ASEAN.

2015 and pursuing an agreement on a Regional Comprehensive Economic Partnership (RCEP). It is also one of the drivers of the United States' efforts to pursue discussions on two major free trade and investment agreements – the Transatlantic Trade and Investment Partnership (TTIP) and the Trans-Pacific Partnership (TPP).

However, in some cases competing integration agreements are creating strategic competition: in Latin America, the Pacific Alliance and Mercosur provide different models of integration; in Ukraine, the country was torn between the European Union and the Eurasian Economic Union; and Asian countries need to assess the US-led TPP and the ASEAN-led RCEP. As illustrated by Table 2.1, the current situation is a complex mix of overlapping and competing regional negotiations.

A driver of the intensifying interplay between economics and geopolitics is the growing direct role of the state in the world economy, which is affecting traditional trade and investment flows and potentially enabling countries to exert geopolitical influence through economic dependency. This trend is manifested in increasing state-led investments in other countries' infrastructure, such as in the case of Chinese investment in Africa or Latin America; strategic investments by sovereign wealth funds and state-owned enterprises in land and businesses in other countries, as seen in the case of Gulf economies' investments in Africa, and government purchases of other governments' debt. In August 2014, China and Japan held 7.2% and 7% of US debt, respectively.

To strengthen their geopolitical position, countries have also reverted to measures that control access to economically important national resources or the prices of commodities over which they exert monopoly power to undermine other economies' performance. These potential ways to leverage power over other countries through economic links are increasingly becoming an explicit part of foreign policy thinking.

In today's interdependent global economy, whenever countries focus on their domestic market – even if the decisions are taken by central banks rather than politicians – there is potential for unintended effects on other countries to spill over into the geopolitical sphere. For instance, one side effect of Japan's expansionary monetary policies to restart its domestic

### Box 2.1: Global supply chains – too lean?

With the opening of markets worldwide and the reduction of barriers to the flow of goods and capital, the creation of value has become a complex process spanning countries and continents. The far-reaching global supply chains set up by multinational corporations are more efficient, but the complexity and fragility of their interlinkages make them vulnerable to systemic risks, causing major disruptions. These comprise natural disasters, including those related to climate change; global or regional pandemics; geopolitical instability, such as conflicts, disruptions of critical sea lines of communication and other trade routes; terrorism; large-scale failures in logistics; unstable energy prices and supply; and surges in protectionism leading to export/import restrictions.

Recent specific examples of threats to the smooth functioning of global supply chains include the Ebola outbreak in West Africa, tensions in the Middle East and the dispute between Ukraine and the Russian Federation. The latter has caused disruptions in the supply of gas to European countries, while sanctions imposed by the European Union and the Russian Federation have restricted access to specific sets of goods and forced some companies to review the architecture of their supply chains. One effect is Germany's exports to Russia were reduced by 26.1% in comparison to the year before, as reported in August 2014.

economy has been the devaluation of the yen by about 50% in recent years, much to the detriment of its neighbours, while quantitative easing in the United States has impacted international capital flows into emerging markets.

### Global Risks Emerging from the Interplay between Geopolitics and Economics

Opinion polls show that the public in countries such as Japan, Germany and the United States are increasingly sceptical about the benefits of trade and foreign investment, even as their governments push for increased liberalization. Despite progress on the trade facilitation agreement, the larger Doha Round of trade negotiations has stalled, costing an estimated $180 billion per year at the global level. Negotiations of regional agreements are also being questioned (one example is TTIP in Germany). Although growing again, global flows of foreign direct investment remain down by more than a quarter from their 2007 peak, and international trade growth has slowed since 2012. It has yet to be determined, however, whether this is merely a cyclical or structural phenomenon heralding a phase of de-globalization in which globalized markets give way to regional groupings and to a rise in protectionist measures.[2]

When confronted with political and economic volatility at home, countries often revert to protectionism under the guise of policies to reduce risk. A recent OECD report shows that despite their professed commitment to free trade, G20 economies have increasingly reverted to protective measures since growth slowed in 2012 in the wake of the global financial crisis.[3] Protectionism can take different forms. It can be related, for example, to the protection of strategic sectors, local content requirements in the case of external investment, or state bailouts.

Economic sanctions are another type of punitive geo-economic measure, such as the tit-for-tat engaged in by Russia and the West, which indicates that some countries are ready to countenance a long period of economic hardship and diplomatic woe to achieve their political goals. The risk is thus significant that if the use of punitive geo-economic measures becomes more widespread, a growing number of countries may revert to protecting national producers and supply chains, which could considerably impact global trade flows. The economic effects of sanctions can include slow growth, unemployment and fiscal pressures. Taken together, the slowdown in globalization, the rise in protectionism and the increasing prevalence of sanctions could give rise to a scenario of slower growth in advanced and emerging economies. Slower growth in emerging economies could translate into social unrest and political instability if the aspirations of large portions of the population cannot be met.

### The Increasing Risk to the Architecture of Global Governance

Much of the interplay between economic and geopolitical interests plays out not in the trade arena but in the Bretton Woods institutions. Countries' inability to agree on an institutionalized, closer coordination of macroeconomic policies to reduce global imbalances provides an interesting example. Some observers see the failure to mitigate these imbalances, combined with the return of strategic competition in an era defined by an erosion of trust, as raising a tail-risk possibility of undermining the Bretton Woods institutions themselves and the international rule-based system more generally.

These developments are reflected in the recent alternative structures being established by selected countries. Brazil, Russia, India and China in 2014 set up the New Development Bank, the so-called BRICs Bank, which is intended to lend up to $34 billion globally, particularly for infrastructure projects. In the same year, together with 20 other countries, China created the Asian Infrastructure Investment Bank for the Asia-Pacific region. Much as a retreat from global multilateralism is worrisome, stronger regional multilateralism is not necessarily a bad thing, as regional solutions to regional problems can be consistent with global governance structures. As already noted, although economic integration is not often explicitly targeted, it binds nations more closely together politically. Some observers see the current push

for RCEP as a means to restore trust in Asia, stabilize security situations and find solutions at a regional level to other ongoing problems.

Some observers also see the TPP and TTIP as the last chance for the United States and Europe to bring many developing countries into alignment with a liberal economic institutional framework by creating a domestic market big enough to be able to set the rules in the global economy – an implicit recognition that current global governance institutions are no longer functioning effectively enough to achieve this goal. Yet, increasingly, negotiating countries question the benefits of these mega regional agreements.

Any weakening of global governance could weaken collective resilience to global risks, which respect no national borders and require multilateral responses. These include climate change, where an inability to agree on carbon reductions could result in rising sea levels, more frequent storms and stress to water supplies; migration flows, where pressures on societies and resources could result in conflict; and Internet governance, where a tendency towards fragmentation can already be observed through some large economies' efforts to put into place measures to protect their national networks. Should a global governance solution to the Internet not be found, further fragmentation could significantly reduce the benefits of communication and information networks that the world has come to take for granted.

### What Can Be Done?

At a time of highly interconnected challenges that can only be addressed through global cooperation, reducing the barriers to international collaboration is crucial, as no collaboration is the worst possible outcome. What can stakeholders do to strengthen international collaboration and to reduce the risk of negative effects of geo-economic measures?

Many of the challenges related to international collaboration reflect a lack of trust among the key players. Strengthening trust among leaders and populations in global economies is therefore key to ensuring effective collaboration at a time when strategic competition dominates international relations. Without trust, no decisions at the international level will be taken. However, the responsibility extends beyond the political level: multinational companies and consumers also have a role to play to strengthen the argument in favour of global collaboration in the face of growing pressures to prioritize national economic self-interest.

### Conclusion

Faced with competing strategic pivots and governments' growing tendency to look inwards and prioritize their domestic producers and economies, and with an increased reliance on economic levers as a means to gain geopolitical influence, the coming years could see competitive relationships between the major powers develop into trade and currency wars, requiring economic diplomacy.

While regional institutions and alternative structures have a role, global institutions must respond to pressure to better reflect the rising wealth and power of emerging economies. They remain the most promising means for competing powers to build strategic trust, which could minimize the detrimental effects of geo-economic competition on growth and prosperity.

### Box 2.2: The World Economic Forum's work on geo-economics

The World Economic Forum is developing a clearer understanding of the interaction between geopolitics and economics with the support of its Network of Global Agenda Councils. The Global Agenda Council on Geo-economics aims to become the world's leading network of thinkers on the impact of geopolitics on the global economy and vice versa – launching a vital global discussion that links leaders from the worlds of politics, economics and business in a debate about the major trends that are changing the world. The Council will publish an annual brief identifying the main geo-economic issues on the horizon and delve into the implications of emerging developments, such as the use of sanctions or low oil prices for different regions, actors and sectors. Issues that will be examined in more depth include the next phase of economic warfare, the next wave of state capitalism (including the rise of central banks as drivers of geo-economics and the rise of strategic sectors), the idea of gated globalization, the role of infrastructure in building alliances, and the weakening of peripheral countries by regional agreements. The Forum's work will also include an assessment of impact on selected industries. It will be developed over the coming years and the findings will be integrated into the work of the Forum and its communities.

## 2.3 City Limits: The Risks of Rapid and Unplanned Urbanization in Developing Countries

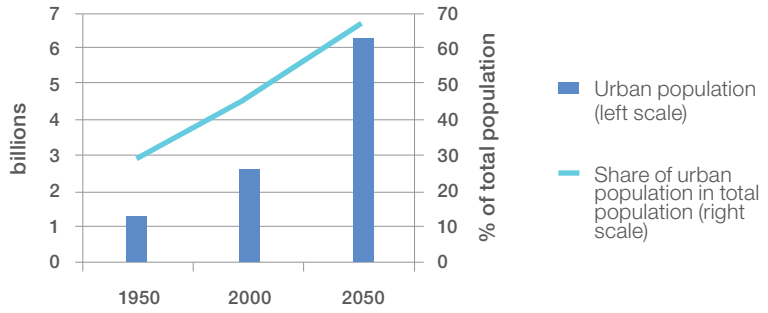
The world is experiencing a historically unprecedented transition from predominantly rural to urban living. In 1950, one-third of the world's population lived in cities; today the number has already reached more than one-half, and in 2050 city dwellers are expected to account for more than two-thirds of the world's population (see Figure 2.1).[4] This rapid rise will mainly take place in developing countries (see Figure 2.2).[5] Africa and Asia – both still comparatively less urbanized than other regions – will be the fastest urbanizing regions with the urban population projected to reach 56% in Africa and 64% in Asia by 2050 (currently at 40% and 48%, respectively).[6] These developments imply an unprecedented shift of the urban world away from the north-west to the south and east.[7]

If managed well, urbanization can bring important benefits for development. Cities are an efficient way of organizing people's lives: they enable economies of scale and network effects, and reduce the need for transportation, thereby making economic activity more environmentally friendly. The proximity and diversity of people can spark innovation and create employment as exchanging ideas breeds new ideas. The diversity of cities can also inculcate social tolerance and provide opportunities for civic engagement. Already today, the linkages between cities form the backbone of global trade, and cities overall generate a large majority of the world's GDP.

One of the main factors driving rapid urbanization in emerging economies is rural-urban migration motivated by the prospect of greater employment opportunities and the hope of a better life in cities. Indeed, when a certain critical mass of population is reached, it is economically viable to deliver many infrastructure projects, such as public transportation. However, a higher population density also creates negative externalities, especially when urbanization is rapid, poorly-planned and occurs in a context of widespread poverty.[8] Estimates suggest that 40% of the world's urban expansion is taking place in slums, exacerbating socio-economic disparities and creating unsanitary conditions that facilitate the spread of disease.[9] The example of the 1994 outbreak of pneumonic plague in the Indian city of Surat suggests how, in a worst-case scenario, poverty and a pandemic in a large-scale informal settlement could potentially lead to a breakdown in urban order.[10]

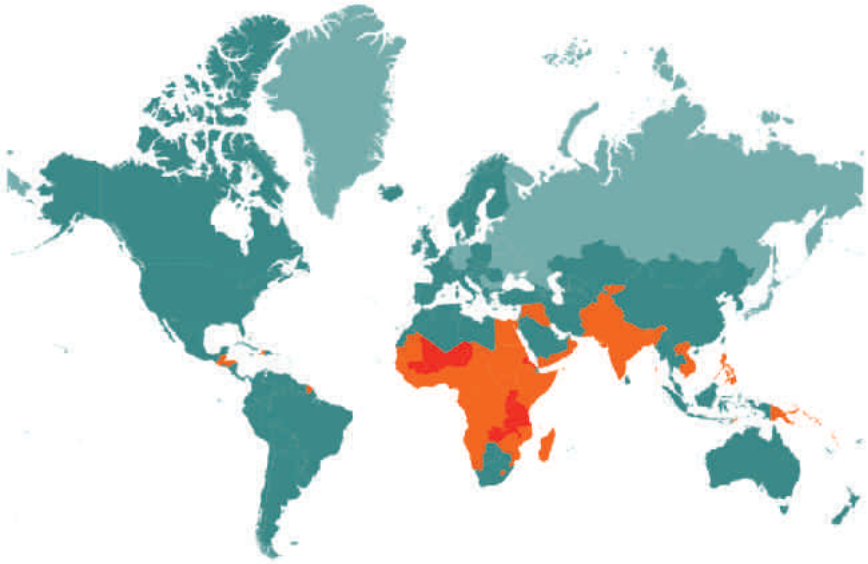
Rapid urbanization can alter the nature of almost every global risk considered in this report by influencing its likelihood and impact. In addition, cities are points of convergence of many risks, which make them particularly vulnerable to chain reactions and amplify the interconnection between global risks. Better knowledge of how such risks interconnect in their materialization at the city level is the first step towards helping cities build resilience. Three regions – South Asia, East Asia and the Pacific, and Latin America and the Caribbean – have identified this risk as among those for which they are the least prepared (Figure 1.7 and for more details see: www.weforum.org/risks).[11] The following sections consider four selected and particularly daunting urban challenges: infrastructure, health, climate change and social instability.

**Figure 2.1:** Global Urban Population Growth (1950-2050)




Source: World Economic Forum calculation based on World Urbanization Prospects (2014 revision) data.

**Figure 2.2:** Forecasted Urban Population Growth 2010-2050



Urban Population in 2050 compared with 2010:

Smaller | Larger but less than double | Double or more, but less than fivefold | Fivefold or more

Source: World Economic Forum calculation based on World Urbanization Prospects (2014 revision) data.

## The Infrastructure Challenge

The quality of a city's infrastructure – its housing, electricity, roads, airports, public transport, drinking water, sanitation, waste management, flood defences, telecommunications, hospitals, schools and so forth – largely determines its residents' quality of life, social inclusion and economic opportunities. It also largely determines the city's resilience to a number of global risks, in particular environmental, social and health-related risks, but also economic risks, such as unemployment. Indeed, the availability and quality of infrastructure are at the core of many of the challenges faced by rapidly urbanizing cities in developing countries, which are developed further in this section of the report.

As cities in developing countries are expanding rapidly, it is likely that infrastructure will not be able to keep pace with their growth nor the increased expectations of their populations. Action to close the infrastructure gap is urgently needed and will strongly influence the potential of risks to have catastrophic cascading effects.

To provide adequate global infrastructure for electricity, road and rail transport, the OECD estimates that telecommunications and water will cost approximately $71 trillion by 2030 – an enormous challenge as it represents about 3.5% of forecasted global GDP.[12] Most of this investment will be needed in emerging economies. For instance, the Programme for Infrastructure Development in Africa estimates that Africa will need to invest up to $93 billion annually until 2020 for both capital investment and maintenance; currently only $45 billion is financed, which leaves an infrastructure gap of $48 billion per year to be financed.[13] In addition to the provision of infrastructure, it is critical to consider its location as risks can emerge if developed in the wrong location relative to the needs of the population.

Where will the money come from? Most governments are under tight budget constraints and many developing countries already spend a large proportion of their national income to meet the basic needs of their population.[14] Consequently, cities are looking for public-private collaboration to involve the private sector in the design, construction and maintenance of infrastructure. However, to promote successful public-private collaboration, corruption must be tackled, as it is a traditional problem in construction projects and dissuades investors. In addition, the key enablers of public-private collaboration at the city level include factors such as transparency (in such matters as partner selection and contract execution) and the availability of accurate data to allow risk assessments. Public-private collaboration is a way for cities to

### Box 2.3: Life in the city – how smart is smart?

Like industry, cities are increasingly investing in information technology-based systems to address the challenges of managing large enterprises and enabling service innovations. While these investments often deliver rapid improvements in efficiency and operational continuity, they also create unexpected new risks: bugs and brittleness.

The growing amount of software used to manage urban infrastructure increases the likelihood of coding errors that can cause catastrophic failures, especially in highly-centralized control systems. For instance, in 2006, San Francisco's Bay Area Rapid Transit network was laid low for days when initial efforts to fix a bug inadvertently triggered a larger and longer outage.

Smart city systems also rely on many underlying technology platforms that are surprisingly brittle. For example, the Global Positioning System (GPS) is not only relied on for navigation services but also serves an irreplaceable time synchronization function. Likewise, thousands of smart city apps and websites rely for their core computational capability on the cloud computing infrastructure of companies such as Amazon, which have experienced several major outages in recent years.

The brittleness of mobile cellular networks presents a special challenge to resilience for large cities. Unlike the Internet – which, at least in theory, possesses significant resilience through its multiple, redundant linkages – cellular networks have several choke points. Cell sites themselves can be damaged physically. More importantly, the supporting wired infrastructures for electrical power and "backhaul" connections to the communications grid can fail: both the Japanese tsunami in 2011 and Superstorm Sandy in 2012 caused damage to cellular networks that took weeks to repair. The most dangerous failure mode for cellular networks is due to congestion – during crises, panic dialling frequently overwhelms the carefully-managed wireless spectrum these networks depend on.

All levels of government will need to be more assertive in auditing and stress-testing vital digital infrastructures. The sudden and unexpected failure of these systems during crises has crippling knock-on effects across official and civilian response and relief efforts. Even during peacetime, the economic and social effects of bugs and brittleness can be devastating, with potential for long-lasting impacts. Assessments must go beyond cybersecurity, as the risks are not just about external threats but also about the fundamentally unstable dynamics of digital infrastructures and the complex, chaotic and unpredictable ways they can interact with civic, social and economic systems.

identify where cooperation can address problems that neither municipalities nor the private sector can solve alone (for example in advanced telecommunications infrastructure) and both will have a major role to play.

Much discussion revolves around the potential for technology to increase the efficiency with which urban infrastructure can be managed. The use of big data, the Internet of Things and ubiquitous smartphones promise to revolutionize aspects of city management, from keeping traffic flowing to reducing electricity outages, tackling crime and preparing for emergencies. Developing countries have the opportunity to leapfrog by avoiding the mistakes made by more advanced countries and applying the lessons learned from the development of smart city infrastructure. However, while "smart cities" should work better, they may also be more vulnerable to cyber error or terror (see Box 2.3). When discussing "smart cities" it is important to note the human component. Indeed, if technology developed for smart cities does not embrace universal design to ensure use by all (including the disabled and the elderly), its benefits could be controversial.

### Cities and Health

In most countries, the health of city dwellers has improved through better access to education and healthcare, better living conditions and targeted public-health interventions.[15]

### Box 2.4: Health in cities – robust plans are needed to face the threat of pandemics

Dense urban living facilitates the spread of infectious diseases. Particular vulnerabilities exist in countries where rapid urbanization results in informal settlements that make it difficult to control transmission and can therefore increase the risks of mosquito-transmitted epidemics, such as malaria, tuberculosis, dengue and yellow fever.

Various examples highlight the impact of urbanization on pandemics. In the Democratic Republic of the Congo, 83% of people with tuberculosis live in cities[1] (around 40% of the population lives in urban areas).[2] In 2009, Mexico City shut down schools, libraries, museums and nightclubs to halt the spread of H1N1 flu. A 2009 cholera epidemic in Zimbabwe heavily affected Harare city, Chitungwiza and Kadoma, also stressing the influence of slums and the lack of urban infrastructure as key igniting factors for the speed and severity of disease outbreaks.[3]

In today's hyperconnected world, it is easier for pathogens to be carried from one city to another and quickly scale up the impact of most outbreaks. The presumed introduction of the virus to the informal settlements of Kenema and Freetown in Sierra Leone has undoubtedly augmented its spread. Sierra Leone is urbanizing at a rate of 3% each year, and in 2005 more than 97% of its urban population lived in slums.[4] The economic impact of Ebola is enormous for the affected countries and their neighbouring countries. The estimated economic cost is $32 billion in the worst-case scenario.[5]

Another aggravating factor to the 2014 Ebola crisis was the lack of a governance mechanism that would allow an effective link between what was being observed at the country and city levels and the alert mechanisms necessary to trigger an emergency response. Looking into the future for an adequate response across geographies, the existence of such a governance mechanism would: (i) allow collaboration between local and national governments, civil society and the private sector across borders; (ii) coordinate the surveillance, collection, sharing and analysis of infectious disease data in real time; (iii) incentivize the private sector to develop and scale up the production and distribution of affordable drugs, vaccines and diagnostics; (iv) establish a network of centres for research into microbial threats; and (v) promote international standards for best laboratory, regulatory and ethical practice.[6]

The vulnerability of urban centres to pandemics points to the need for strong public-private coordination involving organizations beyond the traditional healthcare sector. The ability to mobilize a response from sectors as diverse as food production, telecommunications and corporate supply chains will determine how epidemics are fought in the future. Local, national and cross-border government agencies need to build bridges with all stakeholders and learn from what worked in the past to shape systems with the capacity to respond to pandemics and build the resilience to bounce back afterwards. Coordinating responses and developing global governance mechanisms are critical to contain future outbreaks, which will inevitably occur.

Notes:
[1] WHO, 2010.
[2] United Nations DESA, 2014.
[3] WHO, 2009.
[4] Gire et al., 2014.
[5] World Bank Group, 2014.
[6] Rubin and Saidel, 2014.

One excellent case study is the city of Surat in India. Hitting rock bottom due to a public health disaster in 1994, it introduced measures to drastically raise hygienic standards, making it one of the cleanest cities in India today.[16] However, when urbanization is rapid and unplanned, a combination of high population density, poverty and lack of infrastructure – especially water and waste management – can create the conditions for communicable diseases to flourish.

Almost 700 million urban dwellers currently lack adequate sanitation.[17] The problem is particularly acute in Sub-Saharan Africa and south-central Asia, where 62% and 43%, respectively, of the urban population live in slums.[18] Such conditions create increased risks of illnesses, worm infections, cholera and diarrhoea – a leading cause of preventable death in children – and help spread emerging infectious diseases, such as Severe Acute Respiratory Syndrome (SARS) and H1N1 influenza.[19] With the projected huge increase of populations living in slums and the growing sophistication of transport networks between cities, the spread of infectious diseases could happen extremely quickly and could be difficult to contain, creating the risk of global disease outbreaks.

In addition to communicable diseases, rapid and unplanned urbanization is a key driver in the increased prevalence of non-communicable diseases (NCDs) and their key risk factors, such as unhealthy diets, physical inactivity, tobacco consumption, harmful use of alcohol and pollution.[20] NCDs, including cardiovascular diseases, diabetes, cancer and chronic respiratory diseases, are the leading cause of death globally. These diseases affect high-, middle- and low-income countries. Every year 38 million people die from NCDs; over 14 million die prematurely – before they reach the age of 70 and 85% are in low- and middle-income countries.[21]

The prevalence of diabetes in emerging economies is rising: in China, it is already comparable to that in the United States: in 2013, the figures were 9% and 9.2%, respectively. In Kuwait, diabetes prevalence has been as high as 23%; even in a low-income country such as Burundi, it reached 4.5%.[22] Although a formal link between diabetes and urbanization has not been established, the number of urban dwellers with diabetes in low- and middle-income countries is projected to almost double from 181 million today to 347 million people in 2035.[23] In India for example, diabetes prevalence is close to epidemic proportion and is attributed - at least partially - to urbanization.[24] This will put huge pressure on already fragile healthcare systems, the collapse of which could have devastating cascading effects with dramatic economic losses.

Addressing non-communicable diseases will require efforts to tackle the causes of air pollution, which is estimated to have caused 7 million deaths in 2012.[25] Air pollution tends to be more of a problem in developing than developed countries, in part due to coal-fired power plants and the use of biomass for cooking and heating, but mostly due to private transport vehicles.[26] Over 90% of air pollution in developing world cities is attributed to old, poorly-maintained vehicles running on low-quality fuel and to roads prone to traffic jams.[27] The rapid rise of non-communicable diseases in low-income countries could jeopardize poverty reduction and limit inclusive outcomes from growth.

### Cities and Climate Change

In many developing countries, migration from rural areas to cities is at least partially driven by the increasing prevalence of extreme weather, such as land degradation and desertification, making agriculture more difficult. For example, many people are migrating from dry land areas in north-east Brazil to favelas in Rio de Janeiro.[28] The rapid, inadequate and poorly planned expansion of cities in developing countries can also leave urban populations highly exposed to the effects of climate change. For example, cities tend to be located near the sea or natural waterways, where they are more at risk of flooding. Indeed, 15 of the world's 20 megacities – those with over 10 million inhabitants – are located in coastal zones threatened by sea-level rise and storm surges.[29]

The concentration of people, assets, critical infrastructure and economic activities in cities exacerbates the potential of natural catastrophes to cause unprecedented damage: heatwaves, extreme rainfall and drought-related shortages of water and food will increasingly test the resilience of infrastructure in these and other cities. The effects of shortfalls are likely to be felt mostly by the poor, whose informal settlements tend to be on land at especially high risk from extreme weather.[30] Making cities more resilient to extreme weather events should be a priority for both local governments and the private sector.

Cities not only need to adapt to climate change, they also have a major role to play in mitigating its impact. While established cities with efficient mass transit systems have relatively low carbon footprints, the early phases of urbanization tend to generate massive greenhouse gas emissions as the construction of infrastructure uses concrete and metals that are carbon-intensive to manufacture.[31] Developing countries already account for around two-thirds of annual greenhouse gas emissions, caused in part by their economic growth and rapid urbanization.[32] The rapid expansion of their cities means that mitigation measures have to be taken today to help tackle climate change.

With adequate land-use planning and in coordination with the private sector, cities can develop infrastructure in more sustainable, low-carbon ways – but this requires governance, technical, financial and institutional capacities that are often lacking in developing countries.[33] Leadership within local governments is at the heart of both urban mitigation of and adaptation to climate change.[34] Well-governed cities with universal provision of infrastructure and services have a strong base for building resilience to climate change if processes of planning, design and allocation of human capital and material resources are responsive to emerging climate risks.

### Social Instability

Cities' capacity to generate prosperity already largely determines global growth: just over half the world's

population lives in cities, but they generate more than 80% of global GDP. In addition, most future growth will be generated by midsized cities and not by megacities, as is commonly believed.[35] Ultimately, new migrants in cities are expected to create greater economic value than they would have in the countryside. However, even when cities are successful, the process of absorbing migrants into urban economies is not necessarily smooth. While moving to a city offers individuals more opportunities to improve their living conditions, the high cost of living and competition for livelihoods can also trap people in poverty.[36]

Many of the risks described above can lead to social instability. It is the rapid and unplanned nature of urbanization, rather than urbanization itself, that is linked by many researchers to such risks as urban violence and social unrest.[37] Rapid urbanization in the developing world can quickly bring together large numbers of unemployed youth, a common ingredient of social unrest. Widening inequalities also tend to be more starkly visible in urban than rural areas, with the most wealthy areas of cities often neighbouring quickly-expanding slums. The combination of inequality, competition over scarce resources such as land, impunity from the law and weak city governance increases the risk of violence and potential breakdowns in law and order. Some cities in developing countries are already extremely dangerous, such as for example San Pedro Sula in Honduras, with 169 killings per 100,000 residents in 2011.[38]

Rapid urbanization and the related growing demand for housing are creating pressure on the housing market and social tensions are expected to increase. The shortage of affordable housing not only contributes to social exclusion, it can also threaten to destabilize the wider economy if the housing price increase fuels property bubbles. Making housing more accessible, affordable and adequate for urban dwellers is therefore of critical importance. A wide portfolio of policies, from limiting excessive credit to optimizing land use and development activity in cities, is crucial to mitigate these risks and equitably distribute the benefits of urban growth.

### Conclusion: The Importance of City Governance

Urbanization creates opportunities but also exacerbates risks, and the speed at which it is happening challenges our capacity to plan and adapt. This is particularly true in developing economies. For rapid urbanization to provide opportunities to all, carefully considered urban planning and good governance with effective regulatory frameworks are required. However, governments of rapidly-growing cities often have little time for adjustment and learning. As a consequence, inadequate planning and ineffective governance can bring significant economic, social and environmental costs, threatening the sustainability of urban development.

The inability of governments to provide appropriate infrastructure and public services is at the core of many urban challenges in developing countries, which range from the incapacity to contain infectious disease to the challenges of building climate-resilient cities. At the same time, these challenges have worsened due to the rapid and chaotic development of cities. City leaders from government, civil society and the private sector are ideally positioned to plan rapid urbanization and must act to sustain metropolitan growth.

What is more, as the world continues to urbanize, power will increasingly be concentrated in cities. This power – ranging from economic to social – not only makes cities the centre of gravity, but offers greater scope to find practical solutions to the most pressing challenges. Indeed, many observers and organizations are now focusing on cities and the connections between them rather than directing their attention at the national level. The strength of city-level institutions in addition to national institutions – their capacity to be flexible, innovative and dynamic, and effectively involve multiple stakeholders in governance – will largely determine whether urbanization makes the world more resilient or more vulnerable in the face of global risks.

## 2.4 Engineering the Future: How Can the Risks and Rewards of Emerging Technologies Be Balanced?

From networked medical devices to the Internet of Things, from drought-resistant crops to bionic prosthetics, emerging technologies promise to revolutionize a wide range of sectors and transform traditional relationships.[39] Their impacts will range from the economic to the societal, cultural, environmental and geopolitical.

Emerging technologies hold great and unprecedented opportunities. Some examples are explored in detail in three boxes presented in this section:

- Synthetic biology could create bacteria that turn biomass into diesel (Box 2.6).
- Gene drives could assist in the eradication of insect-borne diseases such as malaria (Box 2.7).
- Artificial intelligence is behind advances from self-driving cars to personal care robots (Box 2.8).

Discoveries are proceeding quickly in the laboratory, and once technologies demonstrate their usefulness in the real world, they attract significantly more investments and develop at an even greater pace.

However, how emerging technologies evolve is highly uncertain. Their potential second- or third-order effects cannot easily be anticipated, such that designing safeguards against them is difficult. Even if the ramifications of technologies could be foreseen as they emerge, the trade-offs would still need to be considered. Would the large-scale use of fossil fuels for industrial development have proceeded had it been clear in advance that it would lift many out of poverty but introduce the legacy of climate change? Would the Haber-Bosch process have been sanctioned had it been evident it would dramatically increase agricultural food production but adversely impact biodiversity?[40] A range of currently emerging technologies could have similar or even more profound implications for mankind's future. Survey respondents highlighted technological risks as highly connected to man-made environmental catastrophes.

### Box 2.5: Classifying emerging technologies

In general, three broad categories of emerging technologies can be distinguished: first, those to do with information, the Internet and data transfer, which include artificial intelligence, the Internet of Things and big data; second, biological technologies, such as the genetic engineering of drought-resistant crops and biofuel, lab-grown meat, and new therapeutic techniques based on RNA[1], genomics and microbiomes; and third, chemical technologies, those involved in making stronger materials (such as nanostructure carbon-fibre composites) and better batteries (through germanium nanowires, for example), recycling nuclear waste and mining metals from the by-products of water desalination plants.

However, any attempt to categorize emerging technologies is difficult because many new advances are interdisciplinary in nature. In particular, information technology underlies many, if not all, advances in emerging technology. A final category of cross-over technologies would include smart grids in the electricity supply industry, brain-computer interfaces and bioinformatics – the growing capacity to use technology to model and understand biology.

Note:
[1] RNA stands for ribonucleic acid; it is one of the three major biological macromolecules that are essential for all known forms of life (along with DNA and proteins). A central tenet of molecular biology states that the flow of genetic information in a cell goes from DNA through RNA to proteins: "DNA makes RNA makes protein". Proteins are the workhorses of the cell; they play leading roles in the cell as enzymes, as structural components, and in cell signalling, to name just a few. For more information see the RNA Society at http://www.rnasociety.org/about/what-is-rna/.

Emerging technology is a broad and loose term (see Box 2.5), and debate about potential risks and benefits is more vigorous in some areas than in others. In the examples that follow, the focus is on technologies that are considered to have wide benefits and for which there is strong pressure for development, as well as high levels of concern about potential risks and safeguards.

### Causes for Concern

Risks of undesirable impacts of emerging technologies can be divided into two categories: the foreseen and the unforeseen. Some examples of foreseen risks are leakage of dangerous substances through difficulties of containment (as is sometimes the case with trials of genetically-modified crops) or storage errors (as with 2014 security failures in US disease-control labs handling lethal viruses);[41] the theft or illegal sale of emerging technologies; computer viruses, hacker attacks on human transplants[42], or chemical or biological warfare. The establishment of new fundamental capabilities, as is happening for example with synthetic biology and artificial intelligence, is especially associated with risks that cannot be fully assessed in the laboratory. Once the genie is out of the bottle, the possibility exists of undesirable applications or effects that could not be anticipated at the time of invention. Some of these risks could be existential – that is, endangering the future of human life (see Boxes 2.6 to 2.8).[43]

Both foreseen and unforeseen risks are amplified by the accelerating speed and complexity of technological development. Exponential growth in computing power implies the potential for a tipping point that could significantly amplify risks, while hyperconnectivity allows new ideas and capabilities to be distributed more quickly around the world. The growing complexity of new technologies, combined with a lack of scientific knowledge about their future evolution and often a lack of transparency, makes them harder for both individuals and regulatory bodies to understand.

## Box 2.6: Synthetic biology - protecting mother nature

For thousands of years, humans have been selectively breeding crops and animals. With the discovery of DNA hybridization in the early 1970s, it became possible to genetically modify existing organisms. Synthetic biology goes further: it refers to the creation of entirely new living organisms from standardized building blocks of DNA. The technology has been in development since the early 2000s, as knowledge and methods for reading, editing and designing genetics have improved, costs of DNA sequencing and synthesis have decreased, and computer modelling of proposed designs has become more sophisticated. (see Figure 2.6.1)

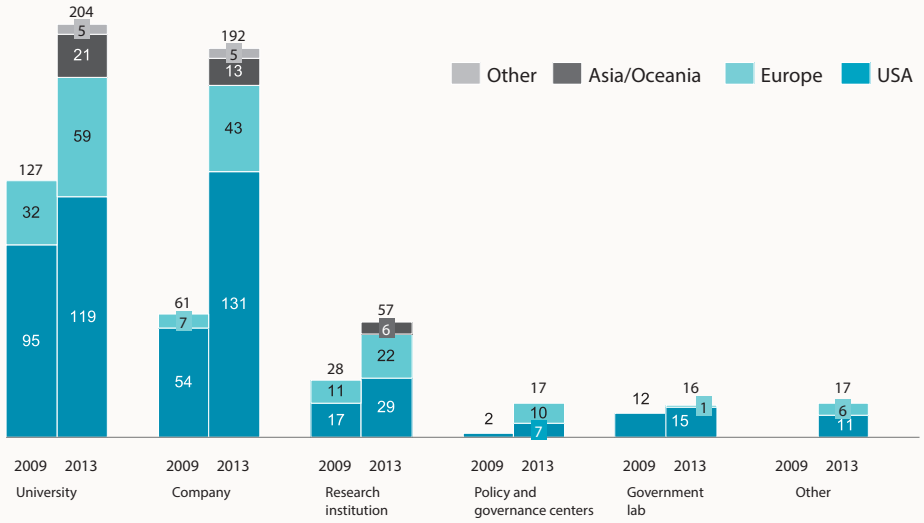
In 2010 Craig Venter and his team demonstrated that a simple bacterium could be run on entirely artificially-made DNA.[1] Applications of synthetic biology that are currently being developed include producing biofuel from E. coli bacteria; designer organisms that act as sensors for pollutants or explosives; optogenetics, in which nerve cells are made light-sensitive and neural signals are controlled using lasers, potentially revolutionizing the treatment of neurological disorders; 3D-printed viruses that can attack cancer;[2] and gene drives as a possible solution to insect-borne diseases (as discussed in Box 2.7).

Alongside these vast potential benefits are a range of risks. Yeast has already been used to make morphine;[3] it is not hard to imagine that synthetic biology may allow entirely new pathways for producing illicit drugs. The invention of cheap, synthetic alternatives to high-value agricultural exports such as vetiver could suddenly destabilize vulnerable economies by removing a source of income on which farmers rely.[4] As technology to read DNA becomes more affordable and widely available, privacy concerns are raised by the possibility that someone stealing a strand of hair or other genetic material could glean medically-sensitive information or determine paternity.

The risk that most concerns analysts, however, is the possibility of a synthetized organism causing harm in nature, whether by error or terror. Living organisms are self-replicating and can be robust and invasive. The terror possibility is especially pertinent because synthetic biology is "small tech" – it does not require large, expensive facilities or easily-tracked resources. Much of its power comes from sharing information and, once a sequence has been published online, it is nearly impossible to stop it: a "DIYbio" or "biohacker" community exists, sharing inventions in synthetic biology, while the International Genetically Engineered Machines competition is a large international student competition in designing organisms, with a commitment to open-sourcing the biological inventions.

Conceivably, a single rogue individual might one day be able to devise a weapon of mass destruction – a virus as deadly as Ebola and as contagious as flu. What mechanisms could safeguard against such a possibility? Synthetic biology and affordable DNA-sequencing also opens up the possibility of designing bespoke viruses as murder weapons: imagine a virus that spreads by causing flu-like symptoms and is programmed to cause fatal brain damage if it encounters a particular stretch of DNA found only in one individual.[5]

**Figure 2.6.1:** Number of Entities Conducting Research in Synthetic Biology




Source: The Wilson Center 2013
Notes: The "Other" category consists of "Community lab space", "Military lab" and "Hybrid research/policy".
No data are available for the categroies "Community Lab Space", "Military Lab", and "Hybrid Research Insitution/Policy Center" in 2009 and for the region Asia/Oceania in 2009

Synthetic biology is currently governed largely as just another form of genetic engineering. Regulations tend to assume large institutional stakeholders such as industries and universities, not small and medium-sized enterprises or amateurs. The governance gap is illustrated by the controversy surrounding the very successful 2013 crowdsourcing of bioluminescent plants, which exploited a legal loophole dependent on the method used to insert genes.[6] The Glowing Plants project, which aims ultimately to make trees function as street lights, was able to promise to distribute 600,000 seeds without any oversight by a regulatory body other than the discretion of Kickstarter. The project caused concern not only among activists against genetically-modified organisms, but also among synthetic biology enthusiasts who feared it might cause a backlash against the technology.[7]

Differences can already be observed in the focus of DIYbio groups in Europe and the United States due to the differing nature of regulations on genetically-modified organisms in their regions, with European enthusiasts focusing more on "bio-art".[8] The amateur synthetic biology community is very aware of safety issues and pursuing bottom-up options for self-regulation in various ways, such as developing voluntary codes of practice.[9] However, self-regulation has been criticized as inadequate, including by a coalition of civil society groups campaigning for strong oversight mechanisms.[10] Such mechanisms would need to account for the cross-border nature of the technology, and inherent uncertainty over its future direction.[11]

Notes:
[1] Gibson, D. et al., 2010. "Creation of a bacterial cell controlled by a chemically synthesized genome". Science 329 (5987): 52–6
[2] See 3dprint.com article "Autodesk Genetic Engineer is Able to 3D Print Viruses, Soon to Attack Cancer Cells"; http://3dprint.com/19594/3d-printed-virus-fights-cancer/.
[3] See Scientific American article "Yeast Coaxed to Make Morphine"; http://www.scientificamerican.com/podcast/episode/yeast-coaxed-to-make-morphine/.
[4] See Inter Press Service News Agency article "Synthetic Biology Could Open a Whole New Can of Worms"; http://www.ipsnews.net/2014/10/synthetic-biology-could-open-a-whole-new-can-of-worms/.
[5] See The Atlantic article "Hacking the President's DNA"; http://www.theatlantic.com/magazine/archive/2012/11/hacking-the-presidents-dna/309147/.
[6] See A. Evans' article "Glowing Plants: Natural Lighting with no Electricity"; https://www.kickstarter.com/projects/antonyevans/glowing-plants-natural-lighting-with-no-electricit, and Scientific American article "Glowing Plants: Crowdsourced Genetic Engineering Project Ignites Controversy"; http://www.scientificamerican.com/article/glowing-plants-controversy-questions-and-answers/.
[7] See Crowdfund Insider's article "Kickstarter Bans GMOs In Wake Of Glowing Plant Campaign"; http://www.crowdfundinsider.com/2013/08/20031-kickstarter-bans-gmos-in-wake-of-glowing-plant-fiasco/.
[8] See NCBI literature "European do-it-yourself (DIY) biology: Beyond the hope, hype and horror"; http://www.ncbi.nlm.nih.gov/pmc/articles/PMC4158858/.
[9] See for example BioScience article "Biosafety Considerations of Synthetic Biology in the International Genetically Engineered Machine (iGEM) Competition"; http://www.biofaction.com/wp-content/uploads/2012/04/igem-biosafety-2013.pdf; "A Biopunk Manifesto"; https://maradydd.livejournal.com/496085.html; and DIYbio Codes; http://diybio.org/codes/.
[10] See "The Principles for the Oversight of Synthetic Biology"; http://www.biosafety-info.net/file_dir/15148916274f6071c0e12ea.pdf.
[11] Zhang, J.Y. et al., 2011.

## Safeguards and Challenges

As illustrated by the boxes on synthetic biology, gene drives and artificial intelligence, governance regimes that could mitigate the risks associated with the abuse of emerging technologies – from formal regulations through private codes of practice to cultural norms – present a fundamental challenge that has the following main aspects.[44]

The current regulatory framework is insufficient. Regulations are comprehensive in some specific areas of emerging technology, while weak or non-existent in others, even if conceptually the areas are similar. Consider the example of two kinds of self-flying aeroplane: the use of autopilot on commercial aeroplanes has long been tightly regulated, whereas no satisfactory national and international policies have yet been defined for the use of drones.

Spatial issues include where to regulate, whether at the national or international level. The latter is further complicated by the need to translate regulations into rules that can be implemented nationally to be fully enforceable. Undesirable consequences have the scope to cross borders, but cultural attitudes differ widely. For example, public attitudes are more accepting of genetically-modified produce in the United States than the European Union; consequently the EU has institutionalized the precautionary principle, while there is more faith in the US that a "technological fix" will be available for most challenges.[45] Safeguards, regulations and governance need to combine consistency across countries with the strength to address the worldwide impacts of potential risks and the flexibility to deal with different cultural preferences.

The timing issue is that decisions need to be taken today for technologies that have a highly uncertain future path, the consequences of which will be visible only in the long term. Regulate too heavily at an early stage and a technology may thus fail to develop; adopt a laissez-faire approach for too long, and rapid developments may have irrevocable consequences. Different kinds of regulatory oversight may be needed at different stages: when the scientific research is being conducted, when the technology is being developed, and when the technology is being applied. At the same time, the natural tendency to think short term in policy-making needs to be overcome. Compared with Internet technology, notably the physical and life sciences have longer cycles of development and need governance regimes to take a long-term approach. History shows that it can take a long time to reach international agreements on emerging threats – 60 years for bioweapons, 80 years for chemical weapons – so it is never too early to start discussions.[46]

The question of who regulates becomes significant when it is unclear where a new device fits into the allocation of responsibility across existing regulatory bodies. This is an increasingly difficult

### Box 2.7: Gene drives – promises and regulatory challenges

In sexually reproducing organisms, most genes have a 50% chance of being inherited by offspring. However, natural selection has in some cases favoured certain genes that are inherited more often. For the past decade or so, research has been exploring how this could be triggered.[1] The "gene drives" method "drives" a gene through a population, stimulating a gene to be preferentially inherited. This gene then can spread through a given population, whose characteristics could thus be modified by the addition, deletion, editing or even suppression of certain genes.

Gene drives present an unprecedented opportunity to cure some of the most devastating risks to health and the environment. Applications are foreseen in the fight against malaria and other insect-borne diseases, which the reprogramming of mosquito genomes could potentially eliminate from entire regions. They are also foreseen in combating herbicide and pesticide resistance, and in eradicating invasive species that threaten the biodiversity of ecosystems.

Technical challenges remain, relating mainly to the difficulty of editing genomes for programming drives in a way that is precise (with only the targeted gene affected) and reversible (to prevent and overwrite possible unwanted changes). A team at Harvard University, MIT and the University of California at Berkeley is making huge progress, such that the development of purpose-built, engineered gene drives is expected in the next few years.[2]

However, gene drives carry potential risks to wild organisms, crops and livestock: unintentional damage could possibly be triggered and cascade through other connected ecosystems. No clear regulatory framework to deal with gene drives currently exists. The US Food and Drug Administration would consider them as veterinary medicines, requiring the developers to demonstrate they are safe for animals that need to be protected. So how are they defined? Both the US policy on Dual Use Research of Concern, which oversees research that has clear security concerns, and the Australia Group Guidelines, a form of private regulations on transfers of biological material, rely on lists of infectious bacterial and viral agents.[3] They do not have the functional approach that would be needed, for example, to regulate genetic modifications to sexually reproducing plants and animals.

Scientists and regulators need to work together from an early stage to understand the challenges, opportunities and risks associated with gene drives, and agree in advance to a governance regime that would govern research, testing and release. Acting now would allow time for research into areas of uncertainty, public discussion of security and environmental concerns, and the development and testing of safety features. Governance standards or regulatory regimes need to be developed proactively and flexibly to adapt to the fast-moving development of the science.[4]

Sources: Esvelt et al. 2014 and Oye et al. 2014.
Notes:
[1] Begun in particular by Prof. Austin Burt, Imperial College London.
[2] CRISPR-Cas9 is a tool that aims to accelerate the technology to edit genomes. It enables an organism's DNA to be rewritten.
[3] See Australia Group, "Guidelines for Transfers of Sensitive Chemical or Biological Items" (June 2012); www.australia-group.net/en/guidelines.html.
[4] Adapted from an interview with Kenneth Oye, MIT, on the regulation of genetic engineering: "3 Questions: Kenneth Oye on the regulation of genetic engineering: Political scientist discusses regulatory gaps in assessing the impact of 'gene drives'"; http://newsoffice.mit.edu/2014/3-questions-kenneth-oye-regulation-genetic-engineering-0717.

issue as innovations become more interdisciplinary and technologies converge. Examples include Google Glass, autonomous cars and M-healthcare: while all rely on Internet standards, they also have ramifications in other spheres. Often no mechanism exists for deciding which existing regulatory body, if any, should take responsibility for an emerging technology.

Striking a balance between precaution and innovation is an overall dilemma. Often potentially-beneficial innovations cannot be tested without some degree of risk. For example, a new organism may escape into the environment and cause damage. Weighing risks against benefits involves attempting to anticipate the issues of tomorrow and deciding how to allocate scarce regulatory resources among highly technical fields.

When a gap in governance exists, it may create a vacuum of power that could be filled by religious movements and action groups exerting more influence and potentially stifling innovation. With that risk in mind, industry players in emerging technologies where institutions are weak or non-existent may seek to respond to a governance gap by demonstrating their responsibility through self-regulating – as the "biohacker" community is attempting in synthetic biology. Another example of a private player highlighting a governance gap is the way Facebook effectively exerts regulatory power in online identity management and censorship, through policies such as forcing users to display their real names and removing images that it believes the majority of users might find offensive.

## Box 2.8: Artificial intelligence – rise of the machines

Artificial Intelligence (AI) is the discipline that studies how to create software and systems that behave intelligently. AI scientists build systems that can solve reasoning tasks, learn from data, make decisions and plans, play games, perceive their environments, move autonomously, manipulate objects, respond to queries expressed in human languages, translate between languages, and more.

AI has captured the public imagination for decades, especially in the form of anthropomorphized robots, and recent advances have pushed AI into popular awareness and use: IBM's "Watson" computer beat the best human Jeopardy! players; statistical approaches have significantly improved Google's automatic translation services and digital personal assistants such as Apple's Siri; semi-autonomous drones monitor and strike military targets around the world; and Google's self-driving car has driven hundreds of thousands of miles on public roads.

This represents substantial progress since the 1950s, and yet the original dream of a machine that could substitute for arbitrary human labour remains elusive. One important lesson has been that, as Hans Moravec wrote in the 1980s, "It is comparatively easy to make computers exhibit adult level performance on intelligence tests or playing checkers, and difficult or impossible to give them the skills of a one-year-old when it comes to perception and mobility".[1]

These and other challenges to AI progress are by now well known within the field, but a recent survey shows that the most-cited living AI scientists still expect human-level AI to be produced in the latter half of this century, if not sooner, followed (in a few years or decades) by substantially smarter-than-human AI.[2] If they are right, such an advance would likely transform nearly every sector of human activity.

If this technological transition is handled well, it could lead to enormously higher productivity and standards of living. On the other hand, if the transition is mishandled, the consequences could be catastrophic.[3] How might the transition be mishandled? Contrary to public perception and Hollywood screenplays, it does not seem likely that advanced AI will suddenly become conscious and malicious. Instead, according to a co-author of the world's leading AI textbook, Stuart Russell of the University of California, Berkeley, the core problem is one of aligning AI goals with human goals. If smarter-than-human AIs are built with goal specifications that subtly differ from what their inventors intended, it is not clear that it will be possible to stop those AIs from using all available resources to pursue those goals, any more than chimpanzees can stop humans from doing what they want.[4]

In the nearer term, however, numerous other social challenges need to be addressed. In the next few decades, AI is anticipated to partially or fully substitute for human labour in many occupations, and it is not clear whether human workers can be retrained quickly enough to maintain high levels of employment.[5] What is more, while previous waves of technology have also created new kinds of jobs, this time structural unemployment may be permanent as AI could be better than humans at performing the new jobs it creates. This may require a complete restructuring of the economy by raising fundamental questions of the nature of economic transactions and what it is that humans can do for each other. Autonomous vehicles and other cases of human-robot interaction demand legal solutions fit for the novel combination of automatic decision-making with a capacity for physical harm.[6] Autonomous vehicles will encounter situations where they must weigh the risks of injury to passengers against the risks to pedestrians; what will the legal redress be for parties who believe the vehicle decided wrongly? Several nations are working towards the development of lethal autonomous weapons systems that can assess information, choose targets and open fire without human intervention. Such developments raise new challenges for international law and the protection of non-combatants.[7] Who will be accountable if they violate international law? The Geneva Conventions are unclear. It is also not clear when human intervention occurs: before deployment, during deployment? Humans will be involved in programming autonomous weapons; the question is whether human control of the weapon ceases at the moment of deployment. AI in finance and other domains has introduced risks associated with the fact that AI programmes can make millions of economically significant decisions before a human can notice and react, leading for example to a May 2012 trading event that nearly bankrupted Knight Capital.[8,9]

In short, proactive and future-oriented work in many fields is needed to counteract "the tendency of technological advance to outpace the social control of technology".[10]

Notes:
[1] Moravec, 1988, p. 15.
[2] Müller and Bostrom, 2014.
[3] Bostrom, 2014.
[4] Omohundro, 2008.
[5] Brynjolfsson and McAfee, 2014.
[6] Calo, 2014; http://papers.ssrn.com/sol3/papers.cfm?abstract_id=2402972.
[7] Human Rights Watch, 2012
[8] Johnson et al., 2013.
[9] See Reuters, "Error by Knight Capital rips through stock market"; http://www.reuters.com/article/2012/08/01/us-usa-nyse-tradinghalts-idUSBRE8701BN20120801.
[10] Posner, 2004, p. 20.

A fundamental question pertains to societal, economic and ethical implications. While emerging technologies imply the long-term possibility of a world of abundance, many countries are struggling with unemployment and underemployment, and even a temporary adjustment due to technological advancement could undermine social stability. In ethical terms, advances in transhumanism, using technology to enhance human physiology and intelligence, will require finding a definition for what people mean by human dignity: are enhanced human capabilities a basic human right, or a privilege for those who can pay, even if that exacerbates and entrenches inequalities? At the same time, governance regimes for emerging technologies are strongly influenced by the perceptions, opinions and values of society – whether people are more enthusiastic about a technology's potential benefits than fearful about its risks. This is very domain-related, and not always rational or proportional: it can lead to some technologies being over-regulated and others under-regulated. Many biological technologies that touch on beliefs about religion and human life, for example, are regulated relatively stringently, as evidenced by the worldwide prohibition on human cloning.[47] On the other hand, the human propensity to anthropomorphize means that robotic prototypes in some empathic form of assistive technology (such as Paro, a baby harp seal lookalike robot assisting in the care of people with dementia and other health problems) easily capture public sympathy, which may ease safety, ethical or legal concerns.[48,49] In other areas, such as lethal autonomous weapons, it would probably be easier to get close to unanimous public support to prohibit them as has been the case for landmines. As such, these societal implications constitute an important risk in themselves, as it is difficult to anticipate their impact on the use and path of emerging technologies.

### Thoughts for the Future

Emerging technologies are developing rapidly. Their far-reaching societal, economic, environmental and geopolitical implications necessitate a debate today to chart the course for the future and reap the many benefits but avoid the risks of emerging technologies. This is not a trivial task given the many interdependencies and uncertainties and the fact that many challenges transcend the spheres of decision-makers both across technologies and borders. Regulators face the dilemma to design regulatory systems that are predictable enough for companies, investors and scientists to make rational decisions, but unambiguous enough to avoid a governance gap that could jeopardize public consent or give too much room to non-state actors. Against this backdrop, evolving and adaptive regulatory systems should be designed in a flexible manner to take into account changing socio-economic conditions, new scientific insights and the discovery of unknown interdependencies.

In light of the complexities and rapidly changing nature of emerging technologies, governance should be designed in such a way as to facilitate dialogue among all stakeholders. For regulators, to dialogue with researchers at the cutting edge of developing these technologies is the only way to understand the potential future implications of new and highly-technical capabilities. For the scientific community within and across certain fields, a safe space is needed to coalesce around a common language and have an open discussion around both benefits and risks. At the same time, given that risks tend to cross borders, so must the dialogue on how to respond. And given the power of public opinion to shape regulatory responses, the general public must also be included in an open dialogue about the risks and opportunities of emerging technologies through carefully-managed communication strategies. Governance will be more stable and less likely either to overlook emerging threats or to stifle innovation unnecessarily, if the various stakeholders likely to be affected are involved in the thinking about potential regulatory regimes and given the knowledge to enable them to make informed decisions.

## 2.5 Conclusion

Although the interplay between geopolitics and economics, urbanization and emerging technologies are three very different fields of enquiry, two common themes emerge: the importance of governance and the need for proactivity.

The analysis of the interplay between geopolitics and economics focuses attention on the need to find ways to minimize incentives for national governments to engage in negative tactics, including by making the mechanisms of global governance more effective in resolving tensions among nation states. As this interplay leads to regional institutions gaining in significance, proactive attention to the quality and effectiveness of their governance also becomes more important in creating the capacity to address risks.

There is no doubt that urbanization will continue, so improving the governance of cities will be relevant to a broad spectrum of global risks. An opportunity also exists to be proactive in fostering more effective links between city governments around the world, for mutual learning and collaboration on risks that affect them.

Emerging technologies promise to play a leading role in improving the governance of smart cities, but also present risks. Proactivity is especially crucial here given that the risks that might emerge from entirely new fields of knowledge are impossible to predict. Effective governance at all levels, from industry codes of conduct to national regulations and global cooperation, will determine how well risks from emerging technologies are foreseen and minimized.

## Endnotes

[1] United Nations DESA, 2014.

[2] See the IMF Finance and Development "Slow Trade" article,; http://www.imf.org/external/pubs/ft/fandd/2014/12/constant.htm.

[3] See the "reports on G20 trade and investment measures"; http://www.oecd.org/daf/inv/investment-policy/12th-G20-Report.pdf; see also the Global Trade Alert report, *The Global Trade Disorder*,; http://www.globaltradealert.org/16th_GTA_report.

[4] United Nations DESA, 2014.

[5] Forecasts show that over four-fifths of the world's urban population will live in less-developed regions by 2050.

[6] United Nations DESA, 2014.

[7] McKinsey Global Institute, 2011.

[8] Glaeser, 2013.

[9] United Nations Water, 2013.

[10] World Economic Forum, 2014.

[11] World Economic Forum Global Risks Perception Survey 2014.

[12] OECD, 2007.

[13] See "Improved Infrastructure to Support Africa's Competitiveness" at http://www.afdb.org/en/blogs/afdb-championing-inclusive-growth-across-africa/post/improved-infrastructure-to-support-africas-competitiveness-11755/ and "Strategic Infrastructure in Africa" at http://www3.weforum.org/docs/AF13/WEF_AF13_African_Strategic_Infrastructure.pdf.

[14] McKinsey Global Institute, 2013.

[15] Alirol et al., 2011.

[16] World Economic Forum, 2014.

[17] Hawkins et al., 2013.

[18] See UN Water, Water for Life Decade at http://www.un.org/waterforlifedecade/water_cities.shtml.

[19] Alirol et al., 2011.

[20] Alirol et al., 2011.

[21] World Health Organization, 2014b.

[22] IDF, 2013.

[23] IDF, 2013.

[24] Ramachandran et al., 2008.

[25] WHO, 2014a.

[26] Seto et al., 2014. See also WHO's 7 May 2014 news release "Air quality deteriorating in many of the world's cities"; http://www.who.int/mediacentre/news/releases/2014/air-quality/en/.

[27] See UNEP, "Urban Air Pollution"; http://www.unep.org/urban_environment/Issues/urban_air.asp.

[28] See WHO Bulletin "The Impact of Climate Change: Migration and Cities in South America"; https://www.wmo.int/pages/publications/bulletin_en/Bulletin632-2014_southamerica.html.

[29] World Bank, 2010.

[30] Revi et al., 2014.

[31] Seto et al., 2014.

[32] New Climate Economy, 2014.

[33] Seto et al., 2014.

[34] Revi et al., 2014.

[35] McKinsey Global Institute, 2011.

[36] OECD, 2014.

[37] Muggah, 2012.

[38] See *The Guardian* article "Murder capitals of the world: how runaway urban growth fuels violence"; http://www.theguardian.com/global-development/2014/nov/01/murder-capitals-world-city-violence.

[39] Emerging technologies are defined as contemporary advances and innovation in various fields of technology. See "Emerging Technologies: From Hindsight to Foresight" (page 3); http://www.ubcpress.ca/books/pdf/chapters/2009/emergingtechnologies.pdf.

[40] Synthetic nitrogenous fertilizers now provide over half of the nutrients received by the world's crops: see http://www.engineeringchallenges.org/cms/8996/9132.aspx. See also the Nature Education article "The Nitrogen Cycle: Processes, Players, and Human Impact"; http://www.nature.com/scitable/knowledge/library/the-nitrogen-cycle-processes-players-and-human-15644632.

[41] See *The Guardian* article "From anthrax to bird flu – the dangers of lax security in disease-control labs"; http://www.theguardian.com/world/2014/jul/18/anthrax-bird-flu-dangers-lax-security-disease-control-labs.

[42] See the University of Reading archive article "Attacking human implants: a new generation of cybercrime"; http://centaur.reading.ac.uk/35672/.

[43] See Nick Bostrom's article "Superintelligence: Answer to the 2009 EDGE QUESTION; WHAT WILL CHANGE EVERTYTHING?"; http://www.nickbostrom.com/views/superintelligence.pdf.

[44] Governance regime here is defined as the set of actors and processes that together determine how rules are made and applied. This includes regulation (such as top-down laws and regulatory frameworks made by governments or regulatory authorities) but also other approaches (such as private regulation, codes, standards and even practices determined by culture and history).

[45] Wallach, 2011.

[46] Based on an interview with University of California, Berkeley professor Stuart Russell, conducted by the Risks team on 12 November 2014.

[47] Wallach, 2011.

[48] See *The Economist* article "Seal of approval: A robot around the house doesn't just have to be handy. It has to be likeable too"; http://www.economist.com/news/special-report/21599528-robot-around-house-doesnt-just-have-be-handy-it-has-be-likeable-too-seal.

[49] Wallach, 2011.

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# Part 3: Good Practices on Risk Management and Risk Resilience

## Introduction

Mitigating, preparing for and building resilience against global risks is a long and complex process, a necessity often recognized in theory but difficult in practice.[1] Global risks transcend borders, meaning that often no single entity has the capacity and authority to address them. Multistakeholder collaboration is required but made difficult by misaligned incentives and uncertainties – those with the most to lose from a risk are often not those with the most power to address it. And the highly interconnected nature of global risks means they need to be addressed from multiple angles – although this also means that investments in risk mitigation and resilience can pay off in multiple areas.

Analysing and better understanding global risks is the first step towards successful efforts to address them. Risks must be effectively communicated to the public, government, business and civil society. Even then, action is more likely to happen if stakeholders have examples of good practice on which to draw. With that in mind, this year's *Global Risks* report shares three examples of risk management and resilience practices related to extreme weather events.

The focus on extreme weather events is pertinent given that it tied with large-scale involuntary migration at the bottom of the list when respondents to the Global Risks Perception Survey 2014 were asked to rate what progress had been made in addressing each global risk over the past 10 years (see Figure 3.1). Water crises and risks related to extreme weather events, such as natural disasters, major biodiversity loss and ecosystem collapse, are also in the bottom half of responses. In addition, water crises is the global risk that is perceived as the most potentially impactful in the coming decade (see Figure 1).

The impact of natural hazards is a combination of the frequency and intensity of the hazard with the vulnerability and exposure of people, assets and economic activities. Strengthening resilience is an attempt to reduce the exposure and ultimately the potentially catastrophic impact of natural hazards.

The first practice presented here addresses water crises. In the coming decades, climate change will add to the pressure that economic growth and development are already putting on both groundwater and renewable surface water resources.[2] As water is an issue that must be managed locally, proven local initiatives that can be adapted and replicated elsewhere are needed. The initiative described here was developed in Australia's Murray-Darling Basin and has been transferred in other regions of Asia.

Community-level action to build resilience is the focus of the second practice outlined below, the newly-established Resilient America Roundtable. This highly promising initiative is helping selected local communities in the United States to understand their risk interconnections and design resilience strategies against risks, including extreme weather events. It is hoped that the lessons learned will enable many more communities to do the same.

The importance of adequate risk communication is a recurring theme in effective risk management practices, and it is at the heart of the third practice presented here – on raising public awareness about flood risks in Saxony, a region of Germany that is prone to significant flooding (ZÜRS Public).

The examples showcased here are not intended to be exhaustive; they are selected sources of inspiration and a base for continuing this work in the future.

**Figure 3.1:** Global Risks for Which Most Progress Has Been Made within the Last 10 Years

Source: Global Risks Perception Survey 2014, World Economic Forum.
Note: Respondents were asked to select three global risks for which they believe most progress has been made to address them within the last 10 years. For legibility reasons, the names of the global risks are abbreviated. See Appendix A for the full name and description.

## Practice 1: Interdisciplinary Science for Managing Water Resources and Improving Long-Term Water Security

Securing a reliable supply of clean water has been one of the most important issues throughout human history. Water management involves mitigating four risks: shortages, including droughts; inadequate quality; flooding; and harming ecological systems.[3] According to the United Nations:[4]

- Water use is growing at twice the pace of population growth. By 2025, two-thirds of the world population will be experiencing water "stress conditions".
- One in nine people lacks access to improved sources of drinking water and one in three lacks improved sources of water sanitation. This causes around 3.5 million deaths each year.
- Between 2000 and 2006, droughts, floods and storm surges killed almost 300,000 people and caused an estimated $422 billion worth of damage.

Climate change will increase the frequency and severity of droughts and floods and will lead to overall drier conditions in some world regions.[5] This may heighten the risk of geopolitical destabilization and armed conflict: countries that share rivers have a statistically higher likelihood of armed conflict, and dry countries experience more conflict .[6,7] The Jordan, Rio Grande, Mekong and Nile rivers are all especially associated with conflict risk.

### The Murray-Darling Basin

Australia's Murray-Darling Basin provides water for over 2 million people, including much of the city of Adelaide, as well as 40% of Australia's agriculture. Unsustainable rates of water extraction had been decreasing flow volumes: in 2007, the car ferry at the River Murray mouth was grounded for the first time in its 71-year history.[8]

There was a growing sense that something had to be done to ensure that the river system was not destroyed. Policy-makers realized that they urgently required a model that could provide credible and robust estimates of current and future water availability, to enable them to set equitable and efficient allocations for competing uses. However, such a model had not yet been designed, let alone built.

**Figure 3.2:** The Murray-Darling Basin in Australia

Source: CSIRO Land and Water Flagship

The complexity of modelling an entire river system – which requires handling vast amounts of often incomplete data from multiple sources of varying accuracy and reliability – had been insurmountable until recently. But prior investments in fields such as hydrology, mathematics, climate and statistics had paid off in the shape of advances that were making such a model possible. Then-prime minister John Howard identified it as a national priority and committed government funding.

First, climate patterns as well as individual models of groundwater and surface water inflows and outflows had to be developed, for different parts of an area larger than France. Then these individual models had to be brought together into a single, integrated model. Starting in 2006, a team of around 100 people from 15 organizations developed ways to handle the uncertainties and link the models. The resulting system incorporated 70 individual ground and surface water models and over a century of climate data into a 61,000 gigabyte database – roughly the size of the US Library of Congress.

The project combined both blue-sky and applied research. It involved the development of new techniques for hydrological, environmental and climate modelling, with transparency and expert review to validate methods and build stakeholder trust. The project is the first rigorous attempt worldwide to estimate the impacts of catchment development, changing groundwater extraction, climate variability and anticipated climate change, on water resources at a basin-scale, explicitly considering the connectivity of surface and groundwater systems.[9]

Today the Murray-Darling Basin Authority – a government organization charged with managing the basin's water resources – provides a real-time interactive website where anyone can view daily and yearly water levels, salt loads (electrical conductivity) and water temperatures at recording stations for all the basin's major rivers. This provides traceability and transparency for critical decisions relating to water allocation. In a multistakeholder environment where allocation decisions can impact people's livelihoods, trust in the data is critical for effective policy.

### Next-Generation Models

The general principles of the technologies pioneered in the Murray-Darling Basin are applicable to other river systems, although they need to be adapted to the unique environmental features of each. This is now happening for the Mekong River Basin, one of the largest in the world, which covers China, Myanmar, Lao PDR, Thailand, Cambodia and Vietnam: over 60 million people depend on the Mekong for their water supply, and many hydropower plants are planned or under construction.

The science of river basin planning is also advancing to incorporate social science alongside the physical sciences in efforts to improve the resilience of social, economic and environmental systems. In a 2010 study with funding from the Australian overseas aid agency, the Commonwealth Scientific and Industrial Research Organisation (CSIRO) and the Mekong River Commission developed six scenarios for the Mekong Basin to the year 2050. The Mekong Futures Project sought to understand the complex transboundary regional dynamics to improve decision-making, ensure participatory processes and develop shared future visions. The CSIRO team working on the project had both physical and socio-economic science backgrounds.[10]

Another project will see yet more advanced techniques applied to model water availability, ecosystems and livelihoods for the Koshi River Basin, which stretches from China across the Himalayas, through Nepal and into the Ganges in India. In 2013, CSIRO commenced a collaborative four-year project with the International Centre for Integrated Mountain Development to inform transboundary water reforms.[11] Reliable information about how much water can be safely extracted from a river system is vital to help countries reach agreements on long-term water security.

As the models increase in sophistication, the challenge is to plug them into real-world decision-making processes. Building the models is hard, but so too is convincing policy-makers to act on them when they point towards the need to make difficult choices.

## Practice 2: Resilient America Roundtable

Floods, hurricanes, wildfires, windstorms and other natural hazards kill or injure thousands of people worldwide and cost billions of dollars in the United States each year. The factors that make a community resilient against these threats – able to protect against, absorb, mitigate, respond to or recover from them – differ greatly according to local circumstances. But many communities have not even begun to think about how to assess their resilience, let alone build it.

Started in January 2014, the Resilient America Roundtable initiative by the National Academy of Sciences aims to work with communities in a bottom-up way. Over a three-year time horizon, the purpose of the initiative is to initiate, nurture and learn from local efforts to measure and improve resilience. It emerged from interest in testing ideas included in the 2012 US National Research Council report entitled *Disaster Resilience: A National Imperative* on reducing vulnerability to extreme events, decreasing their costs and mitigating their impacts. The Resilient America Roundtable has a strong multistakeholder component: initiated by nine federal agencies, it convenes experts from the academic, public and private sectors. The science community is represented by the National Academy of Sciences.

The Resilient America Roundtable has designed and is currently catalysing pilot projects in communities in South Carolina, Seattle/Tacoma and Iowa, thus offering a geographic representation by ranging from the west (Seattle/Tacoma) to the middle (Iowa) to the east (South Carolina). The communities were selected based on criteria including their size, ethnic and economic diversity, the range and type of natural hazard risks they face and the presence of motivated community leadership to own and maintain the resulting community resilience strategy in the long term. The pilot projects are structured around four pillars: (i) understanding and communicating risk; (ii) identifying measures or metrics of resilience, including baseline conditions, milestones and definitions of the acceptable or unacceptable consequences of the identified risks; (iii) building or strengthening coalitions or partnerships in building community resilience; and (iv) sharing information or data related to better decision-making for building resilient communities.

The pilot project initially involves five steps, the first two of which have been implemented. First, a Roundtable subcommittee makes visits to engage different community groups including the business community – local corner stores as well as multinational chains; local government agencies; emergency managers and first responders; and the local chapters of community-based non-governmental organizations such as the American Red Cross, the United Way, Points of Light and the Boys & Girls Clubs of America. Separate discussions are held with each about their views on resilience and what elements of quality of life must be maintained during emergency. Around 70-100 people have participated in these conversations so far in Iowa and South Carolina.

Second, 70 people are invited to play a specially-developed "Extreme Events" game, in which everyone chooses a role (first responder, individual, elected official, etc.) in a fictional Coastal City and makes decisions as a scripted scenario unfolds that involves a hurricane and other surprises. The game takes the players through the efforts of finding, sharing and distributing resources. Its purpose is to break the ice and build trust among the members of each community. The game will also be made available online.

Third, a set of interactive table top exercises will be developed to understand and map the specific interdependencies in each community. The pilots have identified certain "community priorities" as a basis for this exercise: in Charleston and Iowa, economic drivers have emerged as community priorities; in Charleston, priorities include cultural identity and tourism and, in Iowa, the thrust is on grain production and export.

Fourth, the community participants will be helped to work through a scenario of a disrupting event in which critical infrastructure fails. The goal is to highlight critical nodes, networks and functions that act as amplifiers or dampeners as the effects of a disrupting event cascade through the system. Finally, the resulting disruption map will identify the nodes

that require hardening or redundancy and that will be used as a basis to design the community's resilience strategy.

In terms of barriers, the initiative relates to two overarching objectives: to build resilience at the community level; and, at a higher level, to gain insights into common themes and local variations on those themes to knit into a national or a larger-scale picture. Concerning the latter, the main challenge has, therefore, been to structure the pilot projects in such a way as to be able to glean common elements or themes from disparate communities. By using the same basic approach (the four pillars) in each community and seeing which elements of the framework play out, it is possible to understand the similarities and differences in how to build resilience and whether there are enough common issues that could be used as a basis to transfer the project to other communities. The big barrier for transferability would be if one were to find through the small sample that each community builds resilience in its own ways and that few or weak ties bind communities together.

Project-wise, the experience has shown so far that one of the main enabling factors for building community resilience to all kinds of risks is for the community to be functional and for the different pieces of that community to work together in a productive way. While a collegial and cooperative approach prevails in some communities from the outset, in others more time needs to be spent to build trust among different sectors and stakeholders. In addition, the key to maintaining momentum is local leadership: having somebody – whether an individual, an agency or an organization – take ownership of the community resilience strategy in a way that allows it to be resourced and maintained over time.

The Resilient America website (http://resilientamerica.nas.edu) facilitates connections among the three pilot and other communities and will share the resulting information and lessons learned. It is hoped that the Resilient America Roundtable's emphasis on risk communication and inclusive understanding of resilience will ultimately spark ideas for similar initiatives in other communities or countries.

## Practice 3: ZÜRS Public – Increasing Awareness of Flood Risk in Saxony – A Practice on Risk Communication[12]

In August 2002, severe floods affected practically two-thirds of the German state of Saxony (Figure 3.3 illustrates the rivers in Saxony, Germany). This disastrous event led to the development of the Flood Protection Investment Programme, which comprises 1,600 individual flood protection measures and 548 flood risk maps for all communities at risk. A statewide risk awareness campaign was also launched.

To better communicate on flood risks, in collaboration with the Ministry of Saxony, the German Insurance Association (GDV) developed an online geographic information system, ZÜRS Public, where homeowners, tenants and businesses can see an exact calculation of the risk exposure to flooding, backflow, torrential rain and earthquakes of their individual address.[13] While similar to other systems, such as Tiris in the Austrian region of Tyrol, it is innovative in its triangulation of data from insurers, the government and some 200 water management agencies across the federal states.[14] The results of this online risk information tool are easy to understand and free of charge.

Since its establishment in 2001, the ZÜRS Public online risk assessment tool has covered some 20 million home addresses, 200,000 km of rivers, and is available in Saxony, Lower Saxony and Saxony-Anhalt. The GDV is working to develop it into a standardized tool for all of Germany. Currently the tool is being developed in Rhineland-Palatinate and Bavaria.[15] Flood risk calculations are presented in four groups:

- high threat: statistically, floods occur at least once every 10 years
- medium threat: statistically, floods occur once every 10-50 years
- low threat: statistically, floods occur once every 50-200 years
- very low threat: statistically, floods occur less frequently than once every 200 years

The initiative aligned the interests of all stakeholders and illustrates the importance of risk communication. Citizens benefit by understanding more about their individual risk exposure. The insurance industry is incentivized to participate as the tool encourages households and businesses to think about their need for insurance. The state also benefits from individuals and businesses taking greater responsibility for risk prevention, both through private insurance and investment in physical prevention measures, as it reduces their potential liability in the event of disasters. To raise awareness further, the state government transparently publishes information online about applications for and disbursements of public compensation for private damages.

**Figure 3.3:** The Rivers in Saxony, Germany

## Conclusion

The three practices described in this section of the report illustrate how risk mitigation and resilience-building efforts can be driven by one stakeholder or can progress through a broad-based multistakeholder coalition. From an emphasis on data collection and analysis in the case of the Murray-Darling Basin, to community building around resilience in the United States and risk communication in Germany, they show how responses to environmental risks can be based at the community, regional or national levels, and highlight the importance of knowledge and capability transfer.

Building resilience means finding ways to change behaviours across sectors and systems, identifying the barriers that must be addressed and the enablers that should be leveraged. Readers of the *Global Risks* report are invited to submit suggestions for practices on risk management or risk resilience to be featured in future editions of the report.

## Endnotes

[1] Resilience is the ability of households, communities and nations to absorb and recover from shocks, while positively adapting and transforming their structures and means for living in the face of long-term stresses, change and uncertainty (Mitchell, 2013).

[2] IPCC, 2014.

[3] OECD, 2013.

[4] UN Water, 2013. UN-Water Thematic Factsheets.

[5] Sheffield, Wood and Roderick, 2012.

[6] Barnett and Adger, 2007.

[7] Gleditsch et al., 2006.

[8] See David Jean's article "Mannum's spirit returns as River Murray flows" in *The Australian*, 18 March 2013; http://www.theaustralian.com.au/news/mannums-spirit-returns-as-river-murray-flows/story-e6frg6n6-1226600145938?nk=ad67eceb8ab2d2391ee90a020efde1a1.

[9] CSIRO, 2008 ;

[10] Smajgl, A. et al., 2011.

[11] CSIRO, 2013.

[12] OECD, 2014.

[13] See https://www.zuers-solutions.de/platform/resources/apps/ZUERS_public/index.html?lang=de.

[14] See https://www.tirol.gv.at/statistik-budget/tiris/.

[15] See http://www.gdv.de/2013/06/zuers-public/.

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# Conclusion

Our lives are very different today from when the first *Global Risks* report was published a decade ago. Little did the world imagine the possibility of the implosion of global financial markets that plunged the world into a socio-economic crisis from which it is still struggling to emerge. The "real world" was nowhere near as interconnected with the virtual one: Twitter did not exist, Facebook was still a student-only service, and the iPhone and Android were still one and two years, respectively, away from their commercial release. The power of interconnectivity has since shown itself forcefully – be it from the convening power of the Arab Spring, the revelation of massive cyber espionage around the National Security Agency, or fast-moving developments in new disruptive business models that are fundamentally changing the global economic landscape.

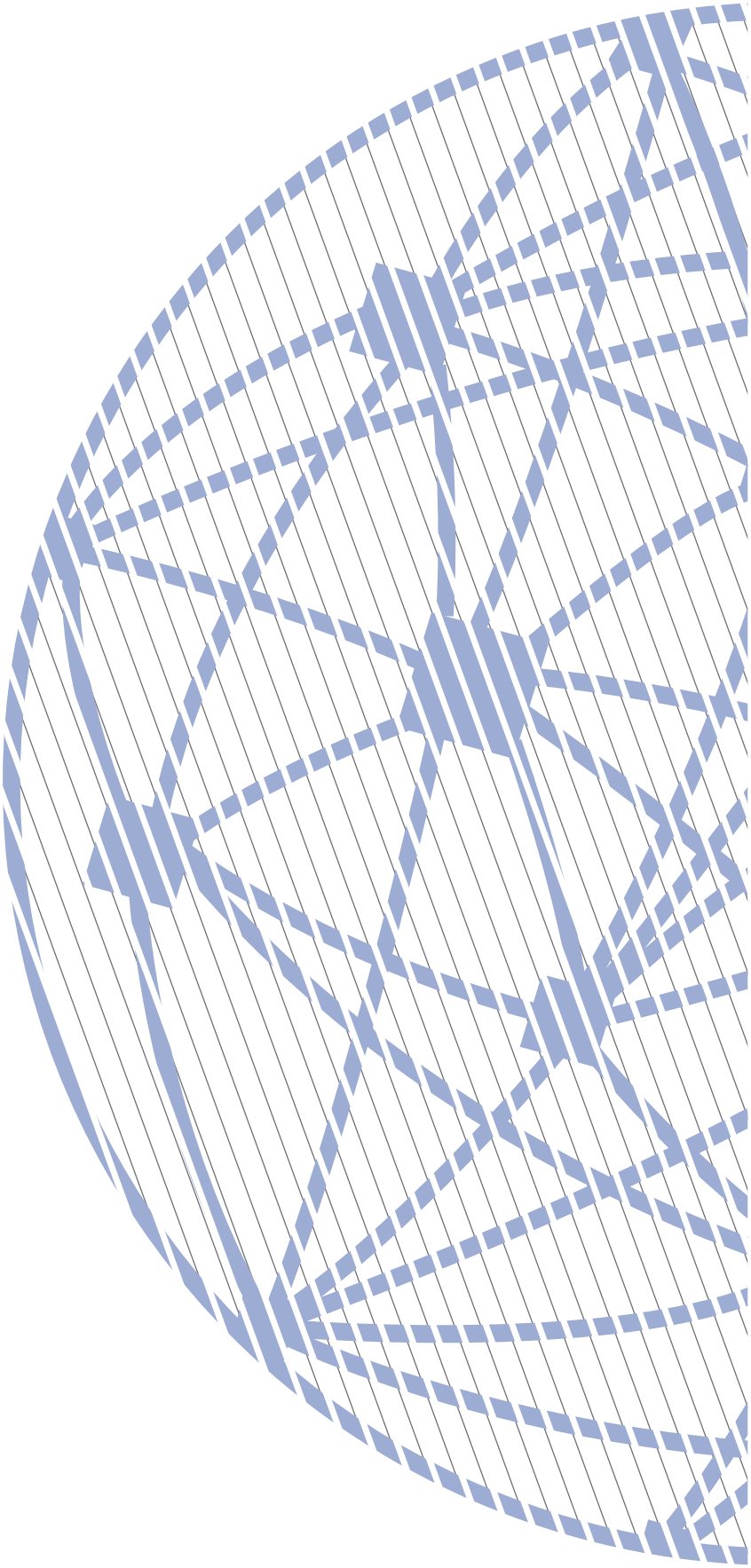
While increased interdependencies have brought the world closer together, the *Global Risks* report series emphasizes the other side of the coin: as people's lives are becoming more complex and more difficult to manage, businesses, governments and individuals alike are being forced to decide upon courses of action in an environment clouded by multiple layers of uncertainty. Indeed, understanding their implications and raising awareness of the interconnection of risks are at the basis of the *Global Risks* report. On the upside, however, the world has not stood still: the importance of risk management and the need to build resilience has since become a top issue for decision-makers who are recognizing that risks are no longer isolated but inherently dynamic in nature and crossing many spheres of influence. Against this backdrop, the need to collaborate and learn from each other is clearer than ever, an aspect that figures prominently in this year's report by featuring initiatives that have demonstrated value and good practices that can be replicated elsewhere.

Ten years of "doing risks" has also led to the recognition that a short-term vision prevents addressing long-term issues. Some slower-moving trends have continued inexorably: the last 10 years have brought conclusive proof that the earth's climate is changing and that human activities are to blame – yet

progress to mitigate greenhouse gas emissions remains frustratingly slow. This lesson is reflected this year in the introduction of different time horizons and the differentiation between risks and trends. Hopefully these innovations will help many public and private organizations around the world address this aspect of human nature in mitigating risks and building resilience.

Indeed, our self-perception as *homines economici* or rational beings has faltered in the aftermath of the financial crisis, whose effects are still unfolding socially, as persistent unemployment, ever-rising inequality, unmanaged migration flows and ideological polarization are among the factors stretching societies dangerously close to the breaking point. Social fragility is even threatening geopolitical stability, as breakdowns in cooperation within states make relations between states more difficult. And a quarter-century after the fall of the Berlin Wall, interstate conflict is once again one of the key risks in terms of likelihood and impact. Yet the means through which conflicts can be pursued are growing more varied, as this report has explored – from geo-economic tools, such as trade sanctions, to cyber attacks on critical infrastructure, to the potential for a new arms race in lethal autonomous weapons systems.

We are not powerless in the face of these concerns. As highlighted previously, multistakeholder collaboration and global governance are key to building resilience and mitigating risks. From major inter-governmental conferences in Sendai and Paris to the finalization of the Sustainable Development Goals, the year 2015 presents an unprecedented range of opportunities to take collective action to address global risks.



# Appendices

# Appendix A: Description of Global Risks and Trends 2015

**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.

**Table A.1:** Description of Global Risks 2015

| | Global Risk | Description |
|---|---|---|
| Economic Risks | Asset bubble 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 ultra-low inflation or deflation in a major economy or region |
| | Energy price shock to the global economy | Sharp and/or sustained energy price increases that place further economic pressures on highly energy-dependent industries and consumers |
| | Failure of a major financial mechanism or institution | Collapse of a financial institution and/or inefficient functioning of a financial system with implications throughout the global economy |
| | Failure/shortfall of critical infrastructure | Failure to adequately invest in, upgrade and secure infrastructure networks leads to a breakdown with system-wide implications |
| | Fiscal crises in key economies | Excessive debt burdens 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 |
| | Unmanageable inflation | Unmanageable increase in the general price level of goods and services in key economies |
| Environmental Risks | Extreme weather events (e.g. floods, storms, etc.) | Major property, infrastructure and environmental damage as well as human loss caused by extreme weather events |
| | Failure of climate-change adaptation | Governments and businesses fail to enforce or enact effective measures to protect populations and to help businesses impacted by climate change to adapt |
| | Major biodiversity loss and ecosystem collapse (land or ocean) | Irreversible consequences for the environment resulting in severely depleted resources for humankind as well as industries such as fishing, forestry, pharmaceuticals |
| | Major natural catastrophes (e.g. earthquake, tsunami, volcanic eruption, geomagnetic storms) | Major property, infrastructure and environmental damage as well as human loss caused by geophysical disasters such as earthquakes, volcanic activity, landslides, tsunamis or geomagnetic storms |
| | Man-made environmental catastrophes (e.g. oil spill, radioactive contamination, etc.) | Failure to prevent major man-made catastrophes causing harm to lives, human health, infrastructure, property, economic activity and the environment |

| | Global Risk | Description |
|---|---|---|
| Geopolitical Risks | Failure of national governance (e.g. corruption, illicit trade, organized crime, impunity, political deadlock, etc.) | Failure of national governance (e.g. corruption, illicit trade, organized crime, impunity, political deadlock, etc.) |
| | Interstate conflict with regional consequences | A bilateral or multilateral dispute between states 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 successfully inflict large-scale human or material damage |
| | State collapse or crisis (e.g. civil conflict, military coup, failed states, etc.) | State collapse of geopolitical importance due to internal violence, regional or global instability and military coup, civil conflict, failed states, etc. |
| | Weapons of mass destruction | Nuclear, chemical, biological and radiological technologies and materials are deployed creating international crises and potential for significant destruction |
| Societal Risks | Failure of urban planning | Poorly planned cities, urban sprawl and associated infrastructure create social, environmental and health challenges |
| | Food crises | Access to appropriate quantities and quality of food and nutrition becomes inadequate, unaffordable or unreliable on a major scale |
| | Large-scale involuntary migration | Large-scale involuntary migration due to conflict, disasters, environmental or economic reasons |
| | Profound social instability | Major social movements or protests (e.g. street riots, social unrest, etc.) disrupt political or social stability, negatively impacting populations and economic activity |
| | Rapid and massive spread of infectious diseases | Bacteria, viruses, parasites or fungi cause uncontrolled spread of infectious diseases (for instance due to 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 Risks | Breakdown of critical information infrastructure and networks | Systemic failures of critical information infrastructure (e.g. Internet, satellites, etc.) and networks negatively impact industrial production, public services and communications |
| | Large-scale cyber attacks | State-sponsored, state-affiliated, criminal or terrorist large-scale cyber attacks cause an infrastructure breakdown and/or loss of trust in the Internet |
| | Massive incident of data fraud/theft | Criminal or state-sponsored wrongful exploitation of private or official data takes place on an unprecedented scale |
| | Massive and widespread misuse of technologies (e.g. 3D printing, artificial intelligence, geo-engineering, synthetic biology, etc.) | Massive and widespread misuse of technologies, such as 3D printing, artificial intelligence, geo-engineering and synthetic biology, causing human, environmental and economic damage |

**Trends**
A trend is defined as a long-term pattern that is currently taking place and that could contribute to amplifying global risks and/or altering the relationship between them.

**Table A.2:** Description of Trends 2015

| Trend | Description |
|---|---|
| Ageing population | Ageing of populations in developed and developing countries driven by declining fertility and decrease of middle- and old-age mortality |
| Climate change | Change of climate attributed directly or indirectly to human activity that alters the composition of the global atmosphere and which is in addition to natural climate variability |
| Environmental degradation | Deterioration in quality of air, soil and water from ambient concentrations of pollutants and other activities and processes |
| Growing middle class in emerging economies | Growing share of population reaching middle-class income levels in emerging economies |
| Increasing national sentiment | Increasing national sentiment among populations and political leaders affecting countries' national and international political positions |
| Increasing polarization of societies | Inability to reach agreement on key issues within countries due to diverging or extreme values, political or religious views |
| Rise of chronic diseases | Increasing rates of non-communicable diseases, also known as chronic diseases, leading to long-term costs of treatment threatening recent societal gains in life expectancy and quality, placing a burden on economies |
| Rise of hyperconnectivity | Increasing digital interconnection of people and things |
| Rising geographic mobility | Increasing mobility of people and things due to quicker and better performing means of transport and lowered barriers |
| Rising income disparity | Increasing socio-economic gap between rich and poor in major countries or regions |
| Shifts in power | Shifting power from state to non-state actors and individuals, from global to regional levels, and from developed to emerging market and developing economies |
| Urbanization | Rising number of people living in urban areas, resulting in the physical growth of cities |
| Weakening of international governance | Weakening or inadequate global or regional institutions' (e.g. the UN, IMF, NATO, etc.) agreements or networks, and loss of trust in them, increasing the global power vacuum and preventing effective solutions to global challenges |

# Appendix B: The Global Risks Perception Survey 2014 and Methodology

As discussed in Part 1, the Global Risks 2015 methodology was reviewed last year for this edition. A number of workshops, interviews and discussions were held with experts and with the Advisory Board, taking into account lessons from past editions as well as developments in the global risks landscape. The concept of trends was introduced in both the survey and the report and some of the global risks analysed in the past were relabelled and classified under a different category or better defined as trends.

The Global Risks Perception Survey (GRPS or survey) was adjusted accordingly to capture the main aspects of both risks and trends and to assess their interconnectedness and impact on societies. The following section describes the survey and methodology in greater detail.

## The Global Risks Perception Survey

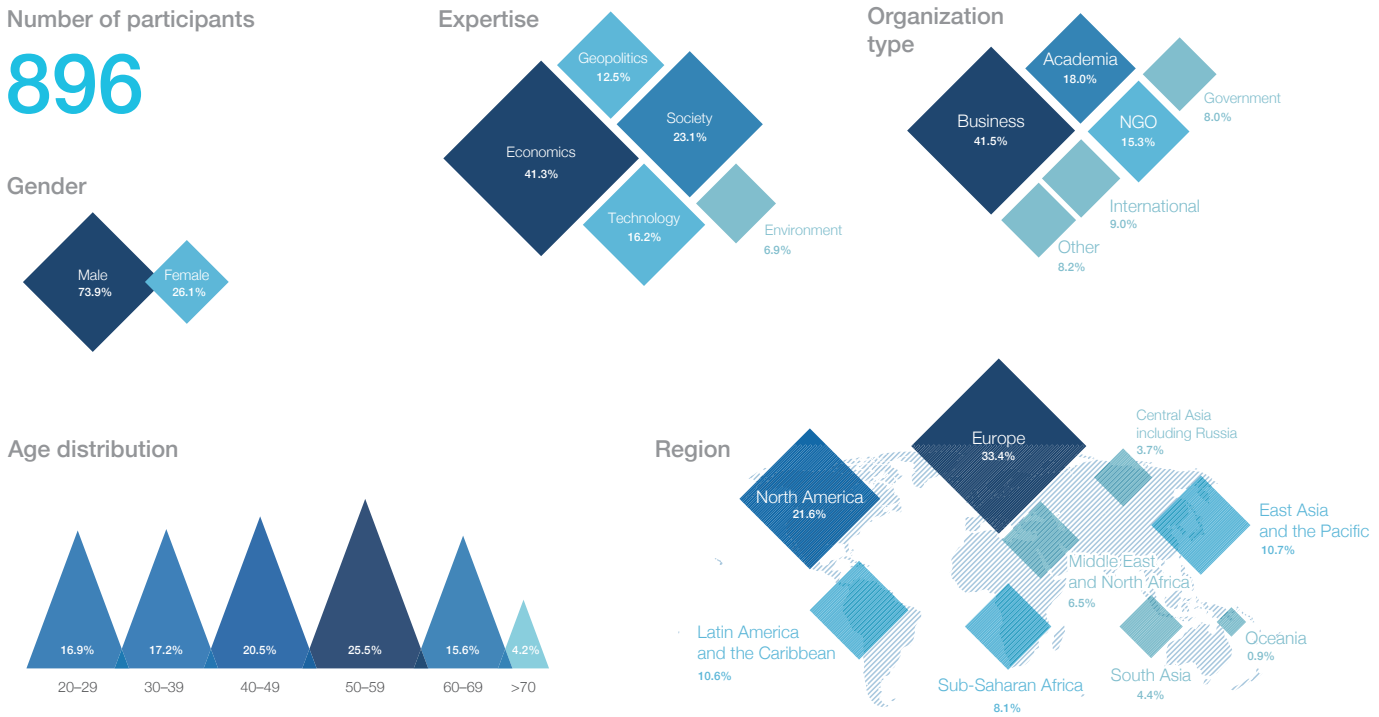
The Global Risks Perception Survey, discussed in Part 1, is the main instrument for assessing global risks and trends in this report. The survey was conducted between mid-July and the end of September 2014 among the World Economic Forum's multistakeholder communities of leaders from business, government, academia and non-governmental and international organizations.[1]

Raw responses were cleaned to improve overall data quality and completeness. All questionnaires with a completion rate of below 50% were dropped, reducing the number of available responses from 1,120 to 896.

In 12 cases, the respondent did not provide any information about gender, but it was possible to infer this information from the other records provided (first and last names). Similarly, 101 respondents did not indicate the region in which they are based and were manually assigned to one on the basis of their country of residence. Among the respondents, 43% completed the survey last year. Details of the sample composition are reported in Figure B.1.

The graph below shows the profile of the 896 survey respondents. To capture the voice of youth, the survey also targeted the World Economic Forum's community of Global Shapers.[2] Those under 30 years of age accounted for approximately one-fifth of respondents.

**Figure B.1:** The Global Risks Perception Survey Sample Composition




Source: Global Risks Perception Survey 2014, World Economic Forum.
Note: Reported shares are based on number of valid responses: Gender: 895 responses; Expertise: 883; Organization type: 885; Age distribution: 882; Region: 847.

## The Global Risks Landscape 2015 (Figure 1)

Respondents were asked to assess the likelihood and global impact of each of the 28 risks. For each risk, they were asked, "How likely is this risk to occur globally within the next 10 years?" and "What is the estimated impact globally if this risk were to materialize? (Impact is to be interpreted in a broad sense beyond just economic consequences)". The possible answers ranged from 1 ("very unlikely" and "low" impact, respectively) to 7 ("very likely" and "high" impact, respectively). Respondents were given the possibility to choose a "Don't know" option if they felt unable to provide an informed answer. For each risk, partial responses, i.e. those assessing only the likelihood or only the impact, were dropped. A simple average for both likelihood and impact for each of the 28 global risks was calculated on this basis. Formally, for any given risk *i*, its likelihood and impact, denoted as $likelihood_i$ and $impact_i$, respectively are:

$$likelihood_i = \frac{1}{N_i}\sum_{n=1}^{N_i} likelihood_{i,n}$$

$$impact_i = \frac{1}{N_i}\sum_{n=1}^{N_i} impact_{i,n}$$

where $likelihood_{i,n}$ and $impact_{i,n}$ are respectively the likelihood and impact assigned by respondent n to risk i and measured on a scale from 1 to 7. $N_i$ is the number of respondents for risk i who assessed both the likelihood and impact of that risk.

## The Global Risks and Risks-Trends Interconnections Maps (Figures 2 and 3)

To draw the global risks interconnections map presented in Part 1, survey respondents were asked to answer the following question: "In your view, which are the most **strongly connected** risks? Please select at least three pairs and up to six pairs from the 28 risks below."

In addition, respondents were asked to identify three to six pairs of strongly connected trends and risks, disregarding directions of causality. This question read: "In your view, which trends are the most **strongly connected** with risks? Please select at least three pairs and up to six pairs from the 13 trends below (you can select the same trend and risk more than once)." The information thus obtained was used to construct the risks-trends interconnections map included in the inside cover flaps of the report.

In both cases, a tally was made of the number of times each pair was cited. To obtain *normalized connection weights*, this value was divided by the count of the most frequently cited pair and, in addition, this ratio was square-rooted to dampen the long-tail effect (i.e. a few very strong links, and many weak ones) for display and presentation purposes. Of the 378 possible pairs of risks, 122, or 32%, were not cited. Similarly, of the possible 364 trend-risk combinations, 116, or 32%, were not cited. Formally, the intensity of the interconnection between risks *i* and *j* (or between trend *i* and risk *j*), denoted as $interconnection_{ij}$, corresponds to:

$$interconnection_{ij} = \sqrt{\frac{\sum_{n=1}^{N} pair_{ij,n}}{pair_{max}}}$$

$$\text{with } pair_{max} = \max_{ij}\left(\sum_{n=1}^{N} pair_{ij,n}\right)$$

where *N* is the number of respondents. Variable $pair_{ij,n}$ is 1 when respondent *n* selected the pair of risks *i* and *j* as part of his/her selection. Otherwise, it is 0. The value of the interconnection determines the thickness and brightness of each connecting line in the graph, with the most frequently cited pair having the thickest and brightest line.

In the global risks and risks-trends interconnections maps (Figures 2 and 3), the area of each node (corresponding to a risk or a trend) is scaled according to the number of times the corresponding risk or trend was cited as a part of the connection pair.

The placement of the nodes was computed using ForceAtlas2, a force-directed network layout algorithm implemented in Gephi software, which minimizes edge lengths and edge crossings by running a physical particle simulation.[3]

## The Risks of Highest Concern (Figure 1.1)

Although the report generally focuses on a time horizon of 10 years, respondents were asked to identify the risks of highest concern within two different time frames: 18 months and 10 years. To identify the top 10 global risks of highest concern, described in Part 1, respondents answered the following question: "In this survey, we are looking at risks within the next 10 years. For this question only, please select the five global risks that you believe to be of most concern within the next 18 months and 10 years, respectively." For any given risk *i* from the list of 28 risks, the share of total respondents (*N* = 896) that declared being concerned about that risk was derived as follows:

$$\%\ concern_i = \frac{1}{N}\sum_{n=1}^{N} c_{i,n}$$

with $c_{i,n}$ equal to 1 if respondent *N* selected risk *i* as a risk of concern and 0 otherwise. The risks with the 10 highest shares were selected as the risks of most concern.

## Progress and Preparedness (Figure 1.7 and Figure 3.1)

Survey respondents were asked to identify up to three risks for which they felt most progress to address them has been made over the past 10 years. Similarly, they were asked to select up to three risks which they believed their region was least prepared for.[4]

For any given risk *i* from the list of 28 risks, the share of total respondents (*N* = 896) who think that most progress has been made in addressing that risk was calculated as follows:

$$\%\ progress_i = \frac{1}{N}\sum_{n=1}^{N} p_{i,n}$$

with $p_{i,n}$ equal to 1 if respondent *N* selected risk *i*, and 0 otherwise.

Similarly, the share of total respondents who thought that their region is least prepared for risk *i* was obtained:

$$\%\ preparedness_i = \frac{1}{N}\sum_{n=1}^{N} r_{i,n}$$

with $r_{i,n}$ equal to 1 if respondent *N* selected risk *i*, and 0 otherwise.

# Appendix C: The Executive Opinion Survey and Views of the Business Community on the Impact of Global Risks on Their Business

Every year since 1979, the World Economic Forum conducts the Executive Opinion Survey (EOS). This survey captures invaluable information on a broad range of socio-economic issues. In the 2014 edition, over 13,000 executives in 144 economies were surveyed.[5]

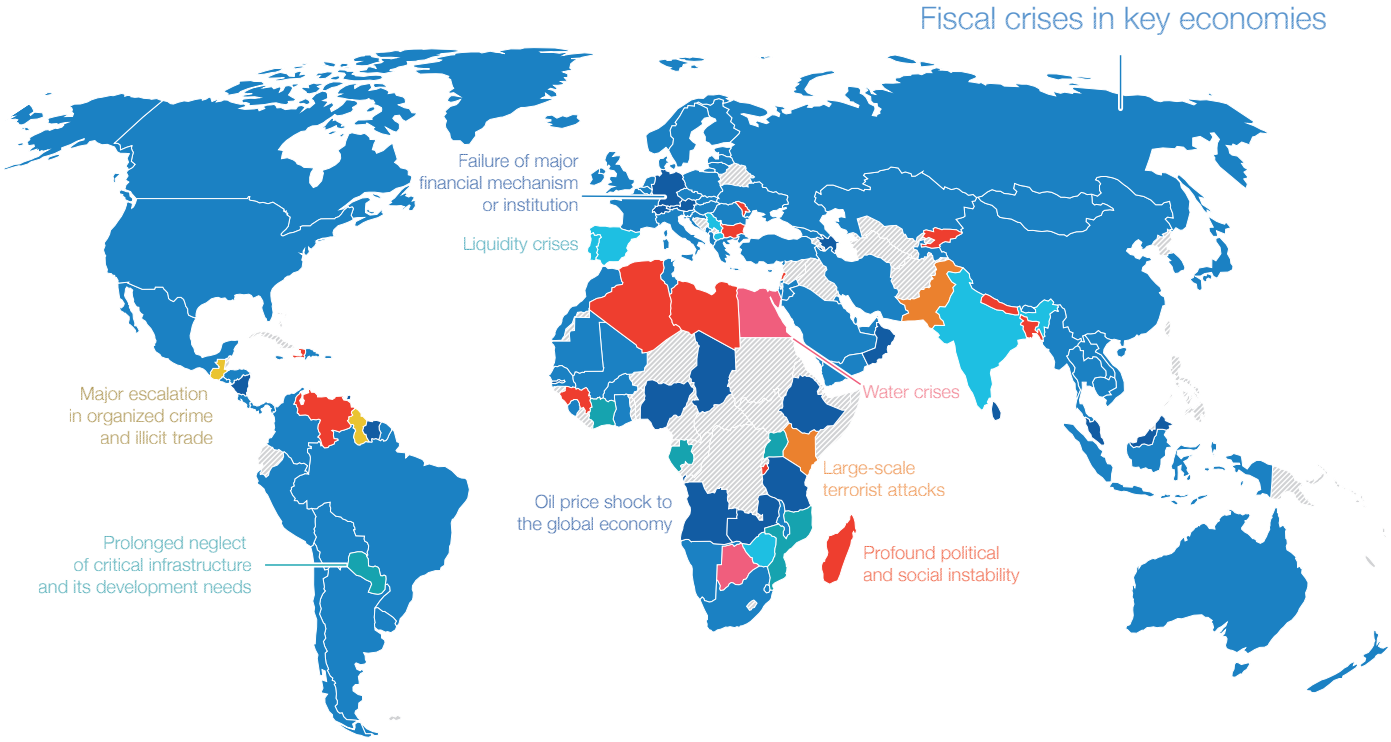
The 2014 edition of the EOS, conducted between February and May 2014, for the first time included a question on the risks of biggest concern. More specifically, respondents were asked to select the five global risks that they were most concerned about for doing business in *their country* and to rank these five risks from 1 (for the one of highest concern) to 5 (for the one of lowest concern).

This list of 19 global risks (Table C.1) in the EOS is different from that used in the present report, although a majority of risks on the former list do appear on the latter, albeit slightly reformulated in some cases. The EOS list was established before the Global Risks Perception Survey (GRPS) methodology was reviewed and a number of risks were redefined or excluded and others were introduced. In addition, whereas the GRPS was agnostic about the impact of global risks on a particular group, the EOS question specifically asked about the impact on the ability to do *business* in the respondent's country. Furthermore, the EOS did not specify any time horizon, unlike the GRPS which considered a 10-year horizon. Finally, the size and nature of the two samples of respondents differed significantly: a multistakeholder group of experts in the case of the GRPS and business executives in the case of the EOS.

For these reasons, the results of the GRPS and EOS are not strictly comparable. Instead, the EOS results provide a complementary perspective – that of businesses on the impact of global risks on their businesses.

To rank the 19 risks based on the level of concern, each received a score derived from the rank assigned by respondents, from 5 for the risk the respondent ranked first, to 1 for the risk ranked fifth (all non-cited risks were assigned a score of zero). As a second step, for each economy the sum of points obtained by each risk across all responses from that economy was divided by the total of points distributed across all risks in the economy. The risk score thus obtained was used to establish a country-level ranking.[6]

**Figure C.1:** Global Risks of Highest Concern for Doing Business, Per Country




Source: Executive Opinion Survey 2014, World Economic Forum.
Note: Only risks that are of highest concern in at least two countries are represented on the map. Other risks of highest concern: Violent interstate conflict (in Armenia), Breakdown of critical information infrastructure and networks (Cameroon), Escalation of economic and resource nationalization (Lesotho), and Greater incidence of environmentally-related events (Philippines).

Figure C.2 reports the results at the global level, as well as for the two main development status groups, *advanced economies* and *emerging market and developing economies*.[7] Aggregate scores correspond to the average scores of each risk across all economies belonging to the group of interest.

Figure C.1 shows a snapshot of the data on a map. Based on the results, fiscal crises is the risk of highest concern for doing business in 93 (65%) of the 144 economies covered by the survey, well ahead of oil price shock and profound political and social instability, both of which come first in 13 economies (9%). The map in Figure C.1 is shaded according to the risk of highest concern. Within a troubled geopolitical context, a fragile and uneven recovery in advanced economies, and a slowdown in many emerging economies, it is not surprising that economic risks are those of most immediate and highest concern to businesses.

In advanced economies, concerns about economic risks are even higher. Fiscal crises is the risk of highest concern in 30 of the 35 advanced economies. In Austria, Germany and Switzerland, failure of a major financial mechanism or institution is the one of highest concern, whereas liquidity crises is the risk of top concern in Portugal and Spain.

Among emerging market and developing economies, fiscal crises is the risk of highest concern – by far – but oil price shock comes second, followed by liquidity crises. Prolonged neglect of critical infrastructure ranks fourth; a major obstacle to business development, economic integration and trade performance, it is the main concern in Côte d'Ivoire, Mozambique, Paraguay and Uganda.

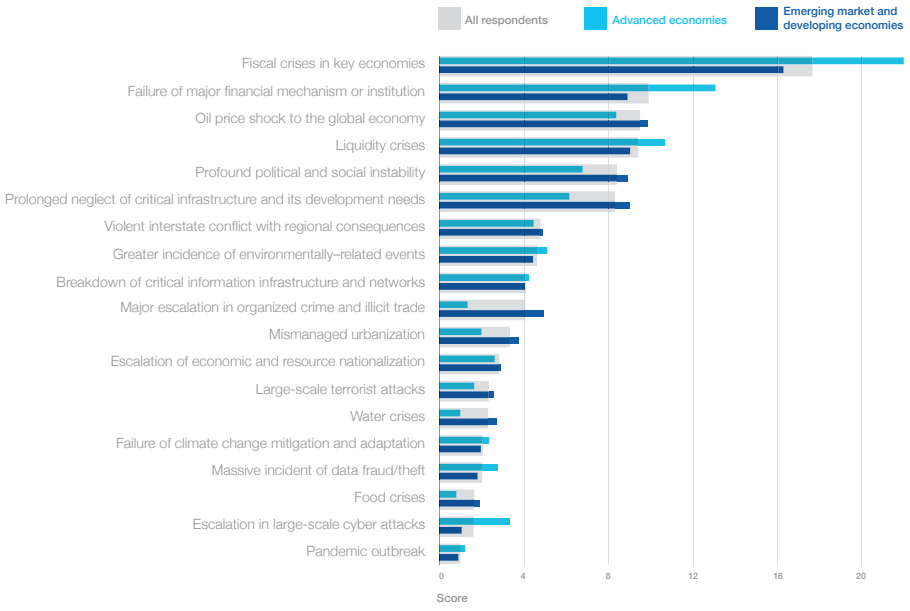
Interested readers can visit the *Global Risks* report's portal at www.weforum.org/risks to access the results for individual economies and regions.

**Table C.1:** The Executive Opinion Survey 2014 List of 19 Global Risks

| |
|---|
| Fiscal crises in key economies* |
| Failure of a major financial mechanism or institution* |
| Liquidity crises |
| Oil price shock to the global economy** |
| Prolonged neglect of critical infrastructure and its development needs** |
| Greater incidence of environmentally related events (weather, natural catastrophes, man-made catastrophes)** |
| Water crises* |
| Failure of climate-change mitigation and adaptation** |
| Major escalation in organized crime and illicit trade |
| Large-scale terrorist attacks* |
| Violent interstate conflict with regional consequences** |
| Escalation of economic and resource nationalization |
| Food crises* |
| Pandemic outbreak** |
| Profound political and social instability** |
| Breakdown of critical information infrastructure and networks* |
| Escalation in large-scale cyber attacks** |
| Massive incident of data fraud/theft* |
| Mismanaged urbanization** |

* denotes risks included in both the Global Risks Perception Survey and the Executive Opinion Survey
** denotes risks whose definition was redefined for the Global Risks Perception Survey 2014
Source: Executive Opinion Survey 2014, World Economic Forum.

**Figure C.2:** Global Risks of Highest Concern for Doing Business, for Advanced Economies and Emerging Market and Developing Economies




Source: Executive Opinion Survey 2014, World Economic Forum.
Note: From the list of global risks above, respondents were asked to select the five global risks of highest concern for doing business in their country and to rank them between 1 (most problematic) and 5. The bars in the figure show the responses weighted according to their rankings.

## Endnotes

[1] See http://www.weforum.org/communities
[2] The Global Shapers Community is a network of hubs developed and led by young people who are exceptional in their potential, achievement and drive to make a contribution to their communities. See http://www.weforum.org/community/global-shapers.
[3] See Jacomy et al., 2012.
[4] Respondents could select the region they were based in from the following list: Europe, Central Asia including Russia, East Asia and Pacific, South Asia, Sub-Saharan Africa, Middle-East and North Africa, Latin America and the Caribbean, North America, and Oceania.
[5] For more information about the Survey, see Browne et al. 2014.
[6] By construction in each economy, the sum of risk scores is therefore 100.
[7] Development status classification is from the International Monetary Fund (situation as of April 2014).

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