Global Governance and Global Catastrophic Risks: Is the United Nations ready for the Anthropocene?

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Executive Summary

The United Nations (UN) was founded on the idea that, if states came together, another catastrophic war of the scale and suffering of World War II could be avoided. Since then, the nature and perception of global catastrophic risk have changed dramatically. Earthquakes, volcanic eruptions and tsunamis still occur, but the range of hazards that are driven at least in part by destructive human action—Anthropocenic risks—has broadened. In addition, some hazards once thought to be exclusively the result of natural processes are now known to be occasionally triggered by human action. The distinction between natural and human-induced risks is being rethought, and perhaps abandoned altogether, in light of the Anthropocene.

As the main anchor of global governance, the UN has tried to understand, anticipate, and adapt to changing notions of risk through early warning systems, early response approaches, and communications channels to scientific communities that monitor certain risks more directly. Some of these tools and mechanisms concentrate on disaster preparedness and response, while others focus more on armed conflict or climate change. Several UN leaderships, including a number of Secretaries-General, have also tried to invest more heavily in prevention of risk, sometimes with corresponding organizational reforms. However, the UN's adaptation to global catastrophic risks has remained piecemeal and highly variable in its efficacy.

Is the UN ready for the Anthropocene? This paper undertakes a literature review in order to analyze the capacities and gaps in the ability of the UN system in anticipating, tracking, and responding to the emerging risks of the Anthropocene. An institutional perspective is adopted, focusing on the organizational structures, practices and capacities in place (or the lack thereof) in light of emerging risks. The guiding questions are:

1. What major risks has the UN system dealt with in the past, and how did these experiences with catastrophes shape the UN's approach?
2. To what extent is the UN system "fit for purpose" in anticipating, monitoring, communicating, and responding to the emerging risks of the Anthropocene?
3. What are the major knowledge gaps regarding global governance and global catastrophic risks, especially as they relate to the role of the UN?

More specifically, the report reviews the existing scholarship on the UN system's own capacity, as well as its ability to harness external capacity, across four dimensions derived from the UN's approach to early warning systems (EWSs): risk knowledge; monitoring and warning service; dissemination and communication; and response capability. The paper argues that major gaps remain across four dimensions and identifies priority areas for further research.

Introduction

The United Nations (UN) was founded on the idea that, if states came together, another catastrophic war of the scale and suffering of World War II could be avoided. Since then, although the specter of another world war has not receded altogether, the nature and perception of global catastrophic risk have changed dramatically. In comparison to the mid-1940s, humans live in a world that is not only much more densely populated, but also one in which the speed of social change has accelerated immensely. This scenario generates new uncertainties and exacerbates old anxieties, including existential ones. Earthquakes, volcanic eruptions and tsunamis still occur, but the range of hazards that are driven at least in part by destructive human action—Anthropocenic risks—has broadened. In addition, some hazards once thought to be exclusively the result of natural processes are now known to be occasionally triggered by human action—including earthquakes. The distinction between natural and human-induced risks is being rethought, and perhaps abandoned altogether, in light of the Anthropocene.

As the main anchor of global governance, the UN has tried to understand, anticipate, and adapt to changing notions of risk. Early warning systems, early response approaches, and communications channels to scientific communities that monitor certain risks more directly. Some of these concentrate on disaster preparedness and response, while others focus more on armed conflict or climate change. Several UN leaderships, including a number of Secretaries-General, have also tried to invest more heavily in prevention of risk, sometimes with corresponding organizational reforms. However, for the most part, the UN's adaptation to major risk has remained piecemeal and highly variable in its efficacy.

This paper is premised on the idea that, rather than inventing new governance mechanisms from scratch, the most effective and legitimate route for dealing with unknown (or little understood) risks is to strengthen the existing global governance system. Despite the current crisis of multilateralism, with new discursive attacks and budgetary pressures, the world would be in much greater peril without the UN. There is thus no need to reinvent the wheel; the basic capacities are in place. While many risks cannot be averted, it is possible to significantly improve on the existing mechanisms and develop new ones altogether. Innovation is needed so as to render the UN system more aware, agile, and responsive to the emerging risks of the Anthropocene, whether by developing its own toolkits or by deepening partnerships with other international organizations, civil society entities, and private sector actors.

Toward this end, the paper undertakes a literature review in order to analyze the capacities and gaps in the ability of the UN system in anticipating, tracking, and responding to the emerging risks of the Anthropocene. An institutional perspective is adopted, focusing on the organizational structures, practices and capacities in place (or the lack thereof) in light of emerging risks. The guiding questions are:

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This report is structured in the following manner. The first section provides an overview of the concept of global catastrophic risk and the idea of the Anthropocene, as well as their relevance to the UN system. The second section analyzes to what extent the UN architecture is fit for purpose to tackle emerging risks in light of the four dimensions specified above. The final part of the report notes key gaps in the knowledge on global governance and global catastrophic risks, focusing on key limitations on the UN's capacity to respond to the Anthropocene.

The Anthropocene and the Risk Society

Some aspects of life on Earth have generally improved over the past decades. Most post-industrial societies have experienced economic growth, a considerable level of welfare and security, and a long-lasting period of peace within their home territories. A number of emerging countries, such as China and India, have been able to lift hundreds of millions out of poverty. Worldwide extreme poverty has fallen by approximately half since 1990, although in highly uneven fashion across regions (World Bank 2019). Global average life expectancy increased by 5.5 years between 2000 and 2016—the fastest increase since the 1960s (World Health Organization 2019). The Global Hunger Index shows decline in world hunger between 2000 and 2017. Child mortality has fallen by more than half since 1990 (UNICEF 2019), and child labor has declined around 40% between 2000 to 2016 (International Labor Organization 2017). Literacy has increased, access to the internet is increasing, solar energy is getting less expensive (Matthews 2018). The overall numbers of victims of war, rape, and genocide have fallen.

There are also some improvements in governance, including as it relates to peace and security. As recently as 1993, most people around the world lived in autocratic states; as of early 2020, more than half of the countries on the planet are at least nominally democratic (Desilver 2019). Nuclear weapons stockpiles have shrunk dramatically starting in the late 1980s, down from a peak of around 70,300 in 1986 to an estimated 13,890 in early 2019 (Kristensen and Korda 2018). International courts of justice, arms control regimes, and cyber norms have been developed to curb and prevent certain kinds of violations.

On the other hand, some indicators also show worrisome declines in human security and the quality of global governance. The year 2017 was one of the most violent since the Cold War ended (Dupuy and Rustad 2017). Air pollution has broken new records in Indian cities, while deforestation has accelerated in contexts as varied as the Amazon and Congo basins. Armed conflicts have transformed in nature rather than abated; for instance, after declining during most of the 1990s, the number of major civil wars has nearly tripled over the past ten years (Einsiedel, Bosetti, Cockayne, Salih and Wan 2017). Since 2011, the number of battle deaths has increased six-fold, and the risk of conflict relapse has increased. Even outside conflict settings, developments in technology have eroded privacy in unprecedented ways and generated new forms of social exclusion (UNCTAD 2019), making parts of the world more vulnerable to sudden shocks. Despite bringing about many benefits, new biotechnology, from

low cost DNA sequencing to precision genome editing—has also raised the spectre of unconventional terrorist attacks, wars, and disasters (Future of Life 2019). Cyber attacks are spreading, from data fraud or theft to offensive maneuvers meant to impair critical infrastructure, and the fragmentation of cyber-space undercuts effective cyber governance (World Economic Forum 2020). Water, food and energy insecurity are exacerbated by climate change in ways that are still poorly understood (see, for instance, Mpandeli et al. 2018).

Many debates about the global catastrophic risks faced by humanity have come to revolve around the idea of the Anthropocene, and specifically the idea that anthropogenic risks are caused primarily by human action (Crutzen 2006, Davies 2016). Keys et al. (2019) qualify as Anthropocenic those risks that emerge from human-driven processes; interact with global social-ecological connectivity; and exhibit complex, cross-scale relationships. Indicators include global climate change, shifting weather cycles, radioactive fallout, large-scale species invasions, and the mass extinction of species (Ellis 2018, Zalasiewicsz et al. 2019). Key to the idea of the Anthropocene is that humankind today is not just witnessing but in fact also causing the sixth mass species extinction in the Earth's history.

As of February 2020, neither the International Commission on Stratigraphy (ICS) nor the International Union of Geological Sciences (IUGS) have officially approved the term Anthropocene as a recognized subdivision of geologic time. Nonetheless, within those bodies there are movements in the direction of official recognition of the Anthropocene, which scientists have argued began with the nuclear age (Subramanian 2019). Outside the scope of these bodies, the term has become more common not just in academic settings and publications, but also in key policy debates, scientific publications and conferences (UNDP 2019). At the same time, there are detractors of the term Anthropocene, for instance who argue that usage of the word can perpetuate misperceptions about humans and nature; some have proposed alternative expressions, such as Capitalocene and Chthulucene (Scientific American 2018).

While the language of the Anthropocene has not yet been widely adopted at the UN, in the 2010s it began to appear in important documents and speeches. In 2012, atmospheric scientist Mark Lawrence of the Max Planck Institute in Manz, Germany, told the General Assembly that "policymakers must accept that the world was in the Anthropocene geologic era" (UNGA 2012). Most notably, in January 2014, Secretary-General Ban ki-moon told his Scientific Advisory Board that "We have entered a new era, which has been given the name 'Anthropocene".

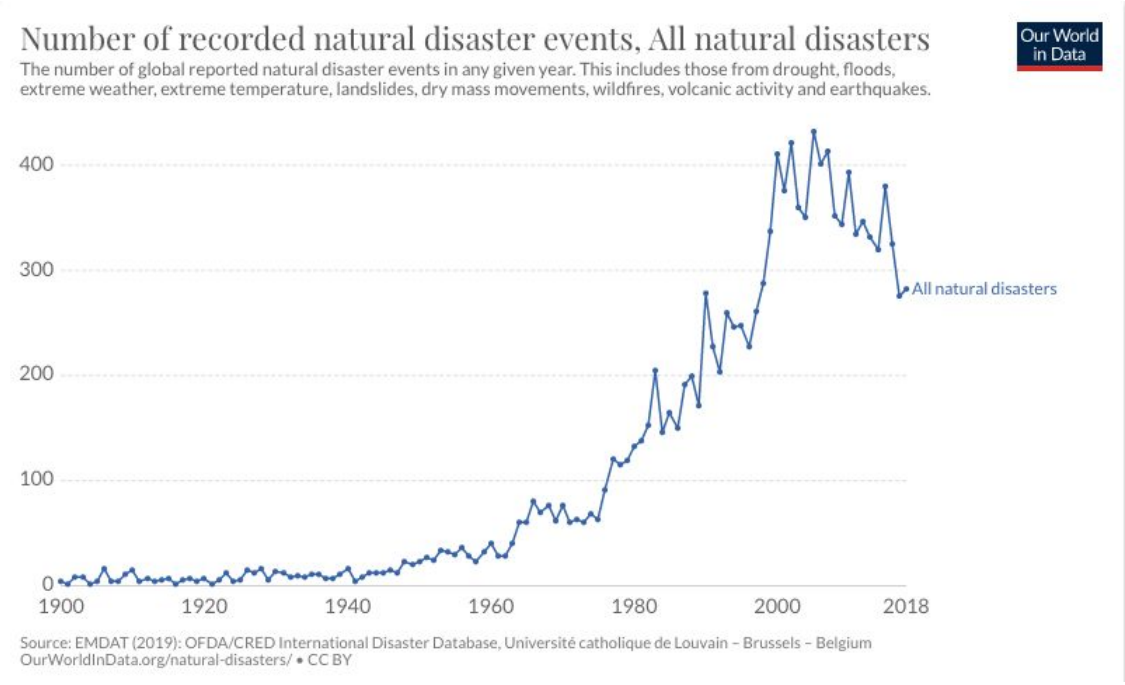
By the late 2010s, the term Anthropocene began appearing in key UN documents. The 2019 UN Human Development Report has a chapter on "Climate change and inequalities in the Anthropocene" (UNDP 2019), and in 2018 the UNESCO *Courier* published an issue devoted to the topic "Welcome to the Anthropocene! (UNDP 2018). The Sustainable Development Goals Partnerships Platform includes an initiative called "Glaciers and Sustainability in the Anthropocene," meant to raise societal awareness of glacier ecosystems vulnerability to natural and anthropogenic impacts (UN 2019). Although, as of February 2020, Secretary-General António Guterres has not directly referred to the Anthropocene, he has referred to climate change as "the defining issue of our time" (UN Secretary-General 2018). Indeed, since the 1992 "Earth Summit", the UN's engagement with climate action has come to encompass a variety of frameworks and mechanisms, including the Intergovernmental Panel on Climate Change (IPCC), legal instruments such as the United Nations Framework Convention on Climate Change (UNFCCC), the 1995 Kyoto Protocol, and the 2015 Paris Agreement. On September

23, 1019, Guterres convened a Climate Summit to bring world leaders of governments, the private sector and civil society together to support the multilateral process and to increase and accelerate climate action and ambition.

The increase in usage of the term Anthropocene, including at the UN, is in part a result of the growing evidence of changing trends in global risks. While the annual deaths due to natural disasters saw a sharp decline from 1900s onwards even as population expanded, extreme events are increasing in number (EM-DAT 2016). The global EM-DAT International Disaster Database, which records and assesses data on the occurrence of “natural” and “technological” disasters by individual countries and regions — show that events typically labelled as “natural disasters” are occurring more frequently than in the past. This trend can be attributed to the interaction of natural and human driven processes: a combination of Earth system processes driving extreme events; human activity; environmental mismanagement; and variations in resilience and vulnerability.

Moreover, the world's risks are not borne equally. Different populations bear risks to differing degrees; countries where social and economic capital are limited are the most vulnerable, and the poor are hit hardest by disaster (Dominey-Howes 2015). The "differential vulnerability" perspective in disasters presumes that a real disaster occurs when it strikes an underprivileged population with limited capacity to anticipate, cope with, resist, and recover from the impact of a natural hazard (Population Reference Bureau 2019). For instance, women and children—especially those in poverty—confront unique challenges when facing disasters. During the 2004 Indian Ocean Tsunami, four times as many women were killed as men, in part due to cultural differences that shaped their immediate responses to the disaster (MacDonald 2005).

Graph 1: Number of recorded natural disaster events, All natural disasters



Drivers of global risk in the Anthropocene

In addition to an increase in the occurrence and intensity of major disasters, the literature also shows that global risks are diversifying. The broadening of the range of global catastrophic risks is associated with structural changes that accelerate the speed of social change and interconnect risks in unprecedented ways. Among the key drivers of uncertainty are: demographic change; geopolitical shifts; political transformations; technological developments; and climate change.

First, at the demographic level, the world has experienced a population boom. Although for most of human prehistory and history population growth was very low, from 1800 to 2019 the world population has increased from 1 billion in 1800 to 7.7 billion (UNFPA 2019). And, despite an overall deceleration—the world population growth rate has halved from over 2% per year 50 years ago to 1.05% per year in 2019—the absolute numbers mean that more people are exposed to disasters and catastrophic risks. This exposure is especially acute in areas—such as Bangladesh, India, and Lebanon—that are densely populated yet which suffer from state fragility, poor infrastructure and high climate vulnerability.

Second, the past three decades have brought about deep geopolitical changes that generate new uncertainties. The accelerated institution-building that took place after World War II harnessed a surge of optimism in Western societies' ability to generate novel mechanisms for tackling global crises and, above all, preventing them altogether. Over the next few decades, this global governance architecture—anchored in the UN system and the Bretton Woods institutions—expanded to include an enlarged NATO, the OECD, WTO, and loose groupings like the G7, G20, and the BRICS. Globalization intensified, propelled by the rapid expansion of international trade, along with the premise that commercial opening could promote

democratization and peace. The liberal world order—part reality, part myth—thus replaced the bipolar configuration and ideological rivalries of the Cold War. In the 2010s, however, the decline of this liberal world order, and especially the rise or resurgence of China, Russia, and India, has led to new uncertainties about peace, conflict, development and governance (see Kagan 2018, Ikenberry 2018, and Acharya 2014).

A third and related source of increasing and diversifying global risks is political change, and most notably the spread of nationalist populism and anti-globalism (López-Alves and Johnson 2018). Since the start of the presidency of Donald Trump, in January 2017, the US government administration has undermined several key multilateral efforts, especially the Paris Agreement, migration and refugee global compacts, and the World Trade Organization (WTO); it has also torpedoed cooperation initiatives meant to curb nuclear risks, such as the Iran nuclear deal. While anti-globalism elsewhere in the world, such as Hungary, Brazil, the Philippines and India, is also driven primarily by domestic politics, there is also a contagion effect: the nationalist discourse of the leadership of the greatest power helps to legitimize and promote anti-globalist sentiment around the world. And the spread of anti-globalism has intensified the challenges of global governance, including as it relates to global risks. The budgets of major organizations, including the UN system, have been slashed, and political willpower to uphold the values of institutional liberalism has reached its lowest point since the Cold War.

At the same time, the crisis in governance and leadership has not led to clear alternatives (Beeson 2019). Ad-hoc coalitions of states have failed to create a unifying agenda for improved governance. The G8 (now G7) lost relevance after excluding Russia in 2014. Neither has the G20 been able to consolidate its intended role as steering committee for global politics. The BRICS grouping, despite its launch of new institutions such as the New Development Bank (NDB), has stumbled as Brazil and South Africa undergo economic recession and political turbulence and as China, India and Russia invest more heavily in Asia-centered initiatives such as the Belt and Road Initiative (BRI) and the Asian Infrastructure Investment Bank (AIIB). Across these spaces, expectations that China would offer an alternative leadership have proven unrealistic or, at the very least, too rushed. Despite its increasingly prominent role in organizations such as the UN and the World Bank, China has mostly adhered to Deng Xiaoping's pragmatic call to "cross the river by feeling the river stones," i.e., moving ahead cautiously by learning the terrain.

These geopolitical shifts and the associated rise in anti-globalism have had a considerable impact on democratic regimes around the world, although unevenly. In many countries, democracy has weakened "from within" as leaders showing increasingly authoritarian preferences maintain a veneer of democracy while eliminating democratic institutions (Ginsburg and Huq 2019, Levitsky and Ziblatt 2018).

Another factor accelerating social change in the Anthropocene is the emergence of new, disruptive technologies that are disseminated both widely and rapidly (Future of Life 2019). The pace at which these new technologies appear, enter the market and are disseminated has accelerated. Areas such as biotechnology (especially through the genetic modification of crops), machine learning and artificial intelligence (AI) have begun to impact different aspects of human life in surprising new ways. Even as such new technologies are unevenly adopted, certain baseline innovations are reaching a much broader public far more quickly than in previous decades, with both benefits and risks. For instance, new technologies are having an incipient

but potentially highly disruptive impact on labor markets. The wave of robotization and automation driving the Fourth Industrial Revolution has begun eroding established labor structures and may further accentuate social inequality and exclusion (Sayer 2016). Entire categories of work are being wiped out, possibly engendering a class of people that are not just underqualified for work, but rather for whom there may be no jobs available. These changes lead to new levels and types of vulnerability, including as they relate to global catastrophic risks.

Climate change intersects all of the changes mentioned so far—from geopolitical shifts to political transformations and the emergence of new technologies—in complex ways. Among the long-term effects of climate change are a decrease in sea ice and an increase in permafrost thawing, an increase in heat waves and heavy precipitation, and decreased water resources in semi-arid regions. Climate change will likely lead to more frequent and severe natural hazards, causing poverty and food shortages and forcing increasing numbers of people to flee their homes (IPCC 2019). The Global Compact on Refugees, adopted by an overwhelming majority at the UN General Assembly in 2018, recognizes that "climate, environmental degradation and natural disasters increasingly interact with the drivers of refugee movements"(UNHCR 2019). The expansion of migratory flows also means that large numbers of people find themselves in highly vulnerable situations.

Although not all migratory flows are triggered by climate, climate change has become a growing factor behind forced dislocation, both within and across borders. And the world has not seen such a large flux of migrants since World War II: according to the UN, 70.8 million people have been forcibly displaced as of January 2020, of which 41.3 million are internally displaced people (IDPs), 25.9 million are refugees, and 3.5 million are asylum seekers (UNHCR 2020). These flows generate new pressures on urban and rural areas that are already poorly equipped to address the demands and needs of their present populations, raising the vulnerability of these communities.

Despite the burgeoning evidence on climate change and repeated calls for greater mitigation and adaptation, its political acceptance still varies widely and is subject to reversals. Indeed, climate change has become a key target of nativist and skeptical leaderships, especially those bent on promoting economic growth at the expense of sustainability. In June 2017, the US withdrew from the Paris agreement, undercutting (but not derailing) collective efforts to reduce carbon output, transition to renewable energy sources, and developing future climate measures. Other countries with climate-denialist or climate-skeptic leaderships, such as Saudi Arabia and Brazil, also have worked to block calls for more ambitious targets to cut fossil fuels and other measures for mitigation and adaptation. Although in some cases subnational governments and non-governmental organizations have stepped up or even taken the lead on climate action, the reluctance of key national governments to maintain climate commitments undermines joint efforts to mitigate and adapt to climate change, and therefore to prevent further disasters (Zhang et al. 2017).

In addition, climate change is increasingly recognized by researchers and policymakers— as well as key global governance institutions, such as the UN Security Council— as a "threat multiplier"(UN News 2019). While the links between the climate and security are indirect, climate change is believed to exacerbate trends in violence and conflict, or to generate new patterns altogether. Whether due to heightened tensions over water resources or the destructive impact of extreme weather events on infrastructure and production, climate stressors contribute

towards loss of social cohesion in ways that produce conflict and violence. This "climate-security nexus" is just one example of how risks are becoming more closely intertwined in the Anthropocene (see, for instance, Abdenur, Kuele and Amorim (2019).

From a risk perspective rather than replace older risks, the risks inherent to the Anthropocene have superimposed new risks onto old ones, and/or exacerbated pre-existing hazards. From volcanic eruptions and earthquakes to nuclear proliferation and pandemics, the Anthropocene presents a much more challenging array of risks to global governance, including the UN system.

Perceptions of risk

While the current era is hardly the first period of high unpredictability in history, these political, geopolitical, technological and climate changes have accelerated the pace of social transformation to the point of radically altering human perception of time. Until just two or three decades ago, most people had a good idea of what everyday life would be like in a generation, and they could more or less make plans for that timeframe. Nowadays, however, humans are left to guess not only what the major political and economic changes will be in the world within a half-century, but also—and far more immediately—what their own everyday life will be in a decade or two (Hariri 2018). People alive today likely will experience yet more disruptive change, and it is almost certain that the next generations will live in a radically different world. This pace of social change and the associated degree of uncertainty it brings makes it more difficult for human society to identify, understand, and tackle emerging risks.

In addition, in the globalizing world, risks have become intertwined in unprecedented ways. As Tanner (2009) has noted,

> In the interconnected world, the impact of any catastrophic event has global implications. It is rare in these times that an event, whether a natural disaster or a political crisis, does not affect people, cultures and states beyond the border of the originating region or state. This interdependence and vulnerabilities are felt in our daily lives today in connection with many risks and dangers, including the global financial crisis, energy scarcity or terrorist threats. It therefore becomes critical to discuss potentially catastrophic events even if their occurrence may not be likely. (cited in Al-Rodhan 2009, p. 37)

Equally relevant to changes in the frequency, intensity and interconnectedness of disasters is the *perception* of risk—and consequently, how society organizes in response to this perception. The perception of risks is not necessarily aligned with probabilistic calculations of a particular catastrophic event taking place. People tend to overestimate some risks and underestimate others. For instance, we tend to overestimate threats that are less likely to affect us but that are easier to remember, such as terrorism, than more complex, long-term threats, such as climate change. Psychologists have identified several cognitive biases that are especially relevant to climate change risks: hyperbolic discounting (the perception that the present is more important than the future); lack of concern for future generations; bystander effect (we tend to believe that someone else will deal with a crisis); and the sunk-cost fallacy (we are biased towards staying the course even when facing negative outcomes) (King 2019).

Several authors have noted that, despite some major improvements in the length and quality of life worldwide, people tend to focus on the bad news due to different types of cognitive biases. For instance, through the "availability heuristic," people tend to estimate the probability of an event by means of the ease with which instances come to mind, and thus they may believe that mass shootings are more common than medical breakthroughs. Another bias is the "sin of gratitude", which leads people to neglect past discoveries and solutions and to focus instead more on persistent problems (Pinker 2018).

Such biases are relevant to the way in which societies perceive risk and organize in response to it. Human populations have always been subject to a certain level of risk, including natural disasters, these were perceived to be triggered by non-human forces. In contrast, modern societies are exposed to the perverse results of the modernization process itself, including a vast array of man-made risks: pollution, new illnesses, crime, and weapons of mass destruction, to name but a few. Sociologists have argued that this dynamic has engendered the "risk society." Beck (1992:21), for instance, defines risk society as "a systematic way of dealing with hazards and insecurities induced and introduced by modernisation itself."

To Giddens (1999), modern society is characterized by a plethora of new risk situations, many of them produced by the accelerating pace of scientific change. In turn, this changing scenario has led to a society that is increasingly preoccupied with safety and with the future. However, to Giddens a risk society "is not intrinsically more dangerous or hazardous than pre-existing forms of social order"(1999, p. 3). Rather, it is one marked by the aspiration to "normalise and control" the perceived risks, and indeed the future itself.

Giddens draws a distinction between external and manufactured risk. The former refers to events that may strike individuals unexpectedly, but that happen frequently and regularly enough in a population to be generally predictable, and so insurable (whether through private insurance or public insurance, which is the predominant concern of the welfare state). Manufactured risks, on the other hand, are generated by human development, especially by the progression of science and technology. For these types of risks, "history provides us with very little previous experience—we often don't really know what the risks are, let alone how to calculate them accurately in terms of probability tables" (Giddens 1999:4).

The transition from a world that was marked primarily by external risks to one in which manufactured risks predominate changes the nature of politics (especially claims of alarmism versus allegations cover-ups of particular risks). One of the consequences of this shift is the emergence of what Beck calls ‘organised irresponsibility’, in which people and organisations become drivers of risk yet but where no one is held specifically accountable[1]. This idea underscores some of the key challenges that humanity faces in addressing the emerging risks of the Anthropocene: how to develop effective mechanisms to monitor, prepare for, and respond to global catastrophic risks.

Defining risks

[1] At the same time, Beck and Giddens do not view risk as a necessarily negative dimension of modern life; in fact, they frequently point out its positive or energising aspect (p. 10).

Bostrom (2008) defines a global catastrophic risk[2] as "a hypothetical future event which could damage human well-being on a global scale, even endangering or destroying modern civilization." One extreme subtype is existential risk— an event that could eliminate all of humanity or, at least, permanently and drastically curtail humanity's potential. These include not only asteroids and supervolcanoes, but also extreme events triggered through human action, for instance by means of new technologies[3].

Not all global catastrophic risks are equal, and some are better understood than others. Risks vary, for instance, by scope, intensity, and probability (Bostrom 2002). Timescales also vary widely: some entail creeping changes, others feature one or more tipping points. Yet others may be "sudden onset." It is also possible that the underlying drivers are present yet remain undetected, until a catastrophic event takes place. Second, the geographic focus and scale of a global catastrophic risk also vary. Some risks epicenters may be more concentrated, as in the case of a supervolcanic eruption or a meteor strike, whereas others will be more diffuse, as happens with several climate change elements or a tsunami with multi-continental reach. In some instances, a short-term epicenter may enlarge to affect a broader geographic space. Or, in the case of cyber risks, hazards may cross over from cyberspace into the material realm, as in the case of a cyber attack that impairs critical infrastructure, or vice-versa.

In the Anthropocene, global catastrophic risks are also characterized by the interconnectedness of systems/realms, in which several factors coincide or overlap. In some cases, dovetailing risks might lead to critical points. For instance, when superpopulation coincides with an acute agricultural scarcity, mass starvation may ensue. Keys et al (2019) argue that "cross-scale systemic environmental risks with global effects" are increasing and that "current descriptions of globally connected systemic risk poorly capture the role of human-environment interactions," leading to a bias towards solutions that ignore the new realities of the Anthropocene. This interconnectedness also means that, far more than before, global catastrophic risks are transnational, whether in their points of origin or in the scope of their direct or indirect impacts.

Different classificatory schemes have been proposed for global catastrophic risks. Some such schemes draw a distinction between Anthropogenic and non-Anthropogenic risks (the former are caused primarily by humans, such as those elicited by technological change, governance, and climate change. The Non-Anthropogenic category encompasses hazards that fall completely outside the realm of human action, such as an asteroid hit. In some cases, however, human action may exacerbate or trigger risks that have long been considered as natural. In fact, dividing global catastrophic risks into Anthropogenic and non-Anthropogenic (see Table 1) is not always straightforward. Modern disasters and risks often, indeed usually, contain elements of both especially due to the role of vulnerability. As Amartya Sen (1999) has noted, droughts and other seemingly natural disasters may become far more severe if they occur in the absence of political freedoms and an independent media. Poor practices and lack of adequate prevention

[2] The literature distinguishes between hazard and risk. A hazard is typically considered to be a potential damage-causing event or action (Ericson 2005), while risk is defined as the consequence of an event weighted by the probability of the event occurring.

[3] There have been attempts to estimate risks but there are significant methodological challenges in estimating these risks with precision. In 2008, the University of Oxford hosted a Global Catastrophic Risks Conference in which a survey of experts on a range of risks was carried out, suggesting a 19% chance of human extinction by the year 2100.

can transform a natural disaster into a man-made catastrophe. When earthquakes struck the Chinese province of Sichuan, on 12 May 2008, shoddy construction of buildings, including schools, led to thousands of fatalities.

[Table 1. Typology of Global Catastrophic Risks]

Category	Type	Drivers	Sample scenarios	Source
Anthropogenic				
	Artificial intelligence (Superintelligence)	Learning computers become super intelligent and become excessively autonomous, taking unexpected actions and/or out-compete humanity	Robots manipulate social groups in ways that provoke wars. Robots become able to independently choose targets to attack with weapons and do so at scale.	Bostrom 2014.
	Biotechnology	Bioengineered organisms such as viruses, bacteria, fungi, plants or animals can disrupt ecosystems or become (through intentional or unintentional action) high-virulence pathogens.	A human-made virus escapes from a laboratory and causes a global pandemic.	Noun and Chyba 2008; Lipsitch and Relman 2015
	Cyberattack	Offensive maneuver by state or non-state actors targets computer information systems, infrastructure, networks, or personal computer devices, sometimes as part of cyberwarfare or cyberterrorism and causing physical damage.	Rogue actors destroy critical infrastructure of countries or regions, such as satellite systems.	World Economic Forum 2018 report; CyberSat conference 2019 edition (on Risk of Satellite Cyber Attack)
	Environmental disaster	Trends such as overpopulation, economic development, and non-sustainable agricultural practices may lead to widespread deforestation, water scarcity, or species collapse.	Amazon reaches "point of no return" due to widespread deforestation.	Lovejoy and Nobre 2018.
	Experimental technology accident	Humans and/or robots create a device that causes widespread destruction.	Biotechnological innovation is weaponized and leads to pandemic.	SIPRI 2019.
	Global warming	Increasing levels of greenhouse gases provoke climate change and sea level rise provoke loss of biodiversity, stresses for food and public health systems.	Global warming leads to spread of infectious diseases.	World Economic Forum 2020.

	Nanotechnology	New technologies, such as molecular manufacturing, lead to new arms races.	Rogue company or state weaponizes nanotechnology	Umbrello and Baum 2018.
	Warfare and mass destruction	Weapons of mass destruction are deployed in ways that cause widespread damage.	Nuclear warfare.	Toon et al. 2019.
	World population and agricultural crisis	Rapid increase in human population, for instance due to medical developments, outpaces increases in agricultural productivity or dovetails with abrupt decline thereof.	Population surge leads to mass starvation.	Singh 2018.
Non-Anthropogenic				
	Asteroid impact	The orbit of rocks left over from the formation of our solar system intersects with that of the Earth, resulting in a collision.	Asteroid collision causes global cooling, resulting in large-scale disaster.	Mathias, Wheeler and Dotson 2017.
	Cosmic threats	Natural Solar superstorm (geomagnetic disturbance, of GMD)	Solar flare shuts down medical, transportation, communication, banking, finance, food and water systems.	Riley 2012.
	Contact with extraterrestrials	Threats generated by contact with extraterrestrial beings.	Extraterrestrial beings invade the planet.	Neal 2014.
	Volcanic eruption	Volcanic eruption or other activity disrupts weather and food systems.	Volcanic eruption causes global volcanic winter.	Papale and Marzocchi 2019.

Other scholars have focused on the decisional dilemmas generated by catastrophic events. Al-Rodhan (2009) uses the term global strategic catastrophes to refer to extreme events that may produce multiple cascading strategic dilemmas for states and the international system. Such dilemmas include: balancing the sovereign rights of states with human rights; transnational responsibilities; and burden-sharing under occasional geopolitical uncertainties. This perspective suggests that every major extreme event with global consequences demands a strategic response by the international system. Adopting this lens to understand the links between Anthropocenic risks and the role of the UN, the next section of the article reviews the literature on the organization's capacity to deal with the emerging risks of the Anthropocene.

The UN and Anthropocenic Risks

A comprehensive and detailed evaluation of the UN system’s capacity to deal with individual types of global catastrophic risks, such as those illustrated in Table 1, is beyond the scope of this paper. However, it is possible to infer some conclusions about the system's capacities,

limitations and gaps based on two sources. Past occasions in which the UN has dealt with and adapted to major risks—both successes and failures—offer lessons about what has worked and what has not. This historical approach can be complemented with analysis of current capacities as identified by the existing literature— secondary sources as well as primary documents from the UN itself. Such an analysis requires casting a broad net to identify, through the existing literature, the UN's capacity to tackle global catastrophic risks in areas such as peace and security (including nuclear proliferation); disasters (such as pandemics); science and technology; and climate change.

The UN's track record with global catastrophic risks

The UN was founded in order to avert global catastrophe, namely the occurrence of another world war through the aggression of one nation against another: "to save succeeding generations from the scourge of war" and "to maintain international peace and security". The United States dropped the first nuclear bomb (August 6, 1945) just one month after the international community met in San Francisco to establish the UN. This turbulent security context helps to explain why, during its first few decades of existence, the predominant notions of global catastrophic risk within the UN system focus on armed conflict and nuclear risks.

Yet, during the Cold War, the geopolitical interests of the superpowers and their allies frequently led to paralysis of the emerging collective security system. The UN Security Council was able to intervene only in conflicts that were not directly related to the core interests of the US and the Soviet Union. In a number of major security crises, such as the Cuban missile crisis and the Vietnam War, the Security Council found itself largely bypassed in favor of direct negotiations between the superpowers and was relegated to a secondary role (Kennedy 2006)[4]. As a result, the UN ended up focusing on smaller conflicts, especially through the deployment of peacekeeping missions—which saw a dramatic growth in the Post-Cold War years, along with a doubling of adopted Security Council resolutions (Meisler 1995).

In addition to the concern with conflict and nuclear risks, in 1945 the international community was also deeply aware of the risk of pandemics, including in times of war (the 1918 influenza pandemic had infected 500 million people around the world, or around 27% of the world population then). Less than three years later, the World Health Organization (WHO) was founded and worked towards major achievements such as the eradication of smallpox (achieved in the 1970s) and the establishment of epidemiological information dissemination mechanisms. However, outside of the scope of public health, attempts at creating scientific advisory bodies within the UN had limited results. The Advisory Committee on the Application of Science and Technology to Development (ACAST) was, from its inception, regarded with mistrust and suspicion not only by member states, but also by some UN specialized agencies, and ended up being disbanded (Stuart 2016).

At the same time, on the humanitarian front, the UN began to follow in the footsteps of the non-governmental organizations, such as the International Committee of the Red Cross (formed in 1863), that pioneered humanitarian action. Some initial normative steps were taken to define the UN's role in major humanitarian crises. The 1977 *Measures to Expedite International Relief,*

[4] However, in 1962, UN Secretary General U Thant was a key negotiator between Nikita Kruschev and John F. Kennedy.

endorsed by both the UN General Assembly and the International Conference of the Red Cross, was followed by General Assembly Resolution 36/225d (1981), which called for strengthening the UN's capacity to respond to disasters. Added pressure came from outside the UN. In the 1980s, the famine in Ethiopia, which caused over one million deaths and was broadly covered by media and celebrities, generated broad awareness of the need for dedicated disaster mechanisms and humanitarian action.

The UN's role in nuclear crises was also constrained by geopolitics during the Cold War, but the nuclear arms race, nuclear proliferation and the so-called "nuclear close calls" prompted some preparedness measures. After the 1986 reactor meltdown at the Chernobyl nuclear power plant in the Soviet Union, the UN began reformulating its approach to post-disaster management. During the first four years after the disaster, Soviet authorities decided to largely deal with its aftermath at the national level, thus limiting the role of the UN. The UN's official account of this period acknowledges the limitations of the organization's role:

> Without Soviet endorsement, the United Nations and its partners sought ways to provide emergency support, which included assessing the nuclear safety and environmental conditions of the contaminated area, and diagnosing the various medical conditions that resulted from the accident. The UN also focused on raising the awareness of the area's inhabitants, teaching them how to protect themselves from radionuclides found in the environment and in agricultural products. (UN 2011)

It was only around the collapse of the Soviet Union in 1991 that a more collaborative, UN-convened structure for post-disaster response emerged. More specifically, in 1990 the Soviet government recognized the need for international assistance. As a result of General Assembly Resolution 45/100, which called for "international cooperation to address and mitigate the consequences at the Chernobyl nuclear power plant", the Under-Secretary-Generals were entrusted with the task of coordinating the Chernobyl co-operation, and the UN called for the formation of an Inter-Agency Task Force. Eventually these efforts led to the establishment of the Chernobyl Forum, under the management of the Office for the Coordination of Humanitarian Affairs (OCHA), and comprising eight specialized UN agencies, along with the governments of Belarus, Russian Federation and Ukraine) and post-disaster recovery. The disaster expanded the UN's disaster response capacities in areas such as strategy formulation, resources mobilization, advocacy and resource distribution[5]. However, the slowness of these developments also underscored the UN's limitations in tackling catastrophic global risks, not only due to operational constraints but also, and indeed primarily, owing to political factors.

In the post-Cold war, major failures in early warning and response prompted some changes in how the UN dealt with global catastrophic risks. The genocide in Rwanda in the second quarter of 1994 marked a turning point in international responses to humanitarian crisis, especially because it was widely perceived to be a failure of early warning. UN attempts at reform yielded limited changes—most notably, they did not significantly alter the Security Council, which has remained anachronistic and, to many analysts, largely ineffective in conflict resolution, especially major or longstanding conflicts such as those in Syria and the Democratic Republic of

[5] The Chernobyl disaster also contributed to a paradigm shift: during the 1990s, as it became clear that environmental and health recovery cannot be separated from development, UNDP became involved in the coordination mechanism for Chernoyl cooperation, launching a long-term development approach for the three affected countries (UN 2011).

Congo (DRC). Yet these experiences and failures triggered efforts to develop and enhance a central component in how the UN deals with global catastrophic risks: early warning systems.

The UN's Capacity to Address Anthropocenic Risks

Drawing on the at-best mixed results with major catastrophes during the Cold War and its immediate aftermath, in the 2010s UN officials proposed a theoretical model of effective warning systems (EWSs). EWSs are, broadly put, methodologies that draw on qualitative and/or quantitative analysis for anticipating and responding to risks[6]. In some instances, scenario projection—extrapolating from current trends drawing on evidence—has enabled the UN to design preparedness plans for more specific types of situations. These scenarios are drawn in order to estimate their possible physical and socioeconomic impacts, and to assess potential the potential humanitarian and other response requirements. EWS can be used to monitor risks as varied as famine, genocide, earthquakes, missile launches, and disease outbreaks (see, for instance, on agricultural projections, see Alexandratos and Bruinsma 2012).

Within the UN's ideal EWS model (see Table 2 below), such systems must feature four effective and well-linked elements: risk knowledge; monitoring and warning service; dissemination and communication; and response capability. Risk knowledge refers to assessment requiring systematic collection and reliable analysis of data in ways that consider the dynamic nature of hazards and vulnerabilities. Monitoring and Warning Service refers to continuous tracking of hazard parameters and precursors in order to generate accurate warnings. Dissemination and Communication require that the EWS reach those are at risk through clear messages with simple, useful information disseminated through multiple channels. And finally, response capability encompasses education and preparedness programmes, including disaster management plans (UNISDR 2006). This model offers an analytical framework for analyzing the UN's overall capacity to address the emerging risks of the Anthropocene.

Table 2: The Four Elements of Effective Early Warning Systems

The Four Elements of Effective Early Warning Systems

Risk knowledge	Monitoring and warning service	Dissemination and communication	Response capability
Systematically collect data and undertake risk assessments Are the hazards and the vulnerabilities well known? What are the patterns and trends in these factors? Are risk maps and data widely available?	*Develop hazard monitoring and early warning services* Are the right parameters being monitored? Is there a sound scientific basis for making forecasts? Can accurate and timely warnings be generated?	*Communicate risk information and early warnings* Do warnings reach all of those at risk? Are the risks and the warnings understood? Is the warning information clear and useable	*Build national and community response capabilities* Are response plans up to date and tested? Are local capacities and knowledge made use of? Are people prepared and ready to react to warnings?

Source: UNISDR 2006.

[6] Communities around the world have long accumulated knowledge about warning signs for disasters such as volcanic eruptions and tsunamis. Within the specific context of global governance, some of the earliest EWSs grew out of the Cold War arms race as part of defense systems, for instance designed to identify imminent missile attacks. With the computer revolution, improved data analysis and modelling— sometimes accompanying hardware advances such as earthquake sensing equipment—allowed for a wider application of early warning.

a) Risk knowledge

The UN's capacities and weaknesses to systematically collect and reliable analyze data on Anthropocenic risks revolve in part on the robustness of its early warning systems (EWSs). In this respect, the UN has evolved several mechanisms that promote risk knowledge. Some of these instruments resulted from the International Decade for Natural Disaster Reduction (IDNDR), which was proclaimed in 1989 by UN General Assembly (Resolution 44/236). Among other recommendations on improved disaster awareness and response, the IDNDR recommended greater international cooperation in the use of the terrestrial and satellite communications technologies in the prediction, monitoring, and early warning of disasters (UN Secretary-General 1995, p.5).

In the 1990s, EWSs became more central to disaster preparedness in global governance mechanisms, particularly the UN system. This new importance was due not only to leaps in computing capacity and satellite technology, which enabled the collection of vast amounts of data, but also—perhaps most importantly— to institutional improvements. Namely, UN leaderships realized that EWSs must combine the scientific and technical abilities of hazard identification and forecasting (including through scientific and technological innovation) with effective communications, public policy commitments, and the awareness and participation of local stakeholders (Jeggle 1998).

The adoption of EWSs was slowly, if unevenly, institutionalized. In 1995, the first Secretary General's Report on Early Warning was delivered to the UNs 50th General Assembly (UN Secretary-General 1995). In addition to underscoring the significance of incorporating advances in science and technology with political commitment and communications, the report also stressed the importance of early warning adoption by individual countries, citing the positive example of the Philippine system of disaster warning that spared an estimated 350,000 casualties when Mount Pinatubo erupted in 1991 (p. 4). Given the common protagonism of states when struck by major catastrophes, the UN realized that, in addition to developing its own risk knowledge capacities, it also had to strengthen such capacities among member state and partner organizations.

However, there is ample recognition within the UN that the system's own expertise does not suffice, especially given the increasing complexity of global catastrophic risks; there is a growing need for qualified knowledge inputs into the policy-making process and risk assessments. Therefore creating strong communications channels with scientific communities for the purposes of identifying and monitoring risks, and assessing the reliability of data being gathered, is crucial. Despite the frustrating experience of the UN ACAST during the Cold War, the IDNDR opened up new opportunities. In particular, the UN General Assembly's 1995 request to the IDNDR's international programme advisory body, the Scientific and Technical Committee, to undertake a further study of ways to improve the effectiveness of early warning for natural and other disasters established a new, high-level communications channel on disaster preparedness between UN leaderships and the scientific community.

Since then, science advisory mechanisms of varying types have emerged throughout the UN system, from ad-hoc approaches involving conference, workshops, and expert group meetings to provide advice, to more institutionalized advisory committees, treaty subsidiary bodies, and

recurring analyses and surveys of major global challenges, such as the Intergovernmental Panel on Climate Change (IPCC). Bodies such as the United Nations Institute for Training and Research (UNITAR) and the United Nations University (UNU), as well as regional centers of excellence, have also contributed towards a broad network of inter-disciplinary research to tackle major global challenges.

As the National Research Council (2002) has noted, however, these mechanisms face a common and inherent challenge: that of balancing scientific credibility (which normally rests upon expertise and independence) with that of influencing political processes (which depends on the balancing of interests). In this respect, the IPCC "clearly stands out as a remarkable innovation in science advice in the United Nations system" because it includes institutionalized channels for interactions between scientists and policymakers (p. 2). However, the UN has been slow to adopt the IPCC model in other risk areas, some of which still lack robust channels to scientific experts.

Given the interlinked hazards of the Anthropocene, interdisciplinary scientific counsel has become more important. As Gottstein (2018) has noted, "interdisciplinary scientific advice of top quality must be made available to decision-makers at the global level". The UN Scientific Advisory Board (SAB), composed of 26 renowned scientists from a broad variety of scientific disciplines, represents one step in this direction. However, existing scientific bodies providing input on global catastrophic risks lack coordination, in that they typically advise only a single UN body. This gap suggests a need for an overall, interdisciplinary advisory system specifically for the avoidance of future catastrophes (Gottstein 2018).

b) Monitoring and warning service

The implementation of monitoring and warning services needed for Anthropocenic risks has varied widely across the UN system. Within the Peace and Security Architecture, conflict-focused EWSs encompass systems as varied in methods and visibility as Horizon Scanning initiatives at the Security Council (see Security Council Report 2017) to the Framework of Analysis for Atrocity Crimes—an early warning tool developed by the United Nations Office on Genocide Prevention and the Responsibility to Protect (UN 2014). Some critics have noted, however, that such systems have failed to predict (even at relatively short notice) not only genocide, but also major conflicts with regional spillovers, such as the Syrian civil war.

In the disaster field, the UN's EWSs were enhanced following the 2004 Indian Ocean Tsunami. Although after the catastrophe struck the UN launched one of the largest relief operations in its history (UN News 2004), it (like other actors) was taken by surprise by the tsunami, underscoring the need to for better monitoring of related risks. Part of the response came in the form of normative developments with concrete goals and timelines. The Hyogo Framework for Action (HFA), adopted in Kobe in early 2005, called upon member states to make major efforts to reduce disaster risks by 2015. In addition, the tsunami that the UN helped to underscore the insufficiency of EWSs, when these existed at all. Through the resulting Indian Ocean Tsunami Warning and Mitigation System, which is coordinated by the Intergovernmental Oceanographic

Commission of UNESCO (IOC-UNESCO) (Casey 2014), the UN has been able not only to boost national EWSs, but also to develop a regional coordination mechanism[7].

As with data collection, information technology has also prompted some changes to risk monitoring at the UN. The "big data" revolution, Artificial Intelligence and machine learning, among other innovations, have allowed for more robust risk modelling (Pauwels 2019). Yet not all populations benefit equally from these improvements. Many developing countries—especially least developed countries (LDCs), small island developing states (SIDS), and landlocked developing countries (LLDCs)—are unable to reap the benefits of ITS innovations for disaster prevention and readiness, including recent improvements in EWSs.

In response to these challenges, in 2006 the UN Office for Outer Space Affairs developed the United Nations Platform for Space-based Information for Disaster Management and Emergency Response (UN-SPIDER). The platform develops solutions to address the limited access developing countries have to specialized technologies (such as remote sensing for Earth observation, satellite-based communication and global navigation satellite systems) that can be essential in the management of disasters and the reducing of disaster risks (Zollner 2018). The platform also promotes knowledge transfer, facilitating the access to data and to information both both the space community and for the disaster management community (Tomaszewski 2014, p. 137).

However, major gaps remain in the UN's risk monitoring capacity. In particular, there is a narrow focus on hazard exposure, at the expanse of two other dimensions of disaster risk: vulnerability, and lack of coping capacity. Given that intertwined challenges of the Anthropocene, disaster risk reduction policy should draw on multi-hazard risk metrics, such as composite indicators able to capture the three dimensions of disaster risks. Since composite indicators are available only at national level, there are limitations to regional and subnational models, but this may become more feasible as data availability and modelling capacity increase (De Groeve et al. 2015).

c) Dissemination and communication

The UN's fitness for purpose in addressing Anthropocenic risks also depends on the strength of dissemination and communication at multiple levels. As previously noted, the development of EWS capacities within the UN system itself does not suffice, since in major risk situations other actors, from states to humanitarian organizations, are also mobilized. Thus the UN must be effective in disseminating the results of its risk assessments to external actors, from policymakers to civil society entities and private sector companies.

With respect to the promotion of EWSs beyond the UN system, several mechanisms have been developed. Key Frameworks such as the Sendai Framework for Disaster Risk Reduction 2015-2030 and the United Nations Plan of Action on Disaster Risk Reduction for Resilience have promoted improved risk monitoring through international cooperation. The International Network for Multi-Hazard Early Warning Systems (IN-MHEWS[8])—established at the Third

[7] More broadly, the tsunami raised awareness within the international community, including the United Nations, of the need to invest in pre-disaster action programs as well as boost capacity to respond in the post-disaster period, especially in high poverty areas (Jayasuriya and McCawley 2010).

[8] The IN-MHEWS Steering Committee is currently composed of the following organizations: FAO, IAEA, IOC-UNESCO, ITU, UNDP, UNESCAP, UNESCO, UNISDR, UNITAR/UNOSAT, UNOOSA/UN-SPIDER, WFP,

United Nations World Conference on Disaster Risk Reduction (WCDRR) in Sendai, Japan, in 2015—facilitates the sharing of expertise and good practices on strengthening multi-hazard EWSs as an integral component of national strategies for disaster risk reduction, climate change adaptation, and building resilience.

The UN has also developed more specific EWS promotion initiatives. In the climate area, for example, the Climate Risk and Early Warning Systems (CREWS) initiative strengthens the capacity of multi-hazard EWSs across 19 countries in Africa and the Pacific, including Least Developed Countries (LDCs) and Small Island Developing States (SIDS). There is also increased programmatic focus on EWSs as a way to support governments in the development of sub-regional and regional disaster EWSs (UN 2020). For instance, the UNDP initiative "Strengthening Climate Information and Early Warning Systems for Climate Resilient Development and Adaptation to Climate Change" builds climate early warning capacity across Africa, Asia and the Pacific.

Recent global health emergencies, such as the 2013-2016 Ebola epidemic in West Africa, the 2015-2016 Zika virus outbreak in Brazil, and the ongoing Coronavirus pandemic (2019-present), have highlighted the essential role of emergency risk communication for the entire emergency response lifecycle, from preparation and response and control to recovery and evaluation (Salvi et al (2018).

As for the UN's capacity to disseminate and communicate specific risks as particular hazards emerge, the UN has recognized that, although advances in technology have improved scientific risk information dramatically, this type of information can easily be wasted if it is not effectively passed on to (and discussed with) decision-makers. As a result, it has put together guidelines such as the 2017 "Public Communication for Disaster Risk Reduction" (UNISDR 2017).

There has also been greater incorporation of ICT innovations in UN emergency communications. For instance, in order to strengthen emergency communications before disasters strike and enhancing coordination efforts during relief operations, in 2009 the UN formed a partnership with two leading global satellite companies, Inmarsat and Vizada, which donated to the International Telecommunications Union (ITU) 70 satellites capable of delivering voice and broadband data wherever disasters take place (UN News 2009). Yet, as with ITC applications in risk knowledge and monitoring, there are challenges in effectively adopting new technologies for risk communication—especially at the national level, due to limited availability of information and analytical capacity.

(b) *Response Capabilities*

The Chernobyl disaster, among others, showed that large-scale catastrophes often mobilize individual states; regional or inter-regional configurations, such as NATO; and other international agencies. In the post-Cold War period, when a major disaster strikes, states are less likely to refuse international assistance—although they may delay cooperation, as the Myanmar government did following Cyclone Nargis (2008). The 2019-present coronavirus outbreak in China also shows that, even after the end of the Cold War, national politics and

WHO, WMO, CREWS, World Bank/GFDRR, EU (EC/JRC), IFRC/Red Cross Red Crescent Climate Centre, ISC/IRDR and in 2018/19 co-chaired by UNOOSA/UN-SPIDER and WMO.

geopolitics may constrain acceptance of assistance. Delays in the issuance of a formal request for such assistance often result from weaknesses in national procedures, regulations, and decision-making, but can also be due to the desire on the part of political elites to promote disaster competence as evidence of global status, or fear of governmental humiliation (Nelson 2010).

However, gaps in the UN's response capacity have also caused delays. In the spring of 1991, the massive failure of the international humanitarian community to provide urgent relief assistance to the Kurds in Northern Iraq led the UN to reconsider its roles in conflict prevention and the provision of humanitarian relief. Top UN officials decided to concentrate more narrowly on the organization's perceived value-added—leadership and coordination—leaving ample space for civil society and other humanitarian actors. This delimitation was reflected in key resolutions, for instance UN General Assembly Resolution 46/182 (1991), which called for a 'strengthening of the coordination of emergency humanitarian assistance of the United Nations system'. The following year saw the establishment of the Department of Humanitarian Affairs (DPA), which in 1997 became known as OCHA[9]. The Emergency Relief Coordinator (ERC) position was created to work with the Secretary-General and the Inter-Agency Standing Committee (IASC)—a standing forum allowing leading officials could convene for routine or emergency reasons, in order to seek joint decision for quick action[10]. The IASC's mandate extends to affected people in internally displaced persons (IDPs), in recognition of the major role that displacement plays in large-scale catastrophes. These steps represented the initial stages in the development of a more effective structure and process of humanitarian inter-agency coordination that encompassed the UN system as a whole (Dedring 1996, p. 35).

OCHA—tasked with coordinating humanitarian action to people affected by disasters and other emergencies—provides leadership in mobilizing assistance and resources on behalf of the humanitarian system. In other words, OCHA was not designed to be an operational agency directly engaged in the delivery of humanitarian programmes, but rather as a broker, facilitator and global advocate, providing support to the humanitarian system. The "cluster approach," formed as an attempt to create a more coordinated and effective humanitarian response system, to some extent allows OCHA to take on these roles while groups of UN and non-UN organizations are deployed across the full disaster cycle: prevention, mitigation, preparedness, disaster, reponse, recovery, and reconstruction[11] (OCHA 2020). However, critics have noted gaps between theory and practice, for instance with declining levels of cooperation efforts between NGOs and OCHA as the disaster cycle progresses (Stumpenhorst, Stumpenhorst and Razum 2011). Such gaps tend to limit the predictable leadership and accountability which the cluster approach is supposed to promote.

[9] Over the past 25 years, UNDAC has responded to more than 281 emergencies in over 100 countries; ranging from floods, to earthquakes and man-made disasters, borne out of conflict.
[10] The ERC works as a global champion for people affected by emergencies and the principal adviser to the Secretary-General on all humanitarian issues. Through the ERC, OCHA amplifies the voices of affected people, champions humanitarian principles and action, and promotes solutions to reduce humanitarian need, risk and vulnerability. At the country level, the ERC maintains close contact with and provides leadership to United Nations Resident Coordinators/Humanitarian Coordinators (RCs/HCs) on matters related to humanitarian assistance.
[11] There are eleven different clusters, each one focusing on a specific set of tasks or functions. Each cluster is headed by one or two UN organizations or agencies. Both the UNDAC team and the OCHA clusters coordinate their efforts with the UN Resident Coordinator and the UN Humanitarian Coordinator in the country affected by the disaster.

The UN also features mechanisms for rapid response. In 1993, in response to the need for better response to sudden-onset emergencies, the UN created the UN Disaster Assessment and Coordination system (UNDAC), an international emergency response team to respond to disasters around the world. The team pools expertise from Member States, to rush to support fellow Member States that are hit by sudden-onset emergencies. When a government affected by a disaster requests such assistance, OCHA may dispatch an UNDAC team to the country within 12 to 48 hours after a sudden-onset disaster to provide technical services, especially in damage and needs assessment, on-site coordination, and information management. UNDAC teams aim to facilitate close links between country-level, regional and international response efforts. When deemed appropriate, the United Nations may also set up an On-Site Operations Coordination Centre (OSOCC) to help local authorities in a disaster-affected country to coordinate international relief.

The UN's response capacity also extends to a longer-term view of the relationship between disasters (and this, global catastrophic risks) and development. While disaster risk and resilience were considered to receive insufficient emphasis on the Millennium Development Goal agenda, the links between disasters and development (see UNISDR, WMO 2012), more attention was paid to this relationship in the formulation of the Sustainable Development Agenda. Especially since the Yokohama Strategy and Plan of Action for a Safer World (1994), several UN documents and frameworks (including the 2030 Agenda for Sustainable Development) have recognized that disaster risk reduction (DRR) is an integral part of social and economic development. Several of the SDGs— or instance goals 4 (education), 11 (cities) and 9 (building resilient infrastructure)—reinforce the links between disaster risk reduction and sustainable development, meaning that UN capacity in these dimensions will depend in part on the successful implementation of Agenda 2030 (UN 2019c). The 2018 launch of the Sendai Framework Monitor, which captures data on the achievements of the Sendai Framework, provides inputs to reports on achieving progress on implementation of the SDGs (UN News 2018).

New linkages have also been developed between early response to disasters and other humanitarian crises, and long-term development. For instance, while OCHA clusters operate during the response phase, the United Nations Development Programme (UNDP) has established the Early Recovery cluster that focuses on the more long-term needs related to recovery. Through this cluster, UNDP links humanitarian efforts with development work, so as to promote sustainable crisis recovery, resilience building and development opportunities.

The UN's unique convening power and its capacity to coordinate immediate and long term responses are most apparent in so-called fragile or conflict-affected settings, but it has also made strides at the global level. The first global summit on humanitarian aid—which was held in May 2016 in Istanbul and brought together governments, civil society organizations, private organizations, and groups affected by humanitarian need— yielded mixed results, with critics stressing the lack of systemic reform (Canyon and Burkle 2016). Part of the failures may be due to inadequate political will. Writing in the mid-1990s, Dedring (1996:35) argued that the growing severity of complex emergencies have already exacerbated the task of coordination in humanitarian matters. Since then, those challenges have only expanded with the ongoing changes of the Anthropocene.

As with the other dimensions of UN preparedness, new technologies are being incorporated that may enhance the UN's capacity to respond to Anthropocenic risks. For instance, drone technology has been used in humanitarian settings. Unmanned aerial vehicles are able to leapfrog over broken infrastructure in places where transportation networks do not exist or have been destroyed, monitoring in real time events on the ground and even carrying some supplies, including vaccines. They have also been used for remote sensing, such as collection of imagery and data, in the aftermath of disasters such as mudslines or in some peace operation settings. The International Atomic Energy Agency (IAEA) has used drones to visually map gamma radiation at Japan's Fukushima nuclear plant after it was damaged by a tsunami in 2011. Working groups have been formed through which agencies such as UNICEF, the World Food Programmes and UNHCR, and the UN Innovation Network - an informal group that meets quarterly to share lessons and advance discussions on innovation across agencies— has been involved. However, drone technology can potentially violate human rights, and— as with other new technologies being deployed in disaster settings—may end up generating far more data than the UN and other stakeholders have the ability to process and analyze.

More broadly, the UN's response capacity—and that of other actors—also depends on the UN's ability to help close the humanitarian finance gap. The UN leads period appeals for funding but in 2020 the unmet requirements stood at US $10.64 billion. Some analysts have argued that, in order to close the gap, the UN and humanitarian agencies must leave behind the traditional, donor-driven funding model and embrace greater adaptation and innovation in problem-solving, especially greater anticipatory action. Lowcock (2019) has noted that, when early signs of impending disaster emerge, channeling funds can cut response times, reduce suffering and diminish costs. The World Bank-UN's Famine Action Mechanism, which draws on early warning data and predictive models to predict acute food insecurity and famine, links thresholds to pre-agreed automatic funding.

Conclusion: Challenges and Knowledge Gaps

Over its 75-year history, the United Nations has worked to improve its capacity to prepare for, identify, monitor, communicate about and respond to global catastrophic risks. These efforts have included norms and frameworks (some of which, as in the case of UN General Assembly Resolutions, issued at the highest levels); dedicated structures and mechanisms; and partnerships and other cooperation arrangements. The UN has also tried to incorporate technological and scientific advances, from satellite-generated data to big data and drones, to improve its understanding and capacity to respond to risks, especially through its capacity to issue early warnings and deploy early responses.

During this period, major near-misses or full-blown catastrophes, from the Cuban Missile Crisis to the Chernobyl Nuclear Meltdown, the Ebola outbreaks and the 2004 Pacific Ocean Tsunami— to mention only four such events—prompted waves of new efforts to innovate, institutionalize, promote awareness, and develop new capacities. With Agenda 2030, the UN's approach to disasters became more closely intertwined with its development efforts, requiring a longer-term perspective on emerging risks.

The United Nations' fitness of purpose during the Anthropocene depends not only on the efforts undertaken in response to past events, but also on the organization's awareness of, and responsiveness to, the increasingly complex, intense, and frequent risks of this era. It is no

longer sufficient to address individual risks, but rather has become necessary to grasp how multiple risks are interconnected. The existing literature reviewed within this paper suggest that, while specialized capacity has increased with respect to risks as varied as tsunamis, pandemics and biotechnology, several gaps still remain.

The UN's capacity to tackle Anthropocenic risks is limited by at least four key factors. The first is the uneven lack of knowledge about Anthropocenic risks, including many of those featured in Table 1. This is particularly true of emerging risks linked to new technologies since, with the accelerating pace of technological innovation, the downsides and implications for governance are still poorly understood, and indeed may change quickly. For instance, the debate about fully autonomous weapons that would be capable of selecting and engaging targets without meaningful human control focus on relatively recent technologies, such as weaponized drones and artificial intelligence, whose risks are still rather poorly understood (Campaign to Stop Killer Robots 2020).

This uneven knowledge, in turn, contributes to unevenness in the international regimes and other governance mechanisms that have been developed to understand, monitor, and prevent certain types of risks, whether or not those instruments are situated within the UN system. The failure of international regimes in certain areas, such as parts of the nuclear and conventional disarmament agendas, means that—when certain Anthropocenic risks are concerned—the international community has little basis for coordinated action.

Another set of challenges stems from the fact that—from a legal standpoint—the disaster response field lacks cohesion. International disaster response laws have emerged in order to improve preparedness for disasters in order to reduce human vulnerability, in both conflict settings and non-conflict disaster settings (although, in the former, International humanitarian Law provides greater clarification on the specific rights and obligations of different parties. However, the field of international disaster response lacks core international treaties, such as the Geneva Conventions and Additional Protocols for International Humanitarian Law. Instead, international disaster law is a piecemeal collection of diverse international, regional and bilateral treaties, non-binding resolutions, declarations, codes, guidelines, protocols and procedures (IFRC 2019)[12].

The second limiting factor is institutional or bureaucratic inertia- the tendency of certain organizations and its actors to perpetuate established procedures and practices, even if they are counterproductive, contrary to the organization's own goals, or outdated. Even outside the realm of disaster prevention, preparedness and response, the United Nations has traditionally been resistant to change (Weiss and Urquhart 2012). This is reflected, for instance, in the many waves of half-finished institutional reforms launched by secretaries-general. In some instances, such as reform of the UN Security Council or the establishment of a truly autonomous Peacebuilding Commission, institutional reform may be primarily a result of insufficient lack of political will, but in other cases much-needed change may have fallen outside the scope of priorities set by the system leadership. Vested geopolitical interests and even the cognitive bias against distant risks may also factor in the UN's slow pace of organizational change, even in the

[12] At the normative level, the adoption of the ‘Guidelines for the Domestic Facilitation and Regulation of International Disaster Relief and Initial Recovery Assistance’ (IDRL Guidelines) by the International Federation of Red Cross and Red Crescent Societies in 2007 is considered to be a significant development, but the guidelines are non-binding.

face of multiplying global risks (see Schwartzenberg 2016). This is particularly concerning because history has shown that governance mechanisms tend to develop more slowly than technological and social change.

The final element limiting the UN's capacity to deal with Anthropocenic risks is the persistent fragmentation of the UN system. As of early 2020 the system consisted of five key active organs (the General Assembly, the Security Council, the Economic and Social Council - ECOSOC, the International Court of Justice (ICJ), and the UN Secretariat (a six organ, the Trusteeship Council, has been inactive since 1994). In addition to the specialized agencies, programs, and funds, the system has subsidiary bodies such as separately administered funds and programs, research and training institutes, and other entities. These add up to over 30 entities that are interconnected in complex and sometimes, tenuous ways, and that operate within a "silo effect" established through the three thematic pillars: peace and security; human rights; and development (Rosenthal 2017). The lack of coherence across the system means that, even with the development of dedicated mechanisms to identify, track, and organize responses to major catastrophes (as reviewed below), gaps may remain in decision-making that are crucial for tackling Anthropocenic risks. It also means that the UN system will continue to encounter difficulties in consolidating the roles it may have to play before the known and unknown risks of the Anthropocene: that of leadership, convenor, coordinator, and broker.

Further research into the topic should focus not only on these limitations, but also on the leitmotifs that emerged repeatedly in this analysis. The role of ICTs in early warning and response to global catastrophic crises should be further explored, with respect to benefits as well as risks. Researchers should also seek to shed light on how ongoing structural reforms announced in 2017 and 2018 may impact the UN's ability to tackle such risks. Finally, more investigation is needed into how the capacities and gaps outlined in this paper shape the norms, structures, and practices of key partner organizations, especially regional ones such as the African Union and ASEAN. Addressing these areas should help to build a fuller picture of the UN system's capacity to address the emerging risks of the Anthropocene.

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