FUTURE EARTH

RISKS PERCEPTIONS REPORT 2020

1st Edition

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Executive Summary

As humanity's size and impact on the planet grows, so too do the risks we face. Global risks are becoming increasingly complex and interrelated, challenging the ability of any one community to accurately and legitimately appraise them. This report aims to bring the voices of scientists into the growing dialogue on global risks by capturing and synthesizing input from the global change science community. This community spans physical, natural and social sciences and its explicit focus on interactions amongst natural and social systems provides a unique perspective that can help to deepen our understanding of global risks and their interconnections.

In this report we summarize key findings from a survey on global risks perceptions of over 200 global change scientists[1] from 52 countries. A key message emerging from the survey is that there are strong interconnections among a particular set of global risks: *climate change*, *extreme weather*, *biodiversity loss*, *food crises* and *water crises*. Scientists identified these five global risks as having the greatest potential for synergistic effects that could lead to a global systemic crisis. Four of them were also perceived as the most urgent risks facing us in the coming decade. Together these five risks threaten the continued integrity of the biosphere and its capacity to support itself and human life. This collective perspective underscores the crucial need to consider societal risks and environmental risks jointly rather than in isolation.

Scientists further stressed the *failure to adequately address and mitigate climate change* as a critical global risk across many different sections of the survey. As well as being ranked among the top most likely and most impactful risks by surveyed scientists, *climate change* was also the most frequently included global risk in the sets of risks with the potential to lead to a global systemic crisis. Furthermore, it was highlighted, alongside *biodiversity loss* and *ecosystem collapse*, as a key global risk that we are committing to today, that will put us on a path to irreversible and devastating change. These results are even more worrisome in light of the serious concerns that scientists have raised about our capacity to keep global temperature rise below 2ºC of warming.

The next decade will be critical for ensuring a more secure, prosperous and equitable world. However, there is a growing existential threat to humanity being driven by the increasing frequency and intensity of global risks and their interconnections. To address this, we need to open the dialogue on risk to a diversity of voices, allowing us to assess a complex issue from multiple perspectives. Ultimately, we strive to enrich our understanding of risks through dialogue and to move the global narrative towards common solutions. We hope this report, and future iterations, will help move us forward on this path.

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[1] Scientists were defined as respondents with at least a Master's degree and one or more years of experience working in their area of expertise.

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Motivation for the Report

There is increasing recognition across multiple sectors of society that the global risks we face are increasingly complex, uncertain, and systemic. Understanding global risks is essential to effectively respond to and govern them. Future Earth's Global Risks Perceptions Initiative strives to capture and analyze the perceptions on global risks of multiple scientific communities. Our aim is to spark and inform a more pluralistic dialogue around risks that draws on a diversity of experience and knowledge.

In this report, we capture and summarize the perceptions of the global change scientific community on global risks and their interconnections. The global change community represents a body of scientists at the forefront of research into planetary-level changes in the Earth system – in both natural and human systems. As such, it has a significant voice to add to the conversation on global risks in its capacity to provide science-informed perspectives. This report complements other major risk assessments conducted with other communities to start a conversation on our respective perceptions of risk. Ultimately, we strive to enrich our understanding of risks through dialogue. This report, and future iterations of it, are important for cultivating global narratives for solutions.

Rationale

How we perceive risk affects how we act on it[2].

It is critical that we accurately assess the full range of risks to humanity and the planet. Over the past 15 years, dialogues and framings of global risks have been strongly shaped by the World Economic Forum's annual Global Risks Report, which surveys the global risks perceptions of world leaders from business, academic, and policy spheres. Yet, as global risks become increasingly complex and interrelated, our ability to accurately and legitimately appraise these risks requires a wider range of communities assessing them.

Around the world, people's vulnerability to hazards differs based on their location, socio-economic status, gender, age, education, cultural background, and a number of other factors. Only through more inclusive dialogues and a stronger understanding of the forces that shape our perceptions of risk can different segments of society jointly move towards developing common strategies to mitigate and adapt to them. Such collective action will only come about when there is a common and shared sense of risk.

Through the Global Risks Perceptions Initiative, Future Earth is working to bring more voices into the global dialogue on risks through expert community surveys, facilitated online dialogues, and new partnerships. This inaugural edition of the Future Earth Risks Perceptions Report 2020 presents the results from the 2019 Global Risks Scientists' Perception survey.

[2] See, for example, Slovic, P. (Ed.). 2000. *The Perception of Risk*. London, England: Earthscan Publications.

Introduction

Scientists warn that humanity has already crossed several planetary boundaries and our impact continues to increase at an exponential rate (Steffen et al. 2015). Today, people and societies are far more interconnected than at any time in our history. Vast networks of global trade, transportation, and telecommunication connect the over seven billion people on the planet. New technologies, economic structures, and cultural norms are changing the fundamental way that humans relate to each other and to nature. As we rapidly transform the world we live in, some outcomes are predictable, but many are not. Understanding and predicting the implications of these transformations more effectively will help us move towards a more secure and sustainable future.

Today, the effects of local disasters can be propagated much further and faster through hyper-connected social, economic, and technological networks. Outbreaks of diseases can quickly jump borders and continents through air travel (e.g. H1N1, SARS, Ebola, coronavirus), social media can ignite and unite social movements across disparate communities (e.g. Arab spring, Fridays4Future), and the downturn of regional economies can have knock-on effects through the global trade system (e.g. US-China trade dispute has reduced global container shipping and has shifted production to other countries in southeast Asia). In addition, the impacts of many disruptions can ripple across multiple systems creating knock-on effects across social, economic, environmental, technological and geopolitical dimensions.

The distance and speed at which these impacts of disruptions and disasters can propagate make it increasingly difficult to predict and effectively mitigate such risks. In addition, dynamics in many of our systems are coupled across large distances ('tele-connected') challenging our capacity to link action and outcome in order to anticipate these risks. Taking a complex systems approach to understanding how risks are interconnected is critically important for developing better prediction, protection, and prevention policies (Keys et al. 2019).

The perspectives of science and scientists are critical to balanced discourse around global risks. Many global change scientists are trained to understand the world as a complex system, where outcomes can be greater than the sum of individual events. Furthermore, many fields of study explicitly look at the processes and causes underpinning the onset of disruptive events and their knock-on effects. Together, this community can provide vital insights into the major risks facing humanity and how they can be managed.

To capture these perceptions, Future Earth conducted the first Global Risks Scientists' Perception Survey in fall 2019. We surveyed over 220 global change scientists in more than 52 countries with expertise spanning the natural, physical, and social sciences. The survey gathered information on the perceptions of experts on the top global risks facing humanity and their interconnections in order to help bring scientific voices and knowledge into the broader global dialogue on risks.

Scientists' Perceptions of Global Risks

A clear warning emerged from the Global Risks Scientists' Perception survey of global change scientists: that the climate crisis poses a serious threat to global security and prosperity. Regardless of background or area of expertise, global change scientists resoundingly pointed to the *failure of climate change adaptation and mitigation* as a central and interconnected risk facing humanity. Failure to effectively and adequately address climate change was seen as the risk most likely to lead to a global systemic crisis through its interactions with *extreme weather*, *biodiversity loss*, and *food crises* and *water crises* over the coming decade. It was also the mostly highly cited risk to which we may be "locking-into" over the next 10 years.

In general, the global change scientific community perceived these top risks as more likely and more impactful than members of the business community surveyed by the World Economic Forum for the same risks (WEF 2020). While the landscapes of identified top risks were similar between the two communities, the business community's overall perception of the potential for these risks were consistently lower (Garschagen et al. 2020, *in press*). This difference is important as a significant amount of research has shown that risk perception is a key determinant of action for risk reduction (Renn 2017, Ostrom 1990). If world leaders and executives do not sense an urgency around these risks, they are unlikely to take the necessary steps to address them. Without a shared sense of urgency across communities, it will continue to be difficult to mobilize global collective action to effectively mitigate and adapt to climate change (Garschagen et al. 2020, *in press*).

Finally, the global change scientists recognized strong interconnections and feedbacks between societal and environmental risks. *Climate change*, *extreme weather* events and *biodiversity loss* were strongly linked to *food crisis* and *water crises*, but also to *involuntary migration*, *social instability*, and the *failure of national* and/or *regional governance*. Together these paint a

picture of how the breakdown of the ecological systems which underpin society could themselves lead to a wider societal crisis. This message reflects the growing body of scientific literature and a more widespread understanding of deep dependence of our societies upon a healthy and functioning ecosystem (MEA 2005, IPBES 2019).

Top Global Risks

In the Risks Perceptions Report 2020, environmental and societal risks emerged as the top risks facing humanity in the decade to come. Of the 30 global risks considered, the top eight ranked by scientists were either categorized as Environmental or Societal risks and were seen to be *Likely* with the potential for *Major* to *Severe* impacts across multiple countries (Figure 1). Of these, *extreme weather* events stood out as the top ranked global risk for both likelihood and impact. This is perhaps not surprising given the high number of heatwaves, floods, and droughts which made headlines across many parts of the world (e.g. Europe, India and Australia).

The next most highly ranked risks by scientists were *biodiversity loss*, *water crises*, and *climate change*. These were followed by *food crises, natural disasters* and *involuntary migration*. The findings reinforce the importance of both environmental and social systems for global security. The likelihood and impact associated with most geopolitical, technological and economic risks were ranked much lower.

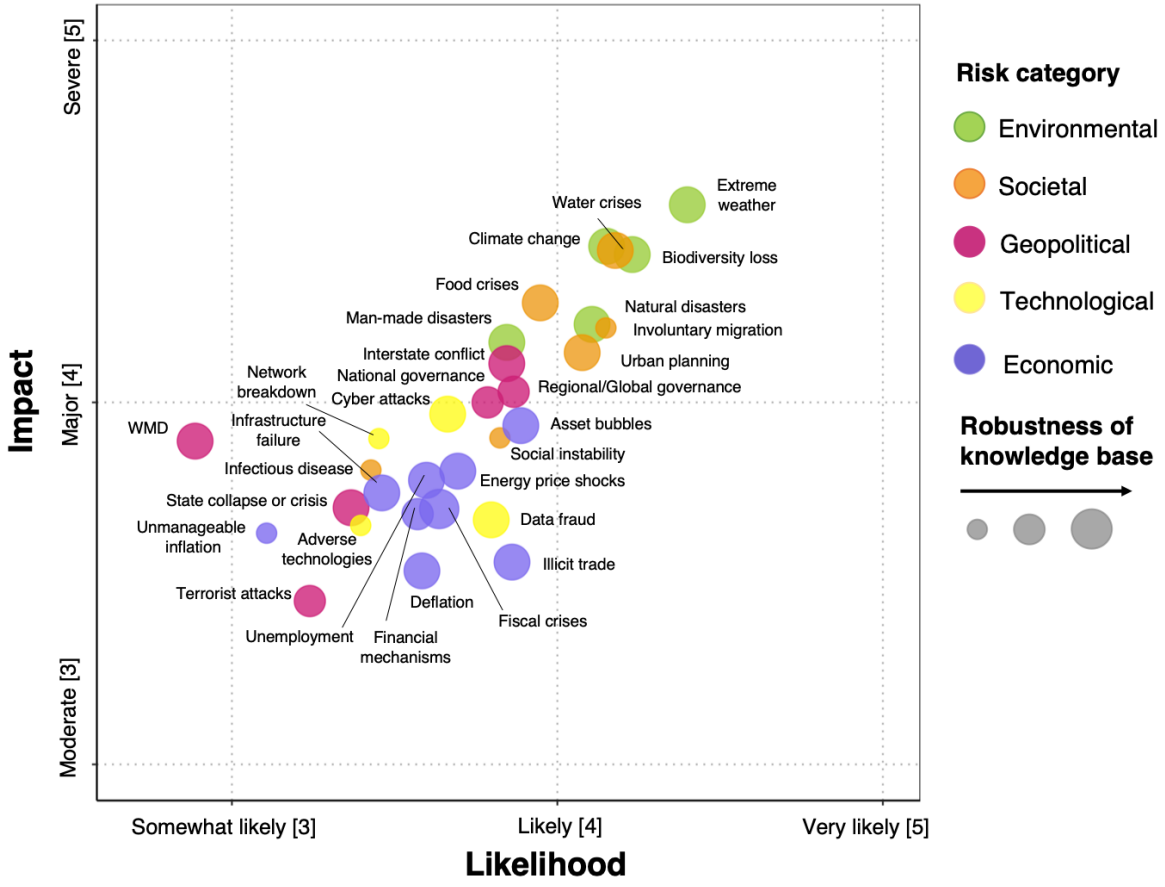

Figure 1. Mean ranked likelihood and impact of global risks, plus robustness of the knowledge base surrounding each risk (size of the circle), for the 30 global risks in 5 categories (risk types). Shorthandle names are used for risks, full names are available in Table 1.

Box 1. Top-ranked global risks

Top risks by likelihood	Top risks by impact
1. Extreme weather	1. Extreme weather
2. Biodiversity loss	2. Climate change
3. Water crises	3. Water crises
4. Climate change	4. Biodiversity loss
5. Urban planning	5. Food crises
6. Man-made disasters	6. Man-made disasters
7. Involuntary migration	7. Urban planning
8. Food crises	8. Natural disasters
9. Asset bubbles	9. Involuntary migration
10. Illicit trade	10. Interstate conflict

In Box 1, the top ten global risks are ranked by mean perceived likelihood of occurrence and impact in the next 10 years. There is a significant overlap between the two lists showing a potentially worrisome congruence that the most likely risks are also those with the greatest perceived impact.

Global Systemic Risks

In general, people tend to take a reductionist approach to risk mitigation, focusing on major, isolated risks such as earthquakes or terrorist attacks, and their prevention. However, the world is highly interconnected through flows of people, materials, and information that interact across small and vast distances alike. It is a complex system within which dynamics are interdependent and difficult to predict. In such systems, even relatively minor shocks or disruptions can propagate in unexpected ways and cause cascades of interdependent failures (Helbing 2013).

However, when a system is organized as a network of networks, the interdependencies between different kinds of systems – e.g. social, economic, environmental – imply a higher degree of risk (Buldyrev et al. 2010, Gao et al. 2011). When cascades flow across networked systems and/or regions, the result is likely to be a 'systemic crisis' – or in some cases even, the meltdown of single systems or subsystems. In order to design effective risk mitigation policies that protect societies and the planet from such global or regional crises, policymakers need to understand which risks are interconnected and which sets of risk pose the greatest threats to the stability and security of our planet and society.

We asked scientists to identify the set of global risks that they perceived to have the greatest likelihood to have interdependent and synergistic effects that could lead to a global systemic crisis. Across responses global change scientists identified five central interconnected risks likely to have synergistic effects: *climate change – extreme weather – biodiversity loss – food crises – water crises* (Figure 2). Together these five risks underpin the continued integrity of the biosphere and its capacity to provide the fundamentals of life to humanity – food and water. Concerningly, four of these five risks were also among the top ranked global risks in terms of their individual likelihood and impact (Box 1).

A significant body of science already exists on the interdependencies between and among these risks. Climate change has driven and will continue to increase the frequency and intensity of many extreme weather events (Perkins et al. 2012, Trenberth et al. 2015, National Academy of Sciences, Engineering, and Medicine 2016). In turn, extreme weather events can also exacerbate climate change by releasing large amounts of stored carbon in affected ecosystems back into the atmosphere (Reichstein et al. 2013), evidenced by the massive wildfires (which were themselves aggravated by drought conditions) across Siberia, Brazil and Australia in 2019. Changes in climate patterns and variability in precipitation also have a strong influence on water availability and food production (Wheeler and van Braun 2013, IPCC 2018). Rainfed agriculture accounts for 60% of global production and covers 80% of the cultivated area (Wani et al. 2009). Even slight changes to the timing and amount of rain can dramatically affect food production, potentially leading to local and/or global food crises. There is also significant evidence that biodiversity will be strongly impacted by climate change through shifts in species ranges, timing of life history events, and trophic dynamics (Bellard et al. 2012). At the same time, biodiversity offers important buffering to climate extremes in food systems (Isbell et al. 2015, IPES-Food 2016) and is the key source for the genetic adaptation of our crops and livestock (Frison et al. 2011, IPES-Food 2016).

Global change scientists also identified a number of secondary risks associated with the core five*: involuntary migration – social instability – national governance – regional or global governance – man-made disasters*. Together, these highlight the systematic links between climate, ecosystems and society. More importantly, this calls for a paradigm shift in how we think about risk and emphasizes the need for scientists and policy makers to explicitly consider risk as a networked system.

Global conventions on climate change, biodiversity, wetlands, species, chemicals, and desertification (including their parties and their secretariats) need to continue and deepen efforts to actively collaborate to ensure that cross-cutting and interacting risks are considered and addressed as a system (Ivanova and Escobar-Pemberthy 2018).

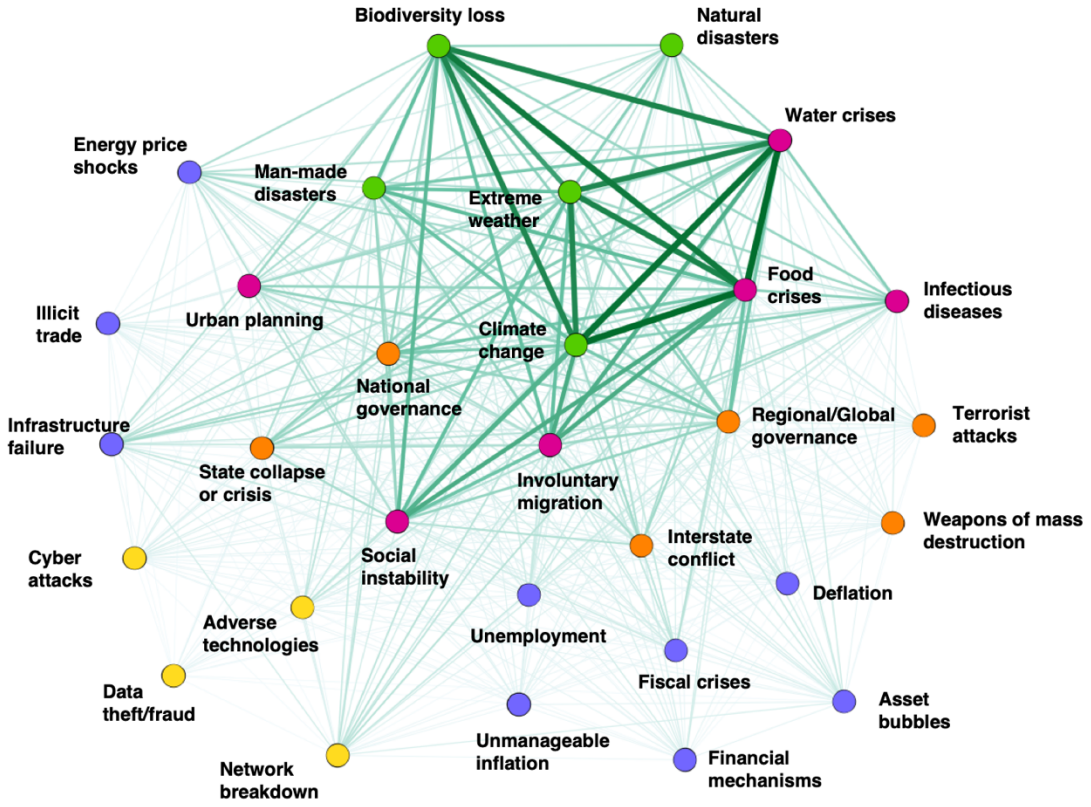

Figure 2. Climate change – Biodiversity loss – Extreme Weather – Food crisis – Water crisis nexus. A network analysis of potentially synergistic risks that can lead to global systemic crisis. The colour of the node indicates the risk category (*green*=environmental; *pink=societal; orange=geopolitical; yellow=technological; blue=economic*). The thickness of the edges represents the frequency of responses identifying a synergistic interconnection between two risks.

Committed Risks

The likelihood of occurrence around many risks is not linear. In numerous systems, especially complex systems, risks can display non-linear dynamics through space and time. This is because processes that underpin many risks are often driven by slow moving variables with internal or external feedbacks with other systems that can be hard to detect (Walker et al. 2012). Gradual changes in these processes can remain insignificant or unnoticed over long periods of time before dramatically shifting once reaching a critical threshold. At this point, new sets of relationships internal to the system or with interacting systems can lead to a state-change (Garschagen and Solecki 2017). These are often thought of as tipping points and it can be hard to predict when or where they will occur in complex systems (Scheffer 2009, 2010). Take for instance widespread social discontent driven by rising inequality. This frustration can remain under the surface and grow for many years before erupting into riots or revolutions, sparked by a seemingly small rise in food or energy prices as seen in Ecuador and Chile in 2019.

By only evaluating likelihood and impact of a risk over the timeframe of the next 10 years, risk perception assessments could overlook risks which we are committing to now but whose impact will manifest multiple decades or centuries from now. We asked scientists to identify the most important risks which they believe we are "locking-into" or those risks for which we have already crossed the threshold that will put us on a path towards irreversible or catastrophic outcomes. Scientists' free-listed responses overwhelmingly pointed towards three risks: *climate change*, *biodiversity loss*, and *ecosystem collapse*.

These responses are supported by a large body of research collected and analyzed by the Intergovernmental Panel on Climate Change (IPCC) and Intergovernmental Platform on Biodiversity and Ecosystem Services (IPBES). In the IPCC's Special Report on Global Warming of 1.5°C, scientists state that humanity has already raised global temperatures by 1°C above pre-industrial levels, and that these historic emissions will lead to significant sea level rise and persist for centuries to millennia (IPCC 2018). In

addition, based on current emissions trends, we are on track to raise global temperatures above the 2.0°C Paris target, beyond which there is a high likelihood for pervasive and irreversible impacts for people and ecosystems (IPCC 2014). In 2019, IPBES released the first comprehensive global assessment of biodiversity and ecosystem services since the Millennium Ecosystem Assessment (MEA 2005). In it, the authors articulate the deep dependence on and interconnection of humanity with biodiversity and estimate that 25% of assessed plant and animal species are already threatened. The recent IPBES report suggests that nearly a million species may face extinction in the coming decades due to interacting direct drivers of land use change, exploitation, climate change, pollution, and invasive species (IPBES 2019).

Emerging Risks

As suggested earlier in this chapter, the landscape of risks is a dynamic space with some risks diminishing over time while new risks emerge. New social movements, politics and/or ecological events can bring our attention to emerging risks which should be monitored as potential threats to the health and stability of human society and the planet. In our survey, scientists were asked which additional risks, not covered in the top 30, they think the global community needs to pay greater attention to.

A qualitative analysis of the 173 responses on this question revealed seven common overarching risks which scientists suggest are important to consider and which were not part of the top 30 in 2019:

Erosion of societal trust, cohesion, and values: Growing distrust within and between groups (including government, business, public institutions and the public), leading to an increase in social tensions and individualism.

Rising inequality: A major divide in the quality and quantity of resources available to different segments of the population including, but not limited to, natural resources, income, and healthcare.

Failing to take into account feedbacks across systems: In development, planning, and business decisions, failing to take into account the interconnections between problems, solutions, risks, and opportunities could have significant detrimental consequences.

Rise of nationalism: The emergence of political structures that promote nationalist ideas of identity and isolation from other countries and undermine intergovernmental processes.

Deterioration of social infrastructure: The weakening of services and facilities that help communities meet their social needs and maximize their potential for development. These include education, communication, health, and transportation systems.

Overpopulation: The potential for the world population to reach a threshold that exceeds the planet's carrying capacity, potentially leading to ecological and societal collapse.

Deterioration of mental health: A significant and widespread decline in mental health affecting emotional, psychological, and social well-being with impacts on economic, political, and social spheres.

Of these risks *the failure to take into account feedbacks across systems* stands out. This risk is not easily classified into an existing risk category. Rather, it speaks to the growing awareness among scientists that the processes underlying risks are interconnected and complex (Helbing 2013). This is a cross-cutting concern that is applicable both within and across the existing risk categories. In our survey, numerous respondents provided narrative descriptions of how a given risk could have compounding effects on other related risks. Given that scientists highlighted systematic links between climate, ecosystems and society in their evaluation of interconnected risks, we suggest that this new risk should also be on the radar of decision-makers and policymakers. Also of note is the large number of emerging global risks focused on societal issues, e.g. erosion of societal trust and cohesion, rising inequality, and rising nationalism; as well as lesser discussed issues such as deterioration of mental health. Together these suggest a need for greater consideration of multiple dimensions of societal well-being in our efforts for our societal transition towards a safe and equitable future.

Future Directions

Through the Global Risks Perspectives Initiative, Future Earth aims to open and stimulate dialogue on our common risks with a growing number of communities. It is only through increased dialogue and sharing that we can accurately assess risks and begin to chart legitimate and fair future pathways to sustainability that reflect the variety of experiences on Earth. Results from the first edition of the Global Risks Scientists' Perception survey are critical to foster these dialogues and to start looking at global risks from multiple perspectives. Through future iterations of the survey and other activities, Future Earth seeks to expand the community perspectives and begin identifying solutions collectively. Join us.

Table 1. List of 30 global risks and five risk categories used in the Future Earth Global Risks Scientists' Perception survey. Shorthandle names for each global risk are in bold.

Category	Risk Name
Environmental	**Extreme weather** events
	Failure of **climate change** mitigation and adaptation
	Major **biodiversity loss** and ecosystem collapse
	Major **natural disasters**
	Man-made environmental damage or **disaster**
Societal	Failure of **urban planning**
	Food crises
	Large-scale **involuntary migration**
	Profound **social instability**
	Rapid and massive spread of **infectious diseases**
	Water crises
Geopolitical	Failure of **national governance**
	Failure of **regional or global governance**
	Interstate conflict with regional consequences
	Large-scale **terrorist attacks**
	State collapse or crisis
	Weapons of mass destruction
Technological	**Adverse** consequences of **technologi**cal**[ies]** advances
	Breakdown of critical information infrastructure and **networks**
	Large-scale **cyber-attacks**
	Massive incident of **data fraud**/theft
Economic	**Asset bubbles** in a major economy
	Deflation in a major economy
	Failure of a major **financial mechanism[s]** or institution
	Failure/shortfall of critical **infrastructure**
	Fiscal crises in key economies
	High structural **unemployment** or underemployment
	Illicit trade
	Severe **energy price shocks** (increase or decrease)
	Unmanageable inflation

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