

Global Risks Perceptions Report 2021



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Key Messages



Scientists systematically ranked likelihood and impact of global risks higher than members of business and economic communities.



All surveyed communities rated environmental risks among the most urgent global risks humanity faces today and as highly interconnected with other global risks.



Technological risks are now seen as more likely to occur, compared to earlier findings.



Five risks emerge as most likely to form an interconnected cluster of risks and lead to a global systemic crisis: *failure to take climate action - biodiversity loss - infectious disease - extreme weather events - human environmental damage*.



Scientists highlighted the need to prioritize inequality as a standalone risk in assessments and perception analyses.



Business and science communities are only two groups of many more with perspectives relevant to dialogues about global risks. There is a continued need to learn from each other and build a global community around mitigating risks.

Introduction



Humanity is facing threats that demand we put aside challenges to global cooperation and take urgent, multilateral action. Inequity, compounded by environmental challenges and widespread digitalization, are rapidly changing the landscape of global risks. This has become more apparent over the last year and a half, marked indelibly by the global COVID-19 pandemic and its cascading effects, but also by rising intensity and severity of extreme events linked to climate change, such as wildfires, heatwaves, and tropical storms.

In this global setting, subject to such volatility, uncertainty, complexity, and ambiguity (VUCA) (see, e.g., [Bennett and Lemoine, 2014](#)), it is more imperative than ever to encourage efforts to better understand, prepare for, and act on global risks. The key to strategic risk management is first developing a more comprehensive understanding of the landscape of risks; that is to say, understanding which risks we are currently facing and which are on the horizon that pose an immediate or existential threat, their relative level of urgency, and how the impact of one risk can be interlinked to other risks.

The World Economic Forum (WEF) has laid fundamental groundwork in terms of analyzing global risks and risk perceptions, producing a regular update over the past 15 years. WEFs efforts in this space have undoubtedly played a pivotal role in characterizing the landscape of risk, especially representing perspectives from members of business and economic communities. Yet, this information can change depending on who and when you ask; this is why understanding risk *perceptions* from different perspectives and worldviews is so important (see, e.g., [Slovic et al., 1982](#); [Rohrman and Renn, 2000](#)). There is a need now to complement WEFs efforts and to represent a broader diversity of viewpoints when

discussing risk ([Garschagen et al., 2020](#)). Thus, our work strives to capture **scientists' perceptions of global risks**.

This report shares the findings of the second iteration of the Global Risks Scientists' Perceptions survey. In repeating the exercise first conducted in 2019 (see [Future Earth, 2020](#)), the project team recognizes the importance of revisiting risk perceptions over time. In particular, given the manifestations of global risks which have taken place since 2019, and the two iterations of the WEF Global Risks Report ([2020](#) and [2021](#)), the time is ripe to reassess scientists' perceptions of global risks as a critical contribution to dialogues about potential solutions. This collaboration between Future Earth, Sustainability in the Digital Age, and the International Science Council (ISC) aims to contribute to the discourse that has been shaped through the WEF's important work with an international analysis of scientists' perceptions of global risks. In doing so, we hope to enrich the conversation around mitigation strategies already underway as well as to spark new and more inclusive dialogues.

Methodology

The 2021 Global Risks Scientists' Perceptions survey was open from June 16 to July 28, 2021. The invitation-only survey was sent to targeted groups with known membership (including scientists from all fields and disciplines, including natural, social, and human sciences) that have links to the organizations partnering on the project – [Future Earth, Sustainability in the Digital Age](#), and [International Science Council \(ISC\)](#) – as well as to members of the [International Observatory on the Social Impacts of AI and Digital Technology \(OBVIA\)](#).

These targeted groups include groups of “nominated experts” from Future Earth and International Science Council, who were either nominated by a peer or self-nominated through an outreach effort in May 2021 seeking to build a community around this survey work.

This rigorous dissemination strategy enables a clearer representation of the sample population. It also allows reporting on the precise number of individuals who received the survey as well

as the response rate by group (more details in Supplementary Material).

See Table 1 for an overview of the groups contacted and response rate by group. See the Supplementary Material for additional information on methodology and demographic data on survey respondents (219 complete responses in total, with expertise concentrated in environmental risks and, to a lesser extent, in societal risks).

Table 1. Population surveyed and response rate. Groups of known membership representing all scientific disciplines whose members were contacted to take the invitation-only survey.

Scientific community – Main groups surveyed	Response rate (%)
Future Earth	19%
International Science Council (ISC)	21%
International Observatory on the Social Impacts of AI and Digital Technology (OBVIA)	4%

The Global Risks Scientists’ Perceptions survey employed the WEF definition of global risk, which 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”.

Based on discussions with the team of Advisors, and following the methodology of the 2019 Global Risks Scientists’ Perceptions survey, the 2021 survey targeted respondents with at minimum a Masters degree or equivalent in the international science community from all fields and disciplines, including natural, social, and human sciences. Respondents were asked to: (a) evaluate the likelihood and potential negative impact over the next ten years for the Top 35 risks identified in the WEF Global Risks Report 2021 (see Table 2, where

the language used in the survey to describe the Top 35 risks was taken directly from [WEF 2021](#); results presented in section 1), (b) identify clusters of interconnected risks (section 1), and (c) identify any additional risks not covered in the Top 35 (results in section 2).

As per WEF 2021 methodology, evaluation of likelihood and potential negative impact were done using a Likert scale from 1 - 5, where 1 is “very unlikely” and 5 is “very likely” in the assessment of likelihood and 1 is “minimal” and 5 is “catastrophic” in the assessment of impact, and values between the extremes of the Likert scales were not assigned specific terms. Ethical approval for the survey was obtained through [Concordia University](#) Research Ethics Board (Certification Number: 30014702).

Table 2. WEF Top 35 Global Risks. From [WEF, 2021](#).
For the full WEF description of each risk, see Supplementary Material.

Risk Category	Global Risk
Economic	Asset bubble burst in large economies
	Collapse of a systemically important industry
	Debt crises in large economies
	Failure to stabilize price trajectories
	Proliferation of illicit economic activity
	Prolonged economic stagnation
	Severe commodity shocks
Environmental	Biodiversity loss and ecosystem collapse
	Climate action failure
	Extreme weather events
	Human-made environmental damage
	Major geophysical disasters
	Natural resources crises
Geopolitical	Collapse of a multilateral institution
	Fracture of interstate relations
	Geopolitization of strategic resources
	Interstate conflict

Table 2 cont. WEF Top 35 Global Risks. From [WEF, 2021](#).
For the full WEF description of each risk, see Supplementary Material.

Risk Category	Global Risk
Geopolitical	State collapse
	Terrorist attacks
Societal	Collapse or lack of social security systems
	Employment and livelihood crises
	Erosion off social cohesion
	Failure of public infrastructure
	Infectious diseases
	Large-scale involuntary migration
	Pervasive backlash against science
	Severe mental health deterioration
	Widespread youth disillusionment
Technological	Adverse outcomes of technological advances
	Breakdown of critical information infrastructure
	Digital inequality
	Digital power concentration
	Failure of cybersecurity measures
	Failure of technology governance



Section 1. Scientists' Perceptions of Top 35 Global Risks

Top Global Risks

The survey found that scientists systematically ranked both likelihood and potential negative impact of the Top 35 global risks to be higher than WEF respondents.

This suggests a divergence in urgency to act, with surveyed scientists perceiving a higher degree of urgency to act to mitigate global risks across the evolving landscape. This echoes findings from the earlier Global Risks Scientists' Perception survey, where a significant gap between the two communities was observed ([Garschagen et al., 2020](#)).

Figure 1 presents these findings by risk category, showing the results for scientific survey respondents (darker circles) and WEF respondents (lighter circles), with each individual global risk connected by a grey line between the average values by respondent group.

Figure 1 also shows that, for all risks save two (*prolonged stagnation* and *debt crises*), surveyed scientists perceived both a higher likelihood and higher potential negative impact as compared to the WEF respondent group of business and economic communities.

Average responses are also shown in Figure 2, with results from surveyed scientists shown in Fig. 2A and WEF respondents in Fig. 2B. For each graph, the average likelihood across all evaluated risks is shown as a vertical line and the average potential negative impact is shown as a horizontal line. Comparing average likelihood and average impact across the two groups of respondents further drives home the fact that surveyed scientists perceived global risks to be, on average and nearly

across the board, more likely and to have a higher potential negative impact.

It is notable that there was no major divergence observed between the two groups regarding the relative order of risks – by and large, the relative ranking of global risks was seen to be fairly similar across both communities.

In Figure 2, risks in the upper-right quadrant (highlighted in grey) have been ranked as above-average with regards to both likelihood and potential negative impact, and can therefore be seen as the most urgent global risks to address.

Both communities – surveyed scientists and the WEF respondents – ranked Environmental Risks (plotted as green dots in Figure 2) as highly urgent and, unsurprisingly, *infectious disease* rose to become a highly ranked global risk in 2020-2021.

It is interesting to further note that risks located in the upper-right quadrant, which contains all of the environmental risks for surveyed scientists (Fig. 2A) and nearly all for WEF respondents (save *geophysical disasters*, Fig. 2B), represent issues that fit descriptions of systemic risks (see, e.g., [Renn et al., 2020](#)) that will require a high degree of global cooperation to address (though some risks in other quadrants likewise fit this description, it is notable that all those in the top-right quadrant do).

In some cases, most notably environmental risks such as *geophysical disasters* and *natural resource crises*, the higher perceived urgency (in terms of likelihood and impact) expressed by surveyed scientists as compared to WEF respondents is particularly pronounced, indicating a continuing divergence between perceptions in the scientific community and the WEF community in line with earlier findings (following [Garschagen et al., 2020](#)).

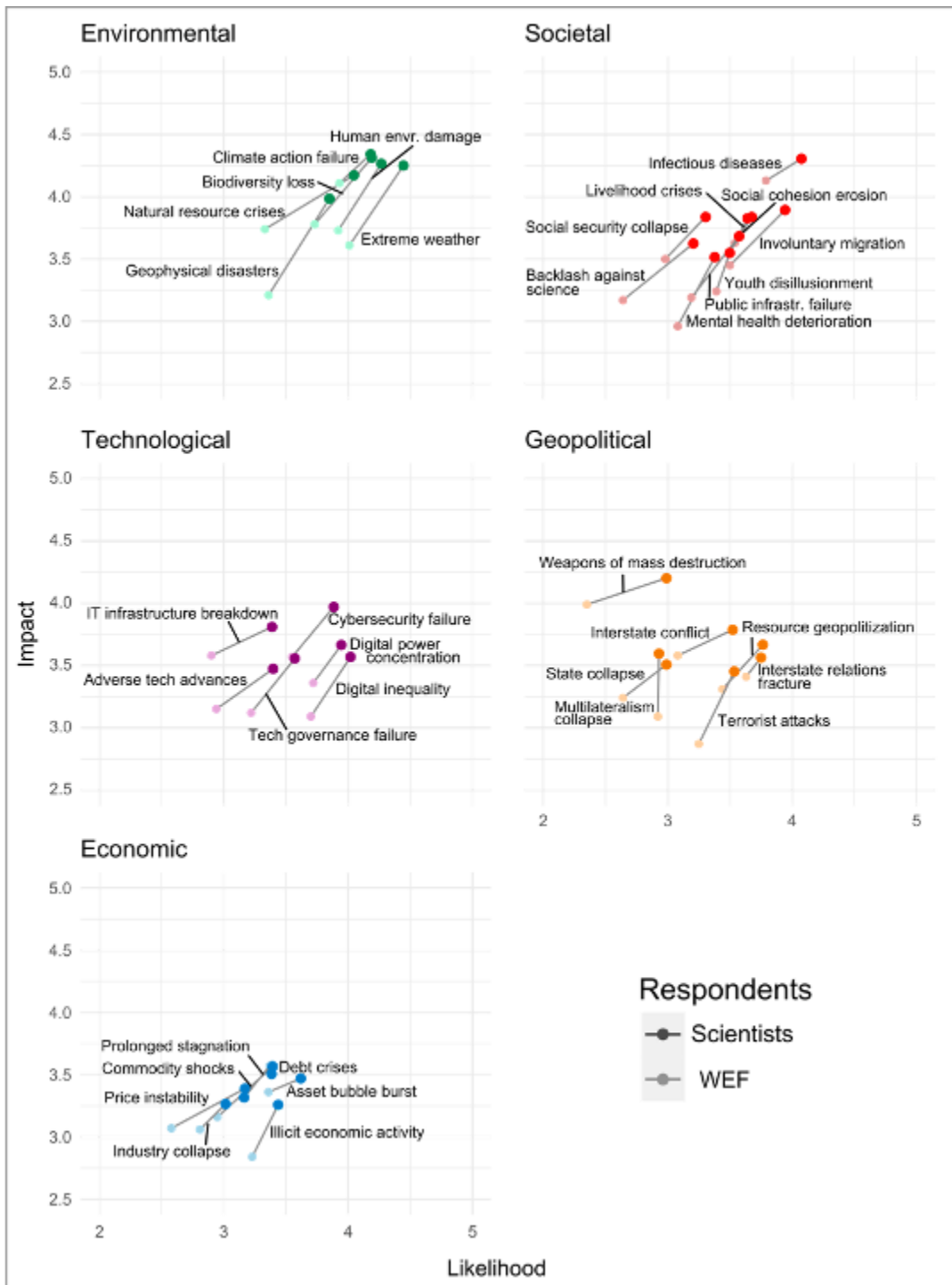


Figure 1. Gap in risk perceptions. Differences between respondents – surveyed scientists (darker circles) and WEF business community (lighter circles), organized into the five risk categories identified by WEF. Each point on the scatter plot represents the average likelihood (x-axis) and potential negative impact (impact, y-axis) for a given risk. Where the name of the risk could not be placed in such a way to make identification immediately obvious, a black line between the abbreviated risk name and the grey line linking surveyed scientists and WEF respondents responses was included. The risk categories are presented in order of the average ranking of likelihood and impact across both the surveyed scientists and WEF respondents: (1) Environmental Risks (avg. likelihood 3.9, avg. impact 4.0), (2) Societal Risks (avg. likelihood 3.4, avg. impact 3.6), (3) Technological Risks (avg. likelihood 3.4, avg. impact 3.5), (4) Geopolitical Risks (avg. likelihood 3.2, avg. impact 3.5), (5) Economic Risks (avg. likelihood 3.2, avg. impact 3.3).

Figure 2A. Surveyed scientists

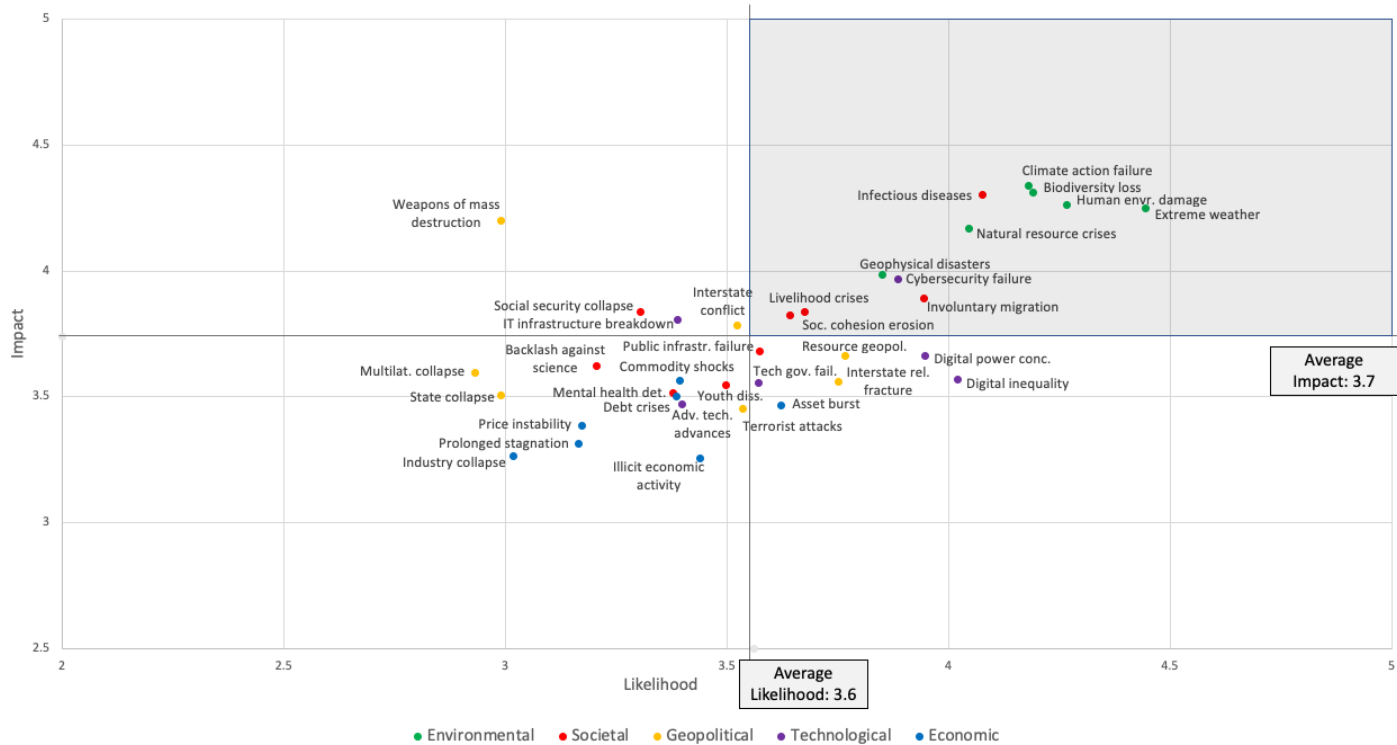


Figure 2B. WEF respondents

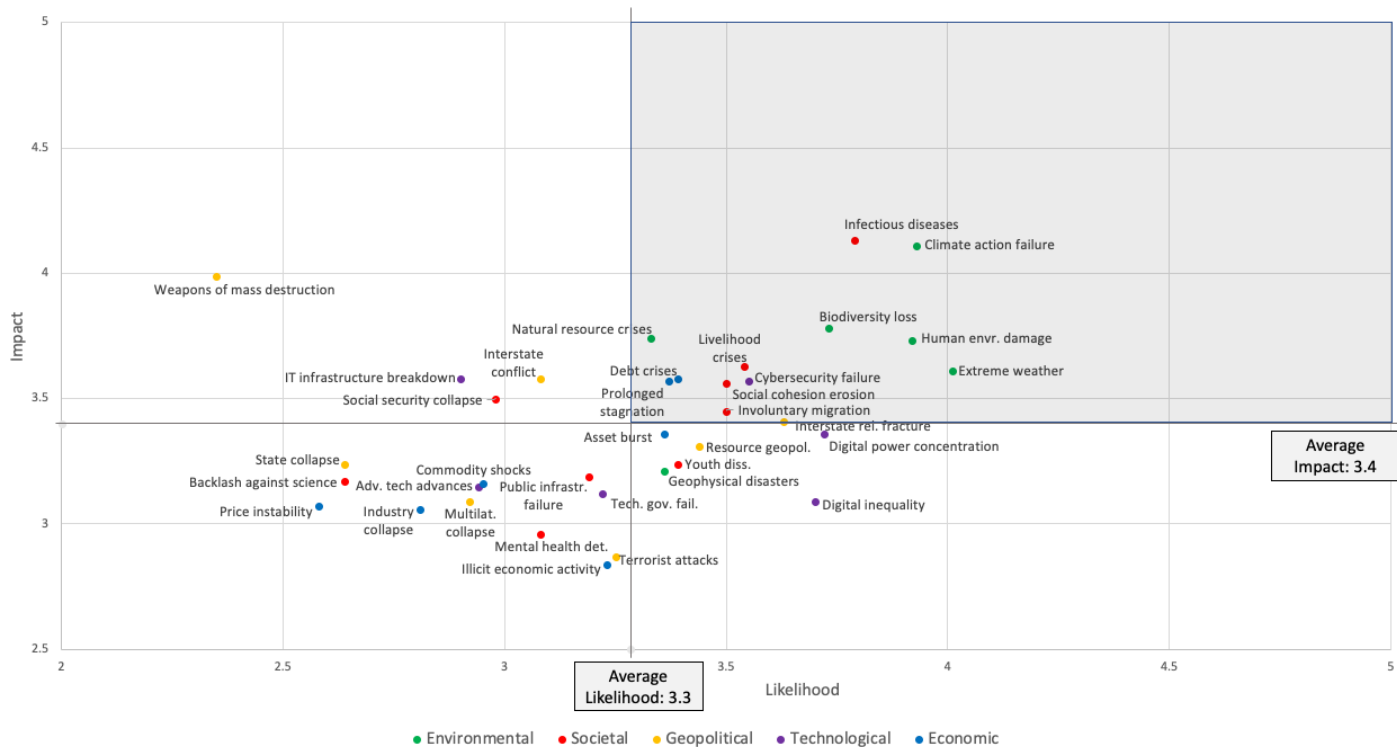


Figure 2. Comparing perceptions on likelihood and impact of global risks between science (Fig. 2A) and business (Fig. 2B). Responses from surveyed scientists to the 2021 Global Risks Scientists’ Perceptions survey are shown in Fig. 2A and responses to the World Economic Forum (WEF) 2021 Global Risks Report are shown in Fig. 2B (data from [WEF 2021](#) and [Marsh McLennan 2021](#)). Both panels depict the average ranking of WEF’s Top 35 Global Risks in terms of perceived likelihood (x-axis) and potential negative impact (y-axis) over the next 10 years. The colour of points represents the category of risks.

In a final ranking, some risks stood out more in terms of only likelihood or only potential negative impact from scientists' perspectives. The most urgent global risks to address were those where there is a confluence of likelihood and potential negative impact, though it is worth noting (as above) that these risks were also those that will require the greatest degree of global cooperation.

The top five risks listed by either variable in Table 3 are the same, though in slightly different order, indicating that these were perceived to be the most pressing and urgent risks requiring immediate attention: *biodiversity loss*, *climate action failure*, *extreme weather*, *human environmental damage*, and *infectious disease*. Three of these five – *biodiversity loss*, *climate action failure*, and *infectious disease* – also emerged in the top five for WEF respondents ([WEF 2021](#)) for both likelihood and impact, further reinforcing the finding that these risks are of critical concern across sectors. In comparison with earlier results in the Risks Perceptions Report 2020, infectious disease and human environmental damage rose higher in the average rankings for both likelihood and impact. Extreme

weather remains the highest ranked global risk by likelihood, but fell lower on the average ranking of potential negative impact. Climate action failure remained stable at the fourth ranked global risk by likelihood, but rose to the top spot in terms of average ranking by potential negative impact.

Also notable is the fact that technological risks such as *digital inequality* and *digital power concentration* emerged as likely, but scientists did not rank these in the top 10 risks by impact. Compared to earlier findings, the average perception is that technological risks are now seen as more likely – they were not included in the top 10 risks for likelihood or impact in the [Risks Perceptions Report 2020](#) (which presented results from the 2019 Global Risks Scientists' Perceptions survey). Meanwhile, perceptions from surveyed scientists regarding the likelihood of economic risks decreased over time and perceptions of both likelihood and impact of *infectious disease* increased. Similar to earlier findings, *weapons of mass destruction* stood out as having the lowest likelihood but a relatively high potential negative impact.



Table 3. Scientists' perceptions of the top 10 risks. Risks ranked by surveyed scientists, by average likelihood and potential negative impact over the next 10 years. The symbols indicate the movement of each risk in this ranking compared to previous results reported in the Risks Perceptions Report 2020 – where an upwards red arrow ▲ indicates an increase in the ranking, a green downwards arrow ▼ indicates a decrease in the ranking, a blue circle ● indicates no movement (same ranking), and a purple star ☆ indicates a new risk in 2021 not included in the 2020 ranking at all.

Top Risks by Likelihood		Top Risks by Impact	
* Indicates that the risk also appears in the WEF top five ranked global risks by both likelihood and impact.			
1. Extreme weather	●	1. Climate action failure*	▲
2. Human environmental damage	▲	2. Biodiversity loss*	▲
3. Biodiversity loss*	▼	3. Infectious diseases*	▲
4. Climate action failure*	●	4. Human environmental damage	▲
5. Infectious diseases*	▲	5. Extreme weather	▼
6. Natural resource crises	☆	6. Weapons of mass destruction	▲
7. Digital inequality	▲	7. Natural resource crises	☆
8. Digital power concentration	▲	8. Geophysical disasters	●
9. Involuntary migration	▼	9. Cybersecurity failure	▲
10. Cybersecurity failure	▲	10. Involuntary migration	▼

Interconnected Risks

An important consideration with regards to global risks is understanding how they interact with one another. Risks do not occur in isolation. They can have compounding effects that amplify the impacts when two or more risks co-occur and they can also have cascading impacts, where the likelihood of further risks occurring increases once one particular risk manifests, creating a domino effect. Understanding the interconnections between global risks – including building awareness of interdependencies and feedback loops – and which groupings of risk present the greatest threats, is thus a key part of improving risk assessment and discussing potential solutions, since strong interconnections need to be taken into account in mitigation planning.

Figure 3 depicts the interconnections between risks as perceived by scientific survey respondents. Surveyed scientists identified five central risks as “*most likely to have compounding effects and to lead to a global systemic crisis*”¹, forming an interconnected cluster of risks: *climate action failure - biodiversity loss - infectious disease - extreme weather - human environmental damage* (where risks are listed in order of how many times they were identified as interconnected with another risk). This shows a strong degree of interconnection amongst environmental risks and also points to a link between *infectious disease* – including, for example, the COVID-19 pandemic – and environmental risks. It is notable that the five interconnected risks identified are the same as those that were ranked as having the highest likelihood of occurrence within the next 10 years and the most severe

potential negative impact (Table 3), providing yet more evidence that these five risks are perceived to be the most urgent issues of our time.

The high degree of interconnections among environmental risks, coupled with the high degree of urgency associated with these risks as seen in Fig. 1 and Fig. 2A and 2B, suggests that environmental risks must be prioritized in dialogues around global risks and potential pathways to mitigate them. The high number of interlinkages between environmental and other categories of global risks also indicates that understanding environmental risks is central to understanding other categories of risk – including societal, geopolitical, technological, and economic risks. This supports previous findings that environmental risks play a key role in amplifying risk drivers and impacts by increasing the occurrence and severity of hazards, changing exposures, and amplifying vulnerability (see [Keys et al., 2019](#)).

Closely linked to the top five most highly interconnected risks are three additional global risks that could result in cascading impacts: *natural resource crises - involuntary migration - resource geopolitization*. These demonstrate the importance of considering interconnections across categories of risk, in this case highlighting the fact that social, geopolitical, and environmental factors have the potential to co-occur and lead to even larger impacts, potentially driving a broader cascade of risks, and also the central role that resource scarcity may play in the coming 10 years.

1 Exact wording from GRSP 2021 survey in quotation and italics.



Section 2. Scientists' Perceptions of Additional Risks Beyond Top 35

Spotlight on Inequality

As the landscape of risk evolves, it is critical to understand not only the likelihood and impact of previously considered risks, but to also explore risks which are either emerging or which may not have been perceived with sufficient urgency in the past to be included in the most recent WEF survey.

When asked to identify additional risks beyond the WEF Top 35, 55% of responses were categorized

as novel additional risks and categorized using Qualitative Content Analysis (see Supplementary Material for additional information on analysis; the remaining 45% of responses were categorized as nuances to the existing WEF Top 35 risks, see “The Need for Nuance” section below).

Of these, the risk of increased *inequality* dominated, representing 19% of all additional risks suggested, cited by 33 individuals (see Box 1 for definition).

Box 1. Definition of Inequality as the top-ranked additional risk.

Definition was written based on survey respondents’ own words following the Qualitative Content Analysis of responses to the question on additional risks.



Inequality: The growing gap within and between nations and between generations regarding equitable access to resources including medicine, water, food, land, and other forms of wealth. This also includes inequality with regards to decision-making power, access to economic markets and healthcare, and issues around racial and gender discrimination.

Inequality was also the top ranked additional risk in our Risks Perceptions Report 2020, pointing towards a continued degree of urgency associated with this global risk. Indeed one important aspect of inequality, *income disparity*, was for many years included in WEFs list of Top Risks as an Economic Risk, and was the highest ranked risk by likelihood from 2012-2014. And while *income disparity* has not been included in WEFs top global risks since the [2014 Global Risks Report](#), it is notable that facets of

inequality (including, for example, digital inequality, unequal access to infrastructure, etc.) are still mentioned prominently across other risks in the WEF Top 35. Most importantly, our findings indicate that surveyed scientists highlighted the need to consider inequality as a standalone risk in risk assessments and risk perception analyses conducted by WEF and other groups, which would also serve to shed light on the interconnections between inequality and other global risks.

Other Additional Risks Identified by Scientists Beyond the Top 35

Although other additional risk categories were much more infrequently mentioned, we list the six next most frequently mentioned categories here to shed light on the diversity of perspectives and on emerging risks which may increase in prominence in coming years. The definitions for the additional risks listed below stem from the Qualitative Content Analysis of the survey responses and,

to the extent possible, use respondents' own words. Of these six categories, all except for *space-related risks* were ranked as having above-average likelihood and potential negative impact, and most relate to governance and norms. The risk of *space-related risks* was ranked as having very high potential negative impact, but very low likelihood of occurrence.



Other additional risk categories listed in order of number of responses:



Shifts in culture & value systems: Loss of diversity in cultural, educational, and religious identities, accompanied or spurred on by the degradation or collapse of cultural and educational institutions and shifts in value systems.



Failure to account for synergistic risks: The occurrence of multiple risks in conjunction without proper planning, integrating multiple categories of risk and featuring severe, cascading consequences across spatial and temporal boundaries.



Erosion of democracy: The erosion of democratic principles, stability, and rule of law around the world, including the rise of authoritarian regimes and dictatorships as well as a rise in nationalist sentiments and cult-like leadership.



Lack of global collaboration and frameworks: A lack of coordination at the global scale due to insufficient collaboration and frameworks for engagement, including the failure of existing frameworks, such as the Sustainable Development Goals and One Health, as well as a deficit in leadership at the global scale.



Space-related risks: Events occurring outside of the Earth's atmosphere with impacts on Earth, including geomagnetic storms, space debris, and meteorites or asteroids.



Increased risks to public health: A rise in non-communicable disease and other health issues, such as poor nutrition, addiction, and auto-immune disorders, in conjunction with failures of public health care systems around the world that could also impact the WEF Top 35 risk *infectious disease*.

We observe that some of the additional risks identified by scientists in our previous survey did indeed appear in some form in WEFs Top 35. Notably, this includes the following of WEFs global risks: *mental health deterioration, social cohesion erosion, and public infrastructure failure.*

This indicates growing and shared concern for these risks across different communities,

pointing to a continued need for cross-sectoral conversations about risks, since different communities can learn from one another regarding emerging risks and the changing landscape of risk. More specifically, different communities (such as scientists and business and economics communities) can identify similar sets of priority risks but can vary considerably on how to understand and address them ([Renn et al., 2020](#)).



The Need for Nuance

One important insight from scientists who responded to the 2021 Global Risks Scientists' Perceptions survey is that there is a need for a more nuanced approach to understanding

global risks. Notably, many responses involved highlighting links between different global risks in WEFs Top 35. When asked to identify additional risks beyond the WEF Top 35, over one quarter of respondents suggested nuances to the description of the already-identified risks.

Notable examples include:



Cumulative human-made environmental damage: In relation to *human environmental damage*, respondents noted the need to account for the cumulative impacts of the types of human-induced impacts listed by WEF such as deregulation of protected areas, oil spills, wildlife trade, and others by considering slower-onset processes as well as sudden events and shocks.



Ecosystem modification, pointing towards incremental changes: Raised as a nuance to the risk of *biodiversity loss*, respondents highlighted the importance of considering the impact of incremental changes to ecosystems, in addition to the already identified risk of irreversible consequences and permanent destruction of natural capital.



Human and planetary security: Integrating nuances related to expanding the concept of security concerns to include both human and environmental perspectives was seen as important across a number of risks, ranging from geopolitical (e.g. *interstate conflict*), to societal (e.g. *involuntary migration*), to technological (e.g. *adverse tech advances*).



Lack of social & environmental justice: In relation primarily to environmental risks, and in particular to the risks of *climate action failure* and *biodiversity loss*, respondents noted a lack of integration of aspects related to different forms of justice, including issues related to access to resources and services and issues around environmental crime.



Planetary health: Issues linking human and environmental health directly in a planetary health or One Health framework focusing on systemic or holistic approaches were raised often by respondents, in particular in relation to *climate action failure*, *biodiversity loss*, and *infectious disease*.

Exploring the nuances highlighted by the scientific community drives home the need to take a systems approach to the assessment and analysis of global risks, and in particular to contextualizing the definition of risks within their broader socio-

economic and socio-ecological contexts. This further points to the need to ensure that decisions about the strategic management of risk must not be taken in isolation.

Future Directions



In a time where global risks are manifesting with increasing threat to human safety, it is time to sound the call more urgently than ever before for broader societal engagement and deliberation to mitigate risks. To effectively and fairly address global risks, a plurality of viewpoints must be represented in all circles making decisions on how to foresee, act on, and circumvent global threats.

Over the last 15 years, the work of WEF has been critical in raising the profile of global risks and highlighting perspectives from members of business and economic communities. Their efforts in this space paved the way for and directly inspired the Global Risks Scientists' Perceptions survey. But business and economic communities and scientists are only two groups of many more that are relevant to this discussion.

Moving forward, it is imperative to prioritize the engagement of groups such as youth, Indigenous populations around the world, farming communities and other rural populations, unions, and policy makers and authorities operating at different scales, to name but a few, to encourage inclusivity in discussions around global risks.

It will also be important to build on this risk perceptions work by expanding on the current analysis and incorporating additional elements of central relevance. In particular, exploring risk communication and risk governance as complementary dimensions to this work and analyzing factors that could explain divergence

in risk perception will be important to integrate. Closely linked to these points is the need to further explore the concept of systemic risks in relation to risk perception, communication, and governance (following [Renn et al., 2020](#)).

As we near the end of the second year of the COVID-19 global pandemic and face a growing diversity of other urgent global risks, opportunities to learn from other perspectives and worldviews, to work together, and to find common ground have never seemed more important.

This report is intended to spark not only dialogues but concrete action. Our science community will continue to build on this initiative through a regular survey to study the evolution of global risk perceptions. We see this as central to building a broader community of practice and understanding around this theme and raising its profile globally. We also hope that the report inspires other groups to take stock of global risk perceptions within their communities and to share that information widely, engaging directly in dialogues around global risks and mitigation pathways across sectors, scales, and geographies.

Through collaborations, dialogue, and collective action, we believe it is possible to switch from the old VUCA, a world characterized by volatility, uncertainty, complexity, and ambiguity, towards a new VUCA state and a world increasingly characterized by vision, understanding, clarity, and agility ([Johansen, 2017](#)).

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An aerial photograph of a forest landscape. The left side is dominated by a dense, lush green forest. On the right, a large area has been cleared, showing a mix of brown soil, greyish-brown tree stumps, and sparse, yellowish-green regrowth. A dirt road or path runs vertically through the center, and another path branches off to the right. The text 'Supplementary Materials' is overlaid in white on the left side of the image.

Supplementary Materials

The Survey

The 2021 edition of the Global Risks Scientists' Perception (GRSP) survey is designed to yield results that complement the World Economic Forum's (WEF) annual Global Risks Report 2021, which reports on the global risk perceptions of leaders from business, economics, and government. The GRSP survey findings as shared in the Global Risks Perceptions Report 2021 report aim to contribute to the discourse that has been shaped through WEF's important work with an international analysis of scientists' perceptions of global risks.

The GRSP survey employs the WEF definition of global risk, which 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"*.

The survey targets scientists from all scientific disciplines who are members of specific groups (see Table S.M.1) with at minimum a Masters

degree or equivalent.

Following WEF's survey model, GRSP survey respondents were asked to evaluate the likelihood and potential negative impact over the next 10 years of the Top 35 risks identified by WEF in the Global Risks Report 2021 ([WEF 2021](#)). The language used to describe these Top 35 risks was taken directly from the WEF report as was the five-point Likert scale (ranging from 1 - very unlikely to 5 - very likely, for likelihood, and from 1 - minimal to 5 - catastrophic, for impact). Again following WEF, no wording was assigned to the Likert scale responses except for these extremes.

In addition to evaluating likelihood and potential negative impact, GRSP survey respondents were also asked to identify any *"additional risks not covered in the Top 35 global risks identified by WEF covered in Module I"* of the survey, and to identify a cluster of interconnected risks, described as *"a subset of up to ten (10) global risks most likely to have compounding effects and to lead to a global systemic crisis"*¹. The WEF Top 35 Global Risks are listed here and the full text of the survey is provided below.



1 Exact wording from GRSP 2021 survey in quotation and italics.

WEF Top 35 Risks

Environmental Risks

- ▶ **Biodiversity loss and ecosystem collapse:** Irreversible consequences for the environment, humankind, and economic activity, and a permanent destruction of natural capital, as a result of species extinction and/or reduction.
- ▶ **Climate action failure:** Failure of governments and businesses to enforce, enact or invest in effective climate- change adaptation and mitigation measures, preserve ecosystems, protect populations and transition to a carbon-neutral economy.
- ▶ **Extreme weather events:** Loss of human life, damage to ecosystems, destruction of property and/or financial loss at a global scale as a result of extreme weather events: cold fronts, fires, floods, heat waves, windstorms etc.
- ▶ **Human-made environmental damage:** Loss of human life, financial loss and/or damage to ecosystems as a result of human activity and/or failure to co-exist with animal ecosystems: deregulation of protected areas, industrial accidents, oil spills, radioactive contamination, wildlife trade etc.
- ▶ **Major geophysical disasters:** Loss of human life, financial loss and/or damage to ecosystems as a result of geophysical disasters: earthquakes, landslides, geomagnetic storms, tsunamis, volcanic activity etc.
- ▶ **Natural resource crises:** Chemical, food, mineral, water or other natural resource crises at a global scale as a result of human overexploitation and/or mismanagement of critical natural resources.

Societal Risks

- ▶ **Collapse or lack of social security systems:** Non-existence or widespread bankruptcy of social security systems and/or erosion of social security benefits: disability, elderly, family, injury, maternity, medical care, sickness, survivor, unemployment, etc.
- ▶ **Employment and livelihood crises:** Structural deterioration of work prospects and/or standards for the working-age population: unemployment, underemployment, lower wages, fragile contracts, erosion of worker rights, etc.
- ▶ **Erosion of social cohesion:** Loss of social capital and a fracture of social networks negatively impacting social stability, individual well-being and economic productivity, as a result of persistent public anger, distrust, divisiveness, lack of empathy, marginalization of minorities, political polarization, etc.
- ▶ **Failure of public infrastructure:** Unequitable and/or insufficient public infrastructure and services as a result of mismanaged urban sprawl, poor planning and/or under-investment, negatively impacting economic advancement, education, housing, public health, social inclusion, and the environment.
- ▶ **Infectious diseases:** Massive and rapid spread of viruses, parasites, fungi or bacteria that cause an

uncontrolled contagion of infectious diseases, resulting in an epidemic or pandemic with loss of life and economic disruption.

- ▶ **Large-scale involuntary migration:** Large-scale involuntary migration induced by climate change, discrimination, lack of economic advancement opportunities, persecution, natural or human-made disasters, violent conflict, etc.
- ▶ **Pervasive backlash against science:** Censure, denial and/or scepticism towards scientific evidence and the scientific community at a global scale, resulting in a regression or stalling of progress on climate action, human health, and/or technological innovation.
- ▶ **Severe mental health deterioration:** Pervasiveness of mental health ailments and/or disorders globally and across multiple demographics, negatively impacting well-being, social cohesion and productivity: anxiety, dementia, depression, loneliness, stress, etc.
- ▶ **Widespread youth disillusionment:** Youth disengagement and lack of confidence and/or loss of trust with existing economic, political, and social structures at a global scale, negatively impacting social stability, individual well-being, and economic productivity.

Geopolitical Risks

- ▶ **Collapse of a multilateral institution:** Dissolution of a global multilateral institution established to resolve economic, environmental, geopolitical, and/or humanitarian crises with regional or global implications: border disputes, environmental commitments, migration crises, health emergencies, trade disputes, etc.
- ▶ **Fracture of interstate relations:** Economic, political, and/or technological rivalries between geopolitical powers, resulting in a fracture of bilateral relations and/or growing tensions.
- ▶ **Geopolitization of strategic resources:** Concentration, exploitation, and/or mobility restriction by a state, of goods, knowledge, services, or technology critical to human development with the intent of gaining geopolitical advantage.
- ▶ **Interstate conflict:** Belligerent bilateral or multilateral conflict between states with global consequences: biological, chemical, cyber and/or physical attacks, military interventions, proxy wars, etc.
- ▶ **State collapse:** Collapse of a state with global geopolitical importance as a result of internal conflict, breakdown of rule of law, erosion of institutions, military coup, regional and global instability.
- ▶ **Terrorist attacks:** Large-scale, scattered, or isolated terrorist attacks carried out by individuals or non-state groups with ideological, political, or religious goals, resulting in loss of life, severe injury, and/or material damage.
- ▶ **Weapons of mass destruction:** Deployment of biological, chemical, cyber, nuclear, and radiological weapons, resulting in loss of life, destruction, and/or international crises.

Technological Risks

- ▶ **Adverse outcomes of technological advances:** Intended or unintended negative consequences of

technological advances on individuals, businesses, ecosystems, and/or economies: AI, brain-computer interfaces, biotechnology, geo-engineering, quantum computing, etc.

- ▶ **Breakdown of critical information infrastructure and networks:** Deterioration, saturation, or shutdown of critical physical and digital infrastructure or services as a result of a systemic dependency on cyber networks and/or technology: AI-intensive systems, internet, hand-held devices, public utilities, satellites, etc.
- ▶ **Digital inequality:** Fractured and/or unequal access to critical digital networks and technology, between and within countries, as a result of unequal investment capabilities, lack of necessary skills in the workforce, insufficient purchase power, government restrictions, and/or cultural differences.
- ▶ **Digital power concentration:** Concentration of critical digital assets, capabilities, and/or knowledge by a reduced number of individuals, businesses, or states, resulting in discretionary pricing mechanisms, lack of impartial oversight, unequal private and/or public access, etc.
- ▶ **Failure of cybersecurity measures:** Business, government, and household cybersecurity infrastructure and/or measures are outstripped or rendered obsolete by increasingly sophisticated and frequent cybercrimes, resulting in economic disruption, financial loss, geopolitical tensions, and/or social instability.
- ▶ **Failure of technology governance:** Lack of globally accepted frameworks, institutions, or regulations for the use of critical digital networks and technology, as a result of different states or groups of states adopting incompatible digital infrastructure, protocols, and/or standards.

Economic Risks

- ▶ **Asset bubble burst in large economies:** Prices for housing, investment funds, shares, and other assets in a large economy increasingly disconnected from the real economy.
- ▶ **Collapse of a systemically important industry:** Collapse of a systemically important global industry or firm with an impact on the global economy, financial markets, and/or society.
- ▶ **Debt crises in large economies :** Corporate and/or public finances overwhelmed by debt accumulation and/or debt servicing in large economies, resulting in mass bankruptcies, defaults, insolvency, liquidity crises, or sovereign debt crises.
- ▶ **Failure to stabilize price trajectories:** Inability to control an unmanageable increase (inflation) or decrease (deflation) in the general price level of goods and services.
- ▶ **Proliferation of illicit economic activity:** Global proliferation of informal and/or illegal activities that undermine economic advancement and growth: counterfeiting, illicit financial flows, illicit trade, tax evasion, human trafficking, organized crime, etc.
- ▶ **Prolonged economic stagnation:** Near-zero or slow global growth lasting for many years.
- ▶ **Severe commodity shocks:** Abrupt shocks to the supply and demand of systemically important commodities at a global scale that strain corporate, public, and/or household budgets: chemicals, emissions, energy, foods, metals, minerals, etc.

Dissemination Strategy

In order to report on response rate and define the population sampled, the survey was conducted by invitation only and sent to targeted groups of known membership composed of scientists. Groups were invited with the aim of soliciting expertise for every category of risk. These included: Future Earth Global Research Project Scientific Steering Committee members, Future Earth Knowledge Action Network Development Teams, focal points from the Future Earth Early Career Researchers Network of Networks, researchers affiliated with the International Observatory on the Societal Impacts of Artificial Intelligence and Digital Technologies (OBVIA), International Science Council (ISC) members (including Unions, Academies of Science, and affiliated members), members of

the ISC Governing Board, members of the ISC Advisory Committees (including the Committees on Science Planning, Outreach and Engagement, Funding and Fundraising, and Small Island Developing States liaison), and ISC Affiliated Bodies (Scientific Committees and heads of Secretariat Programmes and Committees, excluding Future Earth since they are already covered in the groups above). In addition, two new groups were created namely, a group of Nominated Experts from the Future Earth and ISC communities respectively. Both organizations put out a call for nominations in May 2021. Individuals could either nominate themselves or a peer to join a group of experts who would receive the GRSP survey. These groups of Nominated Experts were pre-screened for exclusion criteria (minimum Master's degree or equivalent).

Table S.M.1. Details on the groups surveyed and response rate. This provides additional details on the groups of known membership whose members were contacted to take the invitation-only survey.

Group name	# Members	# Respondents	Response rate (%)
Future Earth Global Research Projects Scientific Steering Committees	128	14	11%
Future Earth Knowledge-Action Networks Development Teams	111	24	22%
Future Earth Early Career Researchers Network of Networks Focal Points	25	9	36%
Future Earth Nominated Experts	43	12	28%
ISC Governing Board	16	2	13%
ISC Advisory Committees	36	9	25%
ISC Affiliated Bodies	308	54	18%
ISC Members	239	30	13%
ISC Nominated Experts	121	55	45%
International Observatory on the Social Impacts of AI and Digital Technology Members	250	10	4%
TOTAL	1277	219	17%

The survey was open from June 16 until July 28, 2021 for a total of six weeks. One invitation email and two reminders were sent to members of each of the targeted groups.

Analysis Methodology

Likelihood and Impact

Averages for all Likert responses to questions on likelihood and potential negative impact in the GRSP survey were calculated. Averages for WEF data were taken from the Marsh McLennan website, a project partner on the WEF 2021 Global Risks Report ([Marsh McLennan, 2021](#)). These average values were used to create the scatter plots in Figures 1 and 2. Average values from GRSP respondents were also used to inform the top 10 risks by likelihood and impact (Table 3).

Interconnections

Responses to the survey question asking respondents to identify up to 10 risks they believed were *“most likely to have compounding effects and to lead to a global systemic crisis”* informed this analysis. First, the number of times each possible pair of risks was selected in the same cluster by the same respondent was calculated (number of overlaps). This data was used in the software gephi to create a network map where the edges between nodes (representing the Top 35 risks) were weighted based on the number of overlaps. Two algorithms within gephi were used to create the network map. The Force Atlas algorithm was used to position the nodes in gephi, which creates a layout of relationships in a scale-free network, followed by the NoOverlaps algorithm to position

the labels.

Additional Risks

Responses to the open-ended questions on additional risks, where respondents were asked to provide up to three responses, were coded independently by a team of three researchers who then consolidated coding categories and re-coded the responses, following Qualitative Content Analysis methodology ([Schreier, 2012](#)).

Any responses clearly linked to the WEF Top 35 were coded as such, and then further analyzed to understand whether there was a slight difference in framing from WEF in order to identify nuances highlighted by GRSP survey respondents. For each additional risk identified, respondents were also asked to evaluate likelihood and potential negative impact using the same five-point Likert scale as the WEF Top 35 risks.

Demographics

The data from 315 total or partial responses was downloaded from Survey Monkey. Data was cleaned, excluding any responses where consent to take the survey was not given, where respondents did not have at minimum a Masters degree or equivalent (or did not respond to that question), and where there was no response to at least one demographics question. This left 219 usable responses from respondents in 65 countries around the world, 35% of whom were female and 65% of whom were male. Additional details on the demographic breakdown of survey respondents can be found in the summary graphics below.

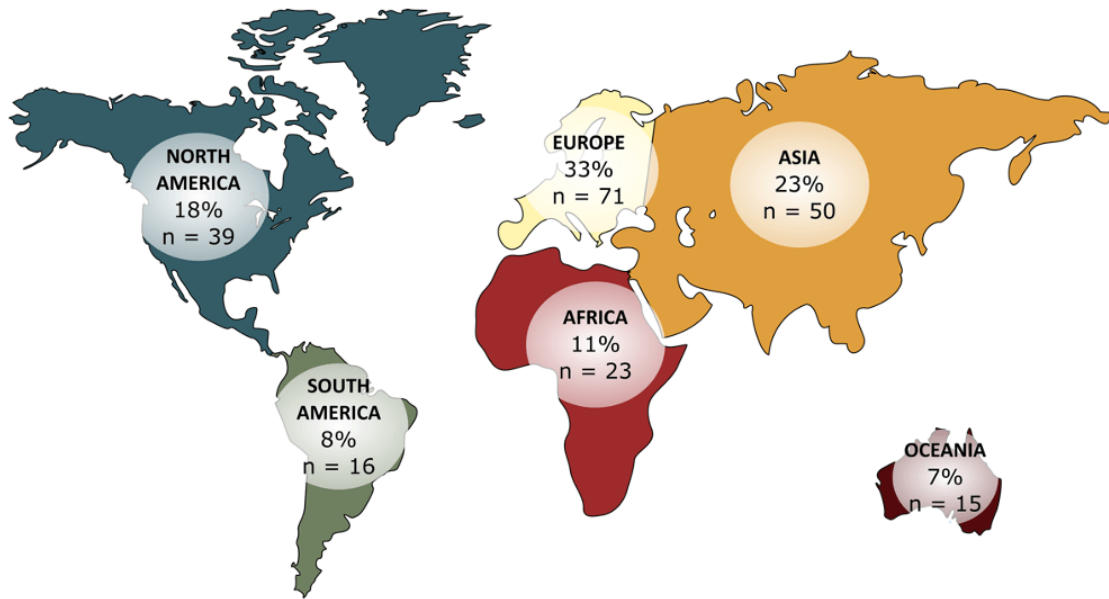


Figure S.M.1. Geographic distribution of respondents to the 2021 Global Risks Scientists’ Perceptions survey.

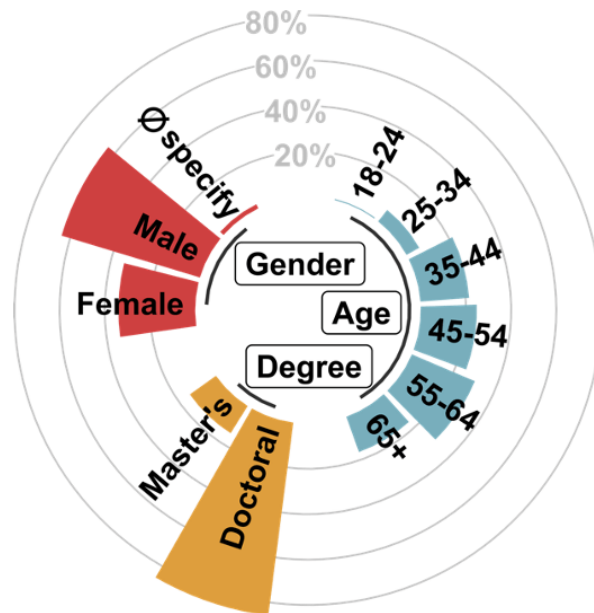


Figure S.M.2. Distribution of respondents (% of total respondents) by gender (red), age (blue), and highest level of education (yellow). For degree, the response indicates the highest degree obtained, and the question referred explicitly to a Master’s or doctoral degree or equivalent. Respondents with less than a Master’s degree were not included in the analysis.

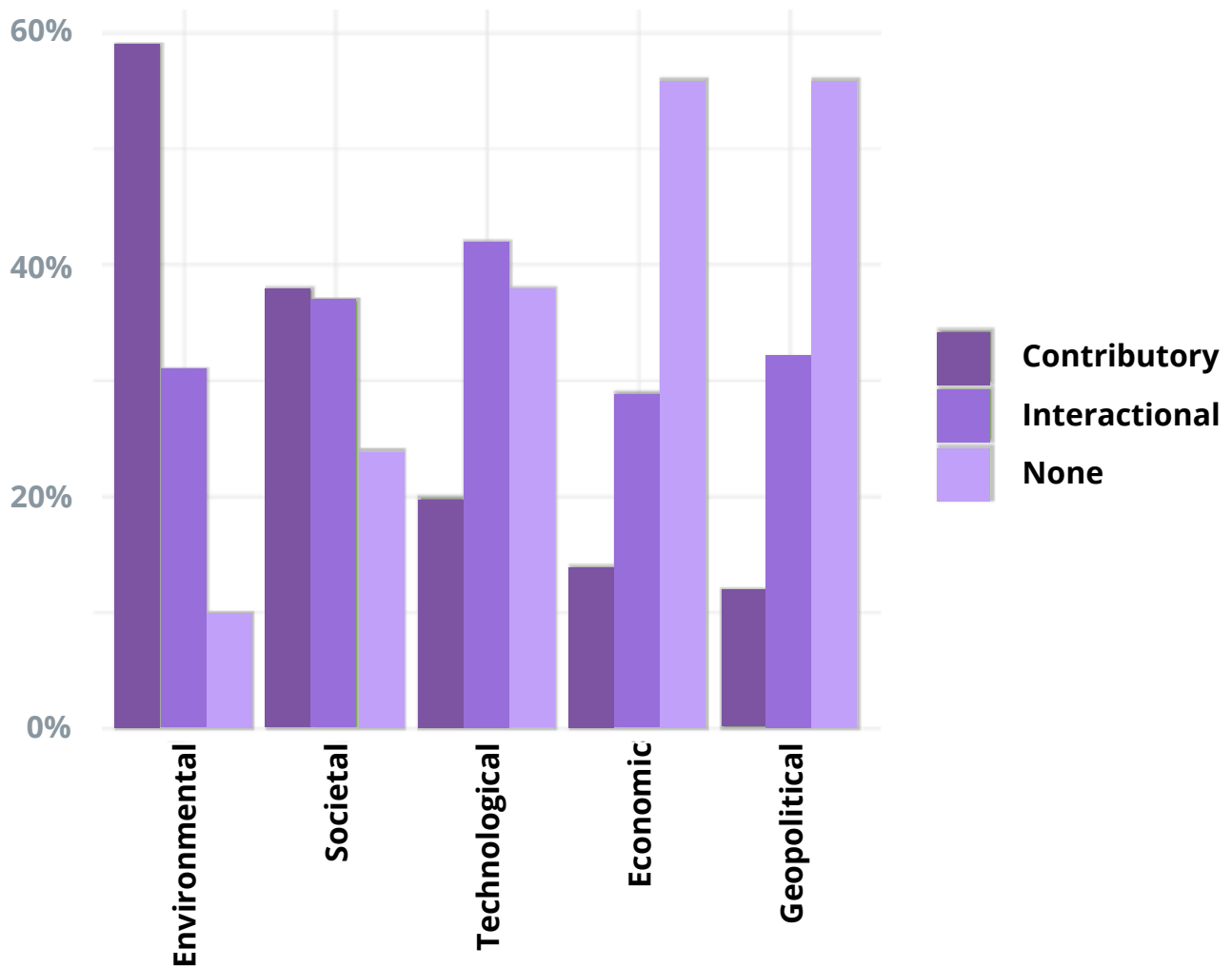


Figure S.M.3. Distribution of respondents (%) by self-declared level of expertise in each of the 5 risk categories. Level of risk was qualified as *contributory* - training and research qualify respondents to contribute to advancing scientific understanding; *interactional* - some specialized training, ability to interact and debate with experts, and; *no expertise* - no specialized training, popular understanding of main issues.

Full Text - Survey

2021 Global Risks Scientists' Perceptions survey

Background

We know that global risks are increasingly complex, uncertain, systemic, and dynamic. The unprecedented global disruptions emerging as a result of the COVID-19 pandemic have drawn attention to the critical importance of global risks around the world. To tackle global risks effectively, we will need a stronger understanding of the likelihood, impact, and linkages between a wide range of risks. The 2021 edition of the Global Risks Scientists' Perception survey is designed specifically to complement the World Economic Forum's (WEF) annual Global Risks Report, which reports on the global risk perceptions of leaders from business, economics, and government. This survey will contribute to the discourse that has been shaped through WEF's important work with an international analysis of scientists' perceptions of global risks.

In this survey, we use the WEF definition of global risk, which 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"*.

The goal of this survey is to spark dialogue, identify knowledge gaps, and support the growth of a multi-sectoral community working toward solutions to global risks. This is a survey of scientists with at minimum a Masters degree or equivalent and you will be asked about your experience and level of expertise in evaluating different types of risk. This information will be used to help assess the perceptions of scientists as a group, and the perceptions of experts on particular types of risk.

In this survey you will be asked to:

- Evaluate the likelihood and potential negative impact over the next ten years for the Top 35 risks identified in the WEF Global Risks Report 2021 (language used to describe the Top 35 risks taken directly from WEF 2021).
- Identify any additional risks not covered in the Top 35. Identify clusters of interconnected risks.
- Identify risks we may be committing to within the next 10 years that could play out over a longer time span.

We expect that the full survey will take approximately 15 minutes to complete. The survey will remain open until July 28, 2021.

Consenting to the study

Study Title: Global Risks Scientists' Perceptions survey 2021

Researcher: Seth Wynes, Department of Geography, Planning and Environment, Concordia University
Researcher's

Contact Information: 1455 de Maisonneuve W.
H 1255-26, Montreal, Quebec, Canada
christopherseth.wynes@concordia.ca

You are being invited to participate in the research study mentioned above. Below we provide information about what participating would mean. Please read carefully before deciding if you want to participate or not. If there is anything you do not understand, or if you want more information, please ask the researcher.

A. PURPOSE

The purpose of the research is to gain a better understanding of how scientists conceive of global risks.

B. PROCEDURES

If you participate, you will be asked to take a 15 minute survey.

C. RISKS AND BENEFITS

This research is not intended to benefit you personally but poses no risks beyond those experienced in everyday life.

D. CONFIDENTIALITY

We will gather the following information as part of this research:

Your opinions on global risks as well as basic demographic information.

* While we are analyzing the data, we will not allow anyone to access the information except people directly involved in conducting the research. We will only use the information for the purposes of the research described in this form. The information gathered will be anonymous. That means that it will not be possible to make a link between you and the information you provide. We will protect the information by storing the data on password protected files until the analysis is complete (note that data will also be stored with Survey Monkey on servers in the United States and will be subject to the US Patriot Act). We intend to publish the results of the research. The data will be made openly accessible to the public once it is published however, it will not be possible to identify you in the published results.

E. CONDITIONS OF PARTICIPATION

You do not have to participate in this research. It is purely your decision. If you do participate, you can stop at any time. There will be no negative consequences for not participating or stopping in the middle.

F. QUESTIONS

If you have questions about the scientific or scholarly aspects of this research, please contact the researcher. If you have concerns about ethical issues in this research, please contact the Manager, Research Ethics, Concordia University, 514.848.2424 ex. 7481 or oor.ethics@concordia.ca.

PARTICIPANT'S DECLARATION

By clicking "Yes" below you agree that you have read and understood this form. You also agree that you have had the chance to ask questions and any questions have been answered and agree to participate in this research under the conditions described.

Do you agree to participate? [Yes / No]

Scientific Expertise

In order to analyze scientists' perceptions, we need to understand your level and area(s) of scientific expertise. What is your highest academic degree? [*Bachelor's degree or equivalent; Master's degree or equivalent; Doctor of Medicine (MD); Law degree; Doctoral degree*]

In this survey, we will ask you to evaluate the World Economic Forum's Top 35 Risks. WEF groups global risks into five categories:

Environmental Risks

- Biodiversity loss and ecosystem collapse
- Climate action failure
- Extreme weather events
- Human-made environmental damage
- Major geophysical disasters
- Natural resource crises

Societal Risks

- Collapse or lack of social security systems
- Employment and livelihood crises
- Erosion of social cohesion
- Failure of public infrastructure
- Infectious diseases
- Large-scale involuntary migration
- Pervasive backlash against science
- Severe mental health deterioration
- Widespread youth disillusionment

Geopolitical Risks

- Collapse of a multilateral institution
- Fracture of interstate relations
- Geopolitization of strategic resources
- Interstate conflict
- State collapse
- Terrorist attacks
- Weapons of mass destruction

Technological Risks

- Adverse outcomes of technological advances
- Breakdown of critical information infrastructure
- Digital inequality
- Digital power concentration
- Failure of cybersecurity measures
- Failure of technology governance

Economic Risks

- Asset bubble burst in large economies
- Collapse of a systemically important industry
- Debt crises in large economies
- Failure to stabilize price trajectories
- Proliferation of illicit economic activity
- Prolonged economic stagnation
- Severe commodity shocks

For each category of risk, please evaluate your level of scientific expertise. DO you have:

- **No expertise:** No specialized training in this category of risk, only popular understanding or awareness of main issues,
- **Interactional expertise:** Some specialized training in this category of risk, ability to interact and debate with other experts on key topics, or
- **Contributory expertise:** Your training and research qualify you to contribute to advancing the scientific understanding of this category of risks.

	No expertise	Interactional expertise	Contributory expertise
Environmental Risks			
Societal Risks			
Geopolitical Risks			
Technological Risks			
Economic Risks			

MODULE I - Evaluating Global Risks

Survey instructions

Please evaluate:

- The likelihood of each risk occurring globally (with impacts across multiple countries) within the next 10 years and
- The potential negative impact from adverse consequences of each risk (for several countries or industries) if it were to occur in the next 10 years.

Note that the name and description of each risk deliberately mirrors the exact wording from the WEF Global Risks Report 2021.

[Under each risk listed below - the following response options are listed. Respondents can select one option per row. Survey instructions are repeated for each category of risk. The order in which risk categories appeared to respondents in the survey was randomized.]

	1 (Very unlikely / Minimal)	2	3	4	5 (Very likely / Catastrophic)	I don't know
Likelihood						
Negative impact						

ENVIRONMENTAL RISKS

Biodiversity loss and ecosystem collapse: Irreversible consequences for the environment, humankind, and economic activity, and a permanent destruction of natural capital, as a result of species extinction and/or reduction.

Climate action failure: Failure of governments and businesses to enforce, enact or invest in effective climate- change adaptation and mitigation measures, preserve ecosystems, protect populations and transition to a carbon-neutral economy.

Extreme weather events: Loss of human life, damage to ecosystems, destruction of property and/or financial loss at a global scale as a result of extreme weather events: cold fronts, fires, floods, heat waves, windstorms etc.

Human-made environmental damage: Loss of human life, financial loss and/or damage to ecosystems as a result of human activity and/or failure to co-exist with animal ecosystems: deregulation of protected areas, industrial accidents, oil spills, radioactive contamination, wildlife trade etc.

Major geophysical disasters: Loss of human life, financial loss and/or damage to ecosystems as a result of geophysical disasters: earthquakes, landslides, geomagnetic storms, tsunamis, volcanic activity etc.

Natural resource crises: Chemical, food, mineral, water or other natural resource crises at a global scale as a result of human overexploitation and/or mismanagement of critical natural resources.

SOCIETAL RISKS

Collapse or lack of social security systems: Non-existence or widespread bankruptcy of social security systems and/or erosion of social security benefits: disability, elderly, family, injury, maternity, medical care, sickness, survivor, unemployment, etc.

Employment and livelihood crises: Structural deterioration of work prospects and/or standards for the working-age population: unemployment, underemployment, lower wages, fragile contracts, erosion of worker rights, etc.

Erosion of social cohesion: Loss of social capital and a fracture of social networks negatively

impacting social stability, individual well-being and economic productivity, as a result of persistent public anger, distrust, divisiveness, lack of empathy, marginalization of minorities, political polarization, etc.

Failure of public infrastructure: Unequitable and/or insufficient public infrastructure and services as a result of mismanaged urban sprawl, poor planning and/or under-investment, negatively impacting economic advancement, education, housing, public health, social inclusion, and the environment.

Infectious diseases: Massive and rapid spread of viruses, parasites, fungi or bacteria that cause an uncontrolled contagion of infectious diseases, resulting in an epidemic or pandemic with loss of life and economic disruption.

Large-scale involuntary migration: Large-scale involuntary migration induced by climate change, discrimination, lack of economic advancement opportunities, persecution, natural or human-made disasters, violent conflict, etc.

Pervasive backlash against science: Censure, denial and/or scepticism towards scientific evidence and the scientific community at a global scale, resulting in a regression or stalling of progress on climate action, human health, and/or technological innovation.

Severe mental health deterioration: Pervasiveness of mental health ailments and/or disorders globally and across multiple demographics, negatively impacting well-being, social cohesion and productivity: anxiety, dementia, depression, loneliness, stress, etc.

Widespread youth disillusionment: Youth disengagement and lack of confidence and/or loss of trust with existing economic, political, and social structures at a global scale, negatively impacting social stability, individual well-being, and economic productivity.

GEOPOLITICAL RISKS

Collapse of a multilateral institution: Dissolution of a global multilateral institution established to resolve economic, environmental, geopolitical, and/or humanitarian crises with regional or global implications: border disputes, environmental commitments, migration crises, health emergencies, trade disputes, etc.

Fracture of interstate relations: Economic, political, and/or technological rivalries between geopolitical powers, resulting in a fracture of bilateral relations and/or growing tensions.

Geopolitization of strategic resources: Concentration, exploitation, and/or mobility restriction by a state, of goods, knowledge, services, or technology critical to human development with the intent of gaining geopolitical advantage.

Interstate conflict: Belligerent bilateral or multilateral conflict between states with global consequences: biological, chemical, cyber and/or physical attacks, military interventions, proxy wars, etc.

State collapse: Collapse of a state with global geopolitical importance as a result of internal conflict,

breakdown of rule of law, erosion of institutions, military coup, regional and global instability.

Terrorist attacks: Large-scale, scattered, or isolated terrorist attacks carried out by individuals or non-state groups with ideological, political, or religious goals, resulting in loss of life, severe injury, and/or material damage.

Weapons of mass destruction: Deployment of biological, chemical, cyber, nuclear, and radiological weapons, resulting in loss of life, destruction, and/or international crises.

TECHNOLOGICAL RISKS

Adverse outcomes of technological advances: Intended or unintended negative consequences of technological advances on individuals, businesses, ecosystems, and/or economies: AI, brain-computer interfaces, biotechnology, geo-engineering, quantum computing, etc.

Breakdown of critical information infrastructure and networks: Deterioration, saturation, or shutdown of critical physical and digital infrastructure or services as a result of a systemic dependency on cyber networks and/or technology: AI-intensive systems, internet, hand-held devices, public utilities, satellites, etc.

Digital inequality: Fractured and/or unequal access to critical digital networks and technology, between and within countries, as a result of unequal investment capabilities, lack of necessary skills in the workforce, insufficient purchase power, government restrictions, and/or cultural differences.

Digital power concentration: Concentration of critical digital assets, capabilities, and/or knowledge by a reduced number of individuals, businesses, or states, resulting in discretionary pricing mechanisms, lack of impartial oversight, unequal private and/or public access, etc.

Failure of cybersecurity measures: Business, government, and household cybersecurity infrastructure and/or measures are outstripped or rendered obsolete by increasingly sophisticated and frequent cybercrimes, resulting in economic disruption, financial loss, geopolitical tensions, and/or social instability.

Failure of technology governance: Lack of globally accepted frameworks, institutions, or regulations for the use of critical digital networks and technology, as a result of different states or groups of states adopting incompatible digital infrastructure, protocols, and/or standards.

ECONOMIC RISKS

Asset bubble burst in large economies: Prices for housing, investment funds, shares, and other assets in a large economy increasingly disconnected from the real economy.

Collapse of a systemically important industry: Collapse of a systemically important global industry or firm with an impact on the global economy, financial markets, and/or society.

Debt crises in large economies: Corporate and/or public finances overwhelmed by debt

accumulation and/or debt servicing in large economies, resulting in mass bankruptcies, defaults, insolvency, liquidity crises, or sovereign debt crises.

Failure to stabilize price trajectories: Inability to control an unmanageable increase (inflation) or decrease (deflation) in the general price level of goods and services.

Proliferation of illicit economic activity: Global proliferation of informal and/or illegal activities that undermine economic advancement and growth: counterfeiting, illicit financial flows, illicit trade, tax evasion, human trafficking, organized crime, etc.

Prolonged economic stagnation: Near-zero or slow global growth lasting for many years.

Severe commodity shocks: Abrupt shocks to the supply and demand of systemically important commodities at a global scale that strain corporate, public, and/or household budgets: chemicals, emissions, energy, foods, metals, minerals, etc.

MODULE II - Identifying Additional Global Risks and Clusters of Risks

Survey instructions:

Please identify up to three (3) additional risks not covered in the Top 35 Global Risks identified by WEF covered in Module I. For each additional risk, please evaluate:

- The likelihood of each risk occurring globally (with impacts across multiple countries) within the next 10 years, and
- The potential negative impact from adverse consequences of each risk (for several countries or industries) if it were to occur in the next 10 years.

Identify a subset of up to ten (10) global risks most likely to have synergistic effects and to lead to a Global Systemic Crisis.

Reminder: Top 35 Global Risks as identified by the World Economic Forum (WEF) in 2021 [*image depicting list of Top 35 Risks included again*].

[For questions 1-3, the following response options are listed.]

	1 (Very unlikely / Minimal)	2	3	4	5 (Very likely / Catastrophic)	I don't know
Likelihood						
Negative impact						

1. Briefly describe an additional global risk not included in the WEF Top 35 risks. [*open answer, 50 chr.*]
2. (Optional) Briefly describe an additional global risk not included in the WEF Top 35 risks. [*open answer, 50 chr.*]

3. (Optional) Briefly describe an additional global risk not included in the WEF Top 35 risks. [*open answer, 50 chr.*]
4. Based on your knowledge, which subset of the Top 35 global risks are most likely to have compounding effects and to lead to a global systemic crisis? Please identify one cluster of interconnected risks by selecting up to 10 risks.
[*Biodiversity loss and ecosystem collapse; Climate action failure; Extreme weather events; Human-made environmental damage; Major geophysical disasters; Natural resource crises; Collapse or lack of social security systems; Employment and livelihood crises; Erosion of social cohesion; Failure of public infrastructure; Infectious diseases; Large-scale involuntary migration; Pervasive backlash against science; Severe mental health deterioration; Widespread youth disillusionment; Collapse of a multilateral institution; Fracture of interstate relations; Geopolitization of strategic resources; Interstate conflict State collapse; Terrorist attacks; Weapons of mass destruction; Adverse outcomes of technological advances; Breakdown of critical information infrastructure; Digital inequality; Digital power concentration; Failure of cybersecurity measures; Failure of technology governance; Asset bubble burst in large economies; Collapse of a systemically important industry; Debt crises in large economies; Failure to stabilize price trajectories; Proliferation of illicit economic activity; Prolonged economic stagnation; Severe commodity shocks; Other - please specify (50 chr.)*]
5. So far, you've responded to questions on Global Risks with a 10-year time scale in mind. Now we want to know if there are risks that we could *commit to and/or cross a threshold towards within the next 10 years* that could *put us on a path toward irreversible or catastrophic outcomes that manifest after the 10-year timespan*? Please provide examples. [*open answer, no chr. limit*]
6. From your perspective, how has overall systemic risk changed over the past year – are we living in a higher or lower risk world? [*Greatly decreased; Decreased; Stayed the same; Increased; Greatly increased*]
7. What factors contribute most significantly to your perspective of how systemic risk has changed over the past year? Please list up to three. [*open answer, no chr. limit*]

DEMOGRAPHIC QUESTIONS

What type of institution are you affiliated with? [*University or university-affiliated research organization; Research organization (external to university); Non-governmental or international organization; Private sector organization; Other - please specify (50 chr.)*]

What scientific domain best describes your work? [*open answer, 50 chr.*]

For how many years have you worked in a scientific organization or capacity since receiving your highest degree? [*<1 year; 1-5 years; 5-10 years; >10 years*]

Where are you based [*drop-down menu of 196 countries + other - please specify (50 chr.)*]

What is your age range? [*18-24; 25-34; 35-44; 45-54; 55-64; 65+*]

Which gender do you most identify with? [*female; male; non-binary; rather not specify*]

Where did you hear about the Global Risks Scientists' Perceptions survey? [*I received a direct invitation through my membership in the ISC; I was nominated through the ISC Open Call; I received a direct invitation through my membership in Future Earth; I was nominated through the Future Earth Open Call; I received a direct invitation through another channel (please specify - 50 chr.)*]

Thank you for participating in the survey.

Results from this survey will be used to inform the Future Earth - International Science Council Risks Perceptions Report 2021 and to improve the survey tool for future iterations. We hope that the results from this survey will help foster a more dynamic dialogue among actors and across disciplines on our common global risks.

Do you have any feedback or comments for us? [*open answer - no chr. limit*]

This survey was designed in collaboration with a team of scientific advisors: [*List of Advisors with affiliations*]