# Risk Communication Strategies for the Very Worst of Cases

JOHNS HOPKINS
BLOOMBERG SCHOOL
*of* PUBLIC HEALTH

**Center for Health Security**

HOW TO ISSUE A CALL TO ACTION ON
GLOBAL CATASTROPHIC BIOLOGICAL RISKS

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# CONTENTS

# Executive Summary

In 2017-18, the Johns Hopkins Center for Health Security conducted a multiphase research project to help inform the development of a strategic approach for communicating about global catastrophic biological risks (GCBRs). In brief, we define a GCBR as a biological development that could adversely affect the human species as a whole or radically change the course of human civilization—for instance, a severe pandemic involving a naturally occurring or deliberately engineered pathogen. GCBRs are an emerging concern among a discrete set of scientists and organizations located principally in Europe and the United States. To conceive and implement activities necessary to prevent or respond to biological threats of a global scale will require effective communication of the issue's importance—internationally—to a range of people with knowledge, influence, and control of resources.

First, we sought to elicit the attitudes and assumptions that influential individuals in science, policy, and practice communities now hold regarding GCBRs. Knowing major ideas in common, diverging points of view, and the rationale behind them can enable issue advocates to define GCBR in meaningful terms and to spur and strengthen commitment to risk reduction.

Second, we analyzed other times in history when it became necessary to alert policymakers, practitioners, and the public to the possibility of a globally catastrophic, potentially existential threat, in order to understand how others have communicated about such dire problems without shutting down the conversation and with successful engagement of public attention and action. Following these analyses, the Center developed a set of considerations and suggestions for individuals and institutions interested in championing the issue of GCBRs more effectively.

# Executive Summary

## PHASE 1

### Defining GCBRs and Persuading Others About the Problem: Expert Reflections

We queried experts from 11 countries and from diverse fields including the life sciences, the history of plagues and pandemics, public health preparedness and disaster medicine, security policy and new technologies, and existential risks about the following: What constitutes a GCBR? How might a GCBR be contained? How can we speak persuasively about GCBRs? Among the major findings were:

*No readily shared definition of what constitutes a GCBR exists among influential professionals knowledgeable about the origins and impacts of extreme biorisks.* For most experts thinking about GCBRs, that which comes readily to mind are well-known naturally occurring pandemics, such as the Spanish Flu and the Black Death, and the certain prospect of another influenza pandemic. Yet, individuals who are familiar with advances in bioscience and biotechnology warn that engineered pathogens have an even greater potential to threaten the human species as a whole. Despite the divergent emphases, the experts still expressed a common conviction that biological threats are forever evolving because of the dynamic and intertwined domains of microbiology, ecology, society, and technology.

*While a GCBR could emerge anywhere and ultimately affect everywhere, rallying a coordinated response will be difficult in a fractured world.* GCBRs are a problem at various scales—local, national, regional, global. No one organization is charged with protecting the well-being of the entire species. Some nations come to the problem with major existing health burdens, uneven outbreak management capacities, and larger economic and political challenges. The term GCBR is potentially polarizing because the Global South's endemic infectious disease problems are not typically included in the core idea. GCBR, for some interviewees, is also an awkward term whose meaning is not readily translated—a poor rallying cry when a global response is necessary. In contrast, "pandemic" is gaining worldwide salience.

*Explaining GCBRs as a pressing and tractable problem whose forward-looking solutions offer benefits today accords the issue greater public priority.* To keep individuals from writing off GCBRs as an improbable, intractable, or expensive problem not worth addressing, advocates should frame the issue as urgent and solvable. Using "pandemic" as the metaphor for the larger problem of GCBRs helps make mitigation both a concrete and proximate objective for diverse communities and nations. Moreover, showing how investments for uncommon events such as a severe influenza pandemic also generate short-term gains can persuade new allies to attend to the GCBR problem, especially countries where current disease burdens already drastically curtail human potential. Framing a pandemic as more than a human health threat can further broaden the set of stakeholders interested in GCBR mitigation.

## PHASE 2

### Communicating About the Very Worst of Cases: Historical Insights

To uncover potential principles for catastrophic or existential risk communication, we spoke to experts who had characterized other global scale threats and moved them into the public domain: nuclear winter, bioterrorism, and climate change. Our case study informants discussed motivations for taking a public stand; sources of influence; communication strategies, challenges, and successes; and unique aspects of communicating about the very worst of cases. Major observations included:

*Underlying political and cultural currents, as well as abrupt crises, influence the extent to which people recognize and/or act on global scale risk.* The knowledge and ideals advanced by the environmental and nuclear disarmament movements helped make the nuclear winter threat more salient. Political climate also stymied global risk awareness, as in the antagonism of a hawkish administration toward nuclear winter science or of fossil-fuel interests toward climate change predictions. Crises have made remote existential threats more real, immediate, and urgent: For example, Hurricanes Katrina and Sandy concretized the disastrous effects of a changing climate, the 2001 anthrax attacks exemplified a deliberate outbreak, and the recent US-North Korea nuclear standoff reignited interest in nuclear winter theories.

*Despite obstacles, scientists have been key champions around existential risks, enabled by their technical expertise, social influence, and global networks.* The epidemiology of smallpox, the atmospheric study of dust and smoke, the climate science behind the greenhouse effect, and other scientific research have been key to substantiating global risks. But scientists have faced major barriers in translating technical knowledge into social action. Nuclear winter theorists were disparaged for departing a "neutral observer" role to weigh in on a highly politically charged policy. In all cases, competing theories have undermined confidence in the basic risk assessment. Experts providing proof of an existential risk have also been hampered by technical idioms and audiences unfamiliar with the basics of physics, the climate system, infectious diseases, and so on.

*People put off acting on global scale risks when they perceive the impacts to be remote—occurring only rarely, in the distant future, or to faraway others.* Much of the world assumed the 2 superpowers threatened only themselves during a nuclear exchange, until planetary cooling was seen to jeopardize every nation's interests. Because the effects of global warming are protracted and experienced more acutely in countries with limited political and economic pull, the climate change movement has had difficulty gaining traction. Concerned about bioterrorism, public health and medical experts struggled to convince policymakers of the dangerous and disruptive effects of a deliberate outbreak, until the anthrax-laden letters shut down government, rattled the public, and overwhelmed health agencies.

## PHASE 3

## Heightening Awareness and Motivating Action Around GCBRs: Recommendations

Based on Phases 1 and 2, we distilled advice on how to prompt more awareness and action around GCBRs for subject matter experts wanting to exert their technical and social authority on this matter and enlist colleagues in doing so, philanthropists seeking to extend the impact of their initiatives that touch on GCBRs (eg, health and security from individual to global levels), and political advocates hoping to make the case for investing a portion of public resources in the issue.

*Relate GCBRs to the current context and concerns of those you seek to engage and make the risk as tangible as possible.* Use "pandemic" as the memorable stand-in for GCBRs, conveying the surety of an influenza pandemic; the surprise of what might come as glimpsed with newly emerging infectious diseases such as SARS, Zika, and Ebola; and the growing but underappreciated risk of a bioengineered pathogen release. To navigate shifting political and cultural winds, tie the issue to contemporary events, ally with groups that hold adjacent interests, and outline the GCBR implications when relevant crises emerge. Reference a planetary "we" while appealing to a self-interested "me," being conscious that larger circumstances affect a person's identity, social obligations, and economic and political power.

*Present GCBRs as a challenge where solutions are possible, enhancing a sense of self-efficacy.* Use a solutions-oriented narrative to prevent seeding a hopeless or fatalistic outlook, and, to the extent possible, outline specific risk reduction approaches or a concrete path to develop an action plan. Avoid radical extremes, relying on middle-of-the-road scenarios that can depict the situation as grave yet tractable. Spotlight the routine co-benefits of investing in GCBR mitigation, thus providing stewards of limited resources a solid justification for expenditures on the issue. Identify leverage points in nonhealth arenas for mitigating a GCBR, broadening the base of stakeholders who can help forestall cascading effects on political, economic, and social systems (eg, how industry can offset workforce depletion and disrupted supply chains).

*Diversify, strengthen, and share the scientific evidence for GCBRs and their mitigation.* Build an interdisciplinary network of scientists who can depict the problem in credible and holistic terms and also work toward solutions, including those that address the social vulnerability of the human host, the virulence and transmissibility of the pathogen, and the role of nonhealth sectors in GCBR mitigation. Foster a genuinely international community of GCBR scholars to strengthen capacity both within and across nations, and advance the knowledge needed to understand, communicate, and manage global biorisks. Provide interested scholars with access to resources (eg, science-writer collaborations) that enable them to convey technical knowledge regarding GCBRs in terms meaningful to a broad audience.

# Project Overview

In the following report, authors from the Johns Hopkins Center for Health Security outline its research and recommendations concerning a strategic communication approach to motivate greater social awareness and action around global catastrophic biological risks (GCBRs).

In brief, a GCBR represents a shift in biology that could jeopardize humanity as a whole, such as a severe pandemic involving a pathogen that emerges through natural evolution, deliberate creation and release, or accidental laboratory escape.[1] Such grave global threats require a commensurate level of study, planning, and effort to withstand them. At present, however, only a small set of scientists and organizations located mainly in Europe and the United States have begun to think systematically about GCBRs.[2-19] Thus, we need an effective way to communicate the issue's significance to audiences worldwide and, in particular, to individuals who can apply their knowledge, influence, and command of resources to the problem.

Three phases comprised this project, as reflected in the report's organization:

In **PART 1**, we spoke to experts in diverse fields relevant to GCBRs, including the life sciences, the history of plagues, public health preparedness, disaster medicine, security policy and new technologies, and existential risks. They addressed the following questions: What is a GCBR? How might a GCBR be contained? How can we speak persuasively about GCBRs? Our goal was to discern how issue advocates might better frame the problem for others, knowing where thought leaders now converge and diverge in their language and reasoning about GCBRs.

In **PART 2**, we conducted historic case studies, interviewing key figures who were among the first experts to characterize other catastrophic, potentially existential risks and move them squarely into the public domain. We explored the communication challenges and opportunities they faced and the approaches they applied when presenting the respective dangers of nuclear winter, bioterrorism, and climate change. Our aim was to uncover potential risk communication principles for the very worst of cases.

In **PART 3**, we considered the joint findings of our key informant interviews and historic cases to develop a set of recommendations for GCBR issue champions. Intended users are subject matter experts who want to exert their authority on the topic among a broader audience and to exhort colleagues to do the same, political advocates who are interested in making a more powerful case for applying a share of public resources to the problem, and philanthropists who wish to maximize the impact of their giving in regards to existential risk, global health, and global security.

# Defining Global Catastrophic Biological Risks and Persuading Others About the Problem:

## Experts on Pathogens, Plagues, and Public Health Weigh In

The power of a severe pandemic to kill in large numbers, disrupt economies and political systems, and unravel the social fabric is a prospect that certain individuals and groups have tried to communicate.[20,21] Compelling evidence suggests that this scenario is even more likely than before: Modern husbandry practices could enable a devastating influenza virus to emerge more easily,[22,23] inadvertent biosafety lapses could release a pathogen of pandemic potential from a lab,[24,25] or national governments or rogue groups—or both working together—could direct the engineering of a bioweapon to cause great harm globally or to exert immense political leverage.[26,27] Moreover, natural microbial events in the past 2 decades (eg, H5N1, SARS, 2009 H1N1, MERS, Zika, Ebola, H7N9) presage the potential regional or global impact that future infectious diseases could inflict.[28-30]

Humanity's fate is increasingly subject to microbial impact, yet society's response is incommensurate with the potential dangers. In this setting, our study takes a first step toward determining how better to heighten awareness and motivate action about GCBRs, such as the scenarios above. Its interest lies at the interface of science and politics: What are these extreme risks and how do they get on the public agenda? These questions involve fundamental communication matters such as ideas, evidence, language, narrative, and persuasion. Considered here are processes of *framing*, whereby a societal problem like a GCBR is defined, delimited, and portrayed to others, and *agenda setting*, wherein an issue prompts attention by decision makers who must weigh competing aims amidst finite public resources and a dynamic political backdrop.[31]

The purpose of Part 1 of this project is to uncover the current ideas, beliefs, and standpoints of diverse experts regarding GCBRs; this baseline is a first step toward the development of a common language and community that can help advance the science and social legitimacy of the issue. A plausible and compelling depiction of the problem could motivate previously unknowing, agnostic, or somewhat skeptical audiences to learn more and to work toward finding solutions. Moreover, by knowing points of expert convergence and divergence, we can better assess whether an authoritative and coordinated network (ie, epistemic community[32,33]) now exists or could exist that has the power to wield its knowledge and to influence the policy enterprise in the interest of improved human welfare—in this case, GCBR mitigation. Epistemic communities have been instrumental in advancing policies at national and international levels for other existential threats.[34,35]

## METHODS

Over a period of 6 months in 2017, the project team conducted 44 one-on-one interviews with key informants. Study participants held expertise in fields that bore directly on GCBRs, including the life sciences, the history of plagues and pandemics, public health preparedness and disaster medicine, security and new technologies, and existential risks. In all, 19 distinct disciplines and 11 countries were represented among interviewees, as were government, nongovernment, and industry sectors.

The project team pursued 3 lines of questioning: What constitutes a GCBR? How might a GCBR be prevented or contained? And what are recommended strategies for communicating persuasively about GCBRs? Interviewees provided their own definitions and examples of a GCBR after being presented with the description of a global catastrophic risk (GCR) as a situation that could affect the human species as a whole or radically change the course of human civilization.[36-38] Conducted by telephone, the interviews typically lasted 45 to 60 minutes. Summary reports were prepared for each interview, and the audiotaped proceedings were later transcribed.

Using NVivo qualitative analysis software, the project team coded the transcripts and summary reports in the rare instance when an interviewee declined taping. Coding themes were drafted initially based on the specific lines of inquiry and then elaborated through group discussion and review of the summary reports. During the coding process, teams of 2 researchers reviewed the entire transcript database for each of the 3 lines of inquiry and associated subthemes. Analysis of the coded data produced the findings discussed below.

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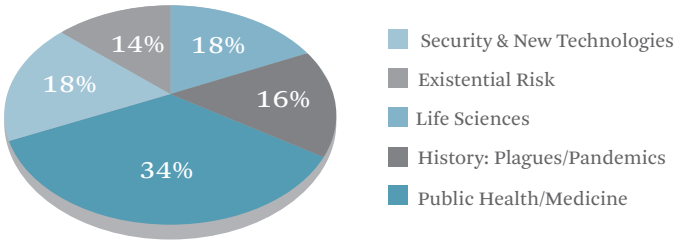

# FINDINGS

## Bounding the Problem—GCBR Attributes and Impacts

➢ There was broad consensus that biological risks are ever evolving, and that novel social, ecological, and technological conditions, and their interplay, are magnifying the potential for a GCB event.

Biological risks have changed over the course of human history and will continue to do so because of the dynamic evolution of societies and the conditions in which they exist. Many experts felt the escalating rates of urbanization and globalization of travel and trade would increase the probability and impact of GCBRs, since these trends bring more people into contact with each other more rapidly. Jet travel has significantly decreased the time it would take for a pathogen to be spread around the world, as seen in the recent Ebola epidemic in West Africa or the SARS outbreak of 2002. Historians pointed out that greater population mobility has driven enhanced spread of contagion throughout history, so we should continue to expect the same as global mobility increases. Travel, upheaval, and chaos associated with World War I, for example, exacerbated the spread of the Spanish flu around the globe. Describing a successive period of heavy mortality in Italy in the 16th and 17th centuries, one interviewee related:

> "Just as a naturally caused but socially constructed impact of crop failure moves people around, and, therefore, moves pathogens around, war does the same thing. And when people are uprooted as refugees, on the one hand, their whole health deteriorates."

A number of experts judged that novel ecological conditions, such as climate change and deforestation, have also heightened the potential for GCB events. Warmer climates contribute to new disease vector patterns, such as the expansion of disease-carrying mosquito populations to regions of the world previously free from this threat. Food insecurity induced by a changing climate amplifies the risk for a GCB event, because, a number of experts noted, malnutrition and famine conditions can increase a population's susceptibility to disease. The increasing interface of humans, domestic animals, and wildlife due to changing habitats has led to emergence of new pathogens with pandemic potential, and that will continue as this interface evolves. As one interviewee told us:

> "What can accelerate matters more when it comes to, for example, zoonotic disease, is that with deforestation proceeding apace and with wild animals being able to migrate more easily into areas of human habitat, that that would unleash pathogens at a rate that we cannot predict or anticipate clearly."

Others also stressed that the effects of ecological changes on biological risks were uncertain, that global warming had reached unprecedented levels, and that "we don't have anything right now to tell us what this level of global warming will do on any level." Many seemed to agree, though, that

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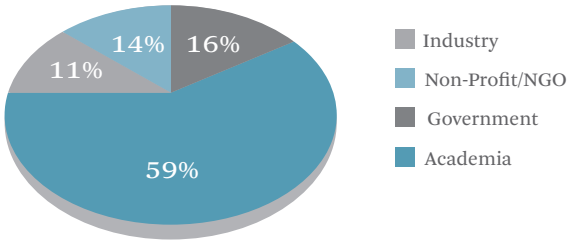

ecological changes are highly interconnected with changing societal conditions, such as population movements, and that together these continually evolving factors will play a role in the emergence and impact of future GCBRs.

While experts saw the interplay of biological risks and changing societal and ecological conditions as having a long historical precedent, many felt technological advances had the power to alter the nature of future biological risks greatly. Specifically, some noted that developments in gene editing and synthetic biology have expanded rapidly in recent years, and barriers to creating a new biological threat have begun to diminish as a result. The increased access to biotechnology has enhanced the potential for the accidental or deliberate release of a new, virulent pathogen that could kill millions of people or destroy significant amounts of the world's food supply very quickly. One expert remarked:

> "I think as laboratory techniques become easier and cheaper, and as the ambition of scientists to do what they consider interesting science involving pathogens expands, there's a risk of creating and then accidentally releasing pathogens that are highly transmissible and for which there is little immunity in the population. And I think that's a new possibility."

Some experts felt the risks posed by new technological developments were less predictable than risks from known biological threats.

### When depicting a GCBR, experts gravitated either toward a naturally occurring threat or a bioengineered agent.

When asked to describe or provide examples of what they thought constituted a GCB event, most experts readily listed naturally occurring pandemics, such as the Spanish Flu of 1918-19 or the Black Death. These familiar events appear in broader analyses of global catastrophic risks (GCRs) as well.[39,40] Experts cited these pandemics because these are known to have caused great human mortality around the world:

> "Certainly, anything that results in a significant human mortality will be a global catastrophic risk. And from an infectious disease point of view, we have 4 or 5 great examples. There is the Plague of Justinian, the Black Death. There is the Columbian Exchange that I just mentioned. And . . . then the most recent will have been the 1918 epidemic. But to me the denominator that affects the course of history is usually a significant human mortality."

For these experts, the fact that naturally occurring pathogens have wiped out almost entire populations in certain regions in the past—for example, measles and smallpox among Native Americans in the New World during the Columbian Exchange—and have the capacity to spread around the world, as occurred with Spanish Flu, supports the idea that such pathogens constitute GCBRs. Among naturally occurring pathogens, many felt influenza was the most likely culprit for a GCBR, since it was "much likelier to go global" and "reach pandemic levels very quickly" because of the rapid transmissibility of the virus that regularly mutates.

Not all experts limited their examples of naturally occurring GCBRs to acute, high-mortality events, however. Some felt that dengue fever, malaria, and HIV/AIDS could all be considered GCBRs because they kill millions of people around the world, even if not all at once. Others believed GCBRs could arise from pathogens that attack crops, animals, and other parts of the ecosystem (eg, bees) that support the human food supply. For instance, the massive biological infection of potatoes in the 19th century contributed to famine conditions in Ireland and other parts of Europe. Therefore, while naturally occurring pathogens constitute a main category of GCBR for people, there is even some variation in which natural threats people emphasized as having the potential to be a GCBR.

Although most interviewees named naturally occurring pandemics as examples of GCB events, experts who listed bioengineered threats felt that these altered pathogens were more likely to cause a true GCB event leading to a permanent loss of human population or human potential. These latter experts argued that since no naturally occurring pandemic has yet caused discontinuity in the human species' ability to

manage, adapt, and move on, these types of threats were unlikely to cause such discontinuity in the future. A synthesized smallpox virus, on the other hand, could potentially kill a significant portion of the human population quickly, because no one would have any immunity to this infectious agent. Additionally, some experts also noted that unfavorable circumstances exist for pathogens to reach the mortality levels characteristic of a global catastrophic risk naturally: An extremely virulent and lethal pathogen, for example, will likely kill human hosts before hosts can transmit it to others. Conversely, a pathogen is more likely to spread widely if human hosts live long enough to pass it on.

There did not seem to be a clear consensus among interviewees about whether accidentally or deliberately released engineered threats were more likely to cause a GCB event in the future. However, many felt the probability of a GCBR caused by a bioengineered pathogen was increasing because of the development of cheaper and more accessible biotechnology and the increased sharing and openness of knowledge in the field of synthetic biology. In particular, some feared, the capacity to manufacture and release a new pathogen was becoming a greater possibility for non-state organizations and actors, such as terrorist groups.

### Presently, GCBR is an amorphous category; communities of practice imagine definitional thresholds and concrete impacts very differently.

Unlike other global catastrophic risks, GCBRs have thus far evaded concrete definition, due in part to the complex intersections between the origin of a given biological threat; its primary, secondary, and tertiary consequences; and the associated scales of these consequences. Some subject matter experts, for example, focused exclusively on threats posed by interactions between dangerous pathogens and their hosts. In this vein, several interviewees proposed that the 2014 West Africa Ebola outbreak and highly pathogenic influenza pandemics might qualify as GCBRs, given the virulence, pathogenicity, and lethality of these viruses, as well as the absence of readily accessible, effective medical countermeasures (ie, drugs, vaccines, and other therapeutics). For example, when asked for historical examples of GCBRs, one informant cited "infectious diseases, particularly those that have killed a lot of people, like plague and [Ebola virus disease]. Historical examples would include TB, influenza, and syphilis, which is now reemerging." Another interviewee, citing SARS, swine flu, and Ebola as examples of GCBRs, further delineated 3 categories of infectious diseases with the potential to cause global catastrophe: pathogens with the potential to emerge across species; pathogens that cause clusters of disease, such as Ebola and H5N1 influenza; and pathogens that go on to become endemic, such as HIV.

Others, meanwhile, measured the severity of infectious disease crises in terms of their associated morbidity and mortality rates, proposing specific numeric thresholds for differentiating among emergencies, catastrophes, and existential events. One expert remarked:

> "Everything below 5 billion [deaths] is not existential but is really terrible and worthy of working on. The only way you would get to say, 10,000 people dying of something, is to have 1,000 people die of it and fail to control it. And so, the idea that we should be worrying about the 5 billion implies very strongly that we should be worrying about the 100,000 or the 5,000 and how we're going to keep those from growing."

A few experts also framed the severity of a given threat in terms of its origin. Some noted, for example, that while naturally emerging pathogens and biological accidents pose considerable threats to human health and security, many communities do possess the health infrastructure required to detect, contain, and counter the threat. By contrast, a deliberately engineered agent in the hands of a nefarious actor could be designed to elicit unfamiliar health consequences, become transmissible by novel or unforeseen routes, or affect select populations.

Despite some divergence among definitions, most interviewees agreed that rates of sickness and death are critical first-order consequences to consider when determining the appropriate level of risk to assign a given biological threat. However, others highlighted the importance of concurrently examining second- and third-order impacts (eg, effects on political stability, macro- and microeconomic performance, resultant social unrest), particularly when analyzing biological catastrophes unfolding over extensive temporal and geographic scales.

In this vein, several experts adopted an ecological approach to defining GCBRs—that is, extrapolating analyses of host-pathogen interactions to encompass their interactions with natural, built, and socioeconomic environments over extensive time scales. One historian, for example, cited the role of syphilis in contributing to Native depopulation in Hawai'i, underscoring the catastrophic consequences associated with the disease's persistence on the island for several generations:

> "In Hawai'i, it's fertility. It's not the fact that syphilis spreads and then you have a lot of ill or dying people. It's that there are then generations, many generations, in which the fertility rate is really shockingly reduced, and that this is one of the mechanisms that really leads to catastrophic risk and catastrophic change over time."

Many interviewees also classified phenomena such as famine, climate change, diminishing human fertility, and the loss of critical plant, animal, and microbial species as second- and third-order GCBRs, in addition to the first-order, direct threats to human health posed by dangerous pathogens. As such, several interviewees noted that the complex interplay among hosts, pathogens, and natural, built, and social systems underscores the need for increased interdisciplinary scholarship around GCBRs. As one expert noted:

> "There's a scarcity of people rigorously trained to straddle disciplines and occupy the interdisciplinary zone between them. . . . We're looking at the need for more interdisciplinary work and greater communication capacity on the part of very trained specialists such that they can move their knowledge to a variety of audiences in a clear and direct way."

### GCBRs are seen as more multifaceted than other GCRs, given the inherently dynamic nature of biological systems and the complexity of their interaction with other systems.

Interviewees indicated that, unlike most GCRs, GCBRs are unique in that human agency and decision making over the course of an unfolding catastrophe could modulate the proliferation and severity of the threat at hand. As such, experts largely agreed that there are several points of traction that could be leveraged to mitigate the consequences of an emerging biological threat before it cascades into a larger-scale, global catastrophe. These include strengthening infection control protocols, enhancing public health and healthcare delivery capabilities, and increasing investments in early detection systems and medical countermeasure development.

Additionally, several interviewees acknowledged the role that new technologies could play in detecting and countering biological threats, while also pointing out that such technologies themselves carry inherent risks. Biotechnologies used to accelerate drug and vaccine development, for example, could also be repurposed by a nefarious actor to cause deliberate harm. Still, while GCBRs could emerge as a consequence of increasingly complex interactions among pathogens, hosts, novel technologies, and their environments, this complexity also gives rise to the potential for increasingly sophisticated responses to such threats.[41]

Notably, human psychology plays a critical role in a potential GCBR's effects, making such events different from other global catastrophic risks. Experts noted that the novelty of a biological threat, apparent vulnerability and severity, and reported rates of transmission often influence public perceptions of the danger. Given variations in GCBR familiarity, scale, and scope, the level of public anxiety could intensify or wane over time. The early days of the HIV/AIDS pandemic, for instance, generated considerable public fear and institutional panic because of uncertainty over the disease's origin and modes of transmission, its sudden emergence and the speed with which it spread, and a lack of medical countermeasures. Today, however—though HIV/AIDS is endemic worldwide, and global morbidity and mortality rates remain high—medical and public health advances have reduced the disease to a chronic, largely manageable condition (contingent on access to health care) that evokes less social reaction than when the pandemic first emerged.

Experts also noted that threat perception often varies depending on the specific populations affected, and this could shape the cycles of panic and neglect that often accompany major biological events. The 2014 West Africa Ebola epidemic, for example, raised considerable alarm in the United States, because of the unique risks the disease posed to American travelers and healthcare workers; by contrast, earlier Ebola outbreaks (which were relegated largely to remote parts of Uganda and the Democratic Republic of the Congo) engendered considerably less global panic.

## Preventing and Containing GCBRs—Mitigation Scenarios and Considerations

### Informants were split in their ideas about *primary prevention* of a GCBR: Did one reduce the chances of a killer pathogen emerging, or minimize the vulnerability of the human host?

When discussing primary prevention, pathogen-focused informants outlined distinct approaches for natural, accidental, and deliberate threats (while recognizing rapid detection was relevant to all 3). Prevention against naturally emerging threats primarily encompassed swine and poultry biosecurity measures (eg, infection control, enhanced hygiene). Many informants noted that primary prevention of engineered pathogens—no matter whether they are released deliberately or accidentally—is much more challenging than naturally emerging threats because they have little precedent. With the "acceleration of biotech," it is hard to anticipate—and thus prevent—threats that are constantly changing. One participant noted, "Synthetic biology poses a real, real challenge for the unknown," because early surveillance systems may not be able to detect and prevent outbreaks of engineered novel pathogens. One interviewee even argued that new threats couldn't be prevented altogether, since there is absolutely "no idea where those new threats are going to come from, when it's going to come, where it's going to come, and in what form."

However, other interviewees noted various oversight and regulatory mechanisms that could help prevent both the accidental and deliberate release of dangerous pathogens, including better laboratory security and "sentinel monitoring for genetic changes within certain organisms." Additionally, interventions that place biosafety responsibilities on those who work directly with genetically engineered or dangerous pathogens, including improving training and education, "practicing prudent . . . aversion when it comes to funding novel research," and supporting "whistle-blowing" for poor lab behavior could potentially prevent deliberate or accidental disease outbreaks.

In contrast to those who enumerated ways to avert a dangerous pathogen from emerging, other interviewees scrutinized the underlying factors that make humans more susceptible to infectious diseases. Various historians commented on the social and economic variables affecting morbidity and mortality rates, with one summing up that "the underlying mortality risk for individual human beings will continue to be affected by essentially access to resources, be that food, shelter, or security." Moreover, many low-income countries have extremely poor water and sanitation systems, which make them much more susceptible to various diseases and illness. Compounded with their weakened health systems, handling even the mild day-to-day health needs is challenging. One interviewee stated:

> "Low-income countries have 9% of the population globally but 25% of the deaths. And it's not because they get hit first; it's just because they get hit worse."

Additionally, food insecurity and malnutrition each play a significant role in making any given population more susceptible to infections and disease. Political instability is another key factor affecting morbidity and mortality, as in the case of the current cholera outbreak in Yemen, which some have labeled as the largest and fastest outbreak of a disease in modern history. The political instability has led to a full-out war in Yemen, blocking those organizations with, as one interviewee noted, "the right moral authority and global standing" from intervening and providing assistance to those most in need.

### When discussing what constituted adequate GCBR preparation and response, respondents often singled out MCM innovations, health systems, and society writ large.

In contrast to prevention, informants noted that preparedness and response would be similar, no matter the origin of the threat, and that genuine readiness would require further advances in technology, health systems, and society writ large. Many informants spoke specifically of innovations in medical countermeasures (MCMs), including rapid platform responses and "developing vaccines for pandemic response," as integral to mitigating future outbreaks with catastrophic potential. However, one informant cautioned that investments in technology often overshadow the practical considerations of MCM dispersal, and challenges such as "being able to vaccinate [the community] in an orderly fashion and reaching everyone" should also be prioritized.

Strong medical and public health systems were seen as measures that both addressed the underlying human host vulnerabilities outlined above and improved the accuracy and timeliness of outbreak detection and response. Most informants highlighted "build[ing] up surveillance capacity" (at both the human and animal interface) and systems that allow for rapid testing in laboratories as critical to outbreak response, but they also noted several limitations of these systems that need to be addressed. One respondent lamented the inconsistencies of "detection mechanisms that we use in various places across the country," which are not integrated, coordinated, or ubiquitous. Other factors were also noted as being important to preparedness and response in connection with a potential GCBR: good infection control in healthcare settings, healthcare surge capacity, improved access to medications and vaccines, strong risk communication, astute clinicians who can recognize potential outbreaks, and strong animal health systems.

Some interviewees underscored that genuine readiness for a GCBR would require changes and activities in sectors other than health. For some informants, strong political structures were essential to minimizing the potential for a GCBR: that is, knowledgeable, informed political leaders who "got" the problem, functioning bureaucracies that were not riddled with corruption and did not divert resources from pressing public health needs, and authorities who engaged and fostered confident publics who felt that leaders were working on behalf of the collective's genuine interests.

In addition, "whole society" approaches to preparedness and response for a GCBR were judged as essential, including continuity of operations planning for defense, food security, banking and finance, industry, critical infrastructure, and other sectors. To consider GCBR only in terms of medical and public health service readiness, warned some informants, would leave other critical sectors vulnerable to major disruptions. Government concerns regarding GCBRs were seen to encompass internal security and the potential for unrest, public confidence in government, and overall economic stability. Lastly, some informants judged a strong capacity for humanitarian relief as a key component of GCBR preparedness and response.

### Informants frequently argued that investing in preparedness and response for more routine biothreats would help build capacities for confronting GCBRs.

In the eyes of many informants, the systems and workforces that are currently in place to detect and respond to routine outbreaks would be the same resources and infrastructure needed to confront GCBRs; thus, continued capacity building in private, public, and nongovernment sectors for everyday threats was important. Efforts to mitigate familiar disease outbreaks were seen as "very relevant to outbreaks of disease that are catastrophic but unlikely to happen," and "rigorous capacities and practice exercises" would help build agility for emergent large-scale threats. A minority opinion did arise, however, that emphasized the difference in preparing for and responding to a globally catastrophic biological event and that in connection with more routine biological threats. To drive home this idea, one respondent juxtaposed readiness for a "rainy day in Florida" with that needed for a major hurricane, adding that "routinizing" globally catastrophic risk was a dangerous proposition politically in that the issue would not receive the kind of planning, attention, and resources that it deserved.

### Improved governance structures were seen as necessary to confront GCBRs.

Many informants felt that today's institutional structures at local, national, regional, and global levels were insufficient to deal with disease outbreaks on a regular basis, confirming that further work would be necessary to build structures to deal with a GCBR, with both effectiveness and equity principles in mind. Together, informants argued for strengthening both centralized, top down, and decentralized, bottom up, approaches to epidemic management. One interviewee underlined the need for a truly robust World Health Organization, envisioned as a "fully independent, politically firewalled, and well-resourced organization that can cry foul and compel governments to action."

Other informants argued for enhancements at the national level, citing findings of the World Bank's International Working Group on Financing Preparedness and the National Academy of Medicine's Commission on a Global Health Risk Framework for the Future. Among needed changes at the national level were updated regulatory regimes matched to current and future biotechnology developments, as well as greater indigenous capacity for vaccine development and manufacture in developing countries. A key informant commented that during the 2009 pandemic influenza, the majority of vaccines were concentrated in developed countries—"countries that weren't the most vulnerable or the most affected"—and that better mechanisms for deciding where resources are distributed during a GCBR would greatly reduce the risk of spread and help with containment. One respondent commented that the Pandemic Influenza Plan managed by the WHO is a step in the right direction, but "we really need to go much further to ensure some level of equity in distribution of these things [vaccines and diagnostics] in a pandemic."

## Communicating Persuasively About GCBRs—Terminology, Audiences, Viewpoints

### Lauded for being comprehensive, the term GCBR was also criticized for its awkwardness, alarmist quality, and ability to splinter a global audience.

In addition to offering their own definitions of GCBR, interviewees reacted to the phrase itself, more often expressing critique than endorsement, and on occasion suggesting alternative language more likely to trigger understanding, interest, and action. Individuals who spoke of the value of the term "global catastrophic biological risk" remarked that each word conveyed a specific and important element of the problem: an incident global in reach, catastrophic in impact, and biological in nature. "When I heard the term," noted one informant, "I thought, 'Ooh, that's nice. . . . It's nesting a lot of different things into a single category." Another interviewee said s/he could not think of a better term:

> "I can't think of any of the four words that's redundant or any other words that need to be added. . . . I can't think how one would improve upon it, because it does express exactly what it is."

That the phrase directly engaged with the term "global catastrophic risk" or GCR, a concept that has already gained traction in its own right, was seen as beneficial in that it broadened current GCR thinking to consider the unique attributes of biological risks more directly. Those who agreed that using a string of descriptors to convey complexity was a reasonable approach nonetheless judged that it came at the cost of its not being "catchy or immediately clear":

> " 'Global catastrophic biological risk' is a little bit of a mouthful, a little bit cumbersome, and a 4-letter acronym is always problematic as opposed to a 3-letter acronym."

Criticism of the phrase "GCBR," however, was not limited to its awkwardness. Several who saw the phrase as problematic worried about its doomsday quality:

> "I worry a little bit about couching things in terms of 'global catastrophe,' because it may lead at least some listeners to roll their eyes and think that we're in the business of the apocalypse here and we've heard these sorts of dire predictions before."

Others remarked that drawing a circle around devastating but infrequent GCBRs could inadvertently be seen as promoting a "boutique interest of the developed world" or "the security and safety of American people" and not protecting the inherent "health and wellbeing" of others, because it separated out infectious disease threats that were already devastating much of the developing world.

Some informants questioned the wisdom of developing new, even clumsy terminology when the word "pandemic" already resonates with many audiences; as one individual asserted, "Half the things that we're always accused about in public health is 'speak common language.'" Some interviewees with experience on the world health stage cautioned that GCBR would be difficult to translate into other languages—a problem especially if one was trying to advocate around an issue of "global relevance." One person noted that, even in English, GCBR was "an unnecessarily long and complex term" that "different people can interpret in different ways."

Asked to imagine a term other than GCBR that could capture the idea of a biological incident whose devastating effects could alter human history, people most often singled out "pandemic," but also had other suggestions: "existential threats to or from biological entities," "global bio-threats," and "high-impact bio-scenario." Regarding an agricultural scenario that jeopardized human well-being through extreme food insecurity, one person noted, pandemic was still an apt phrase as in animal or plant pandemic. "Pandemic" and "great hunger," both of which conjure specific and powerful images, were 2 plainspoken phrases into which GCBR could be boiled, asserted one informant.

➢ To prevent GCBRs' being dismissed as a remote possibility, these infrequent yet consequential scenarios should be cast as real, concrete, and pressing.

For some informants, this tack meant being a persuasive storyteller, using events like the Spanish Flu or Black Death to illustrate the scale and scope of devastation envisioned as returning again, or detailing what an analogous scenario would look like today:

> "We're talking about a complete social dislocation as a society, which would mean that everything we depend on . . . suddenly becomes questionable. So, what would it be like if . . . we found supermarket shelves empty and people unwilling to shake hands and have any close contact in public, or [being] unable to go to work because they're afraid of being infected?"

For others, conveying GCBRs as a genuine concern meant giving hard facts, like a specific dollar figure for a dramatically curtailed gross domestic product: "If you stick to numbers only, then you sound practical, you sound reasonable, you sound calm." One informant suggested using a finite number of scenarios, perhaps 3 to 4, to represent GCBRs overall.

Informants diverged, however, on whether such scenarios should be known histories or conjectured futures:

> "The more you ground this in things that are plausible and linked to things that have happened . . . the better. So, coming up with a zombie pathogen type scenario, genetically modified, kills everybody—is that possible? Sure. Is that really a good way for anyone to be spending their time? Probably not, frankly. I mean, the reality is that we have plenty of biological threats in front of us today."

Another interviewee admonished this retrospective-type thinking:

> "So, what I find is that a lot of the focus is on existing threats, simply because that's the ones we know. And what I worry about is either the state actors determined to generate real doomsday type of weapons to threaten the world for blackmail, or the crossover of agents that we just don't know about."

### Framing a GCBR as more than a health issue could help generate a much broader constituency committed to mitigation.

Many informants warned that talking about the impact of and response to GCBRs strictly in health terms was to diminish their import as well as limit the audiences who need to engage on the topic. Large numbers of sick and dying people may mark a GCBR's severity for some people, but dire economic consequences were seen as having more influence among the political class. One person noted that although health is an important issue for most people, it is not a motivating driver for policymakers. "When it comes down to it," an informant explained, "a treasury minister will be looking at a more holistic, overall economic assessment . . . and say, 'What drives jobs, wealth creation, and where are the big risks?' You will not find health in those big risks."

Framing GCBRs in terms of their security implications was also judged by many informants as motivational for top decision makers. This could involve domestic security concerns:

> "I think in Sierra Leone or in Liberia, where, as result of internal security measures, you actually had parts of the city being cordoned off and people being unable to move around . . . that actually results in a situation where you could have very serious public unrest."

Or it might be characterized as a broader national security concern:

> "The arguments you need to make are how it could destabilize borders, how it could potentially start a nuclear war between Pakistan and India, how it could lead to massive destabilization of the North Korea regime. . . ."

The touchstone issue, one informant noted, with which one could move political leaders to recognize and to act on GCBRs would ultimately depend on the needs and desires of the specific country—that is, whether national government leaders would find these issues "politically palatable."

### Raising the alarm about GCBRs without offering solutions could cause critical audiences to disengage from the topic.

Whatever the audience, many respondents noted, communicating the problem as a tractable one would prevent people from tuning out a discussion about GCBRs. For many, this meant resisting any inclination to "hype" or overdramatize the problem:

> "If one is doing scenarios, then one has to be careful, I think, that the scenarios appear to reflect reality and not appear to have a thumb on the scale that emphasizes the worst possible outcome."

Also readily recommended was offering a solution when alerting someone to the risk—just enumerating risks that have various degrees of plausibility without there being some way to mitigate risks was seen as not being enough. Even an imperfect solution was better than none:

> "One thing that's underappreciated is the importance of producing solutions—even bad ones—as a way of getting the discussion going, rather than just focusing on the problems. I think there's been a tendency . . . to just say, 'Oh, there's a problem. We're two minutes until midnight,' but what's the solution?"

In the case of developing countries, noted some informants, it would be important to articulate solutions that could address their present disease burdens as well as projected ones in the context of a global catastrophe. Outlining the co-benefits of GCBR investments, in fact, was the most frequently advised way to capture people's interest in uncommon yet devastating bio-scenarios:

> "It's the infrastructure that's needed to help people deal with the threats they have every single day of their lives. That, to me, is an easier sell for donors, for governments and so forth, to understand [that] this is a worthwhile investment that is also helping you deal with that one-in-a-million chance that some giant catastrophic risk is going to happen."

One informant, however, spoke adamantly against framing GCBRs as solvable as familiar bio-threats: "The big downside to routinizing catastrophic risk is they won't get funded, and people won't take them seriously."

### To speak persuasively about GCBRs requires knowing one's audience—policymaker, practitioner, public—and tailoring messages to them.

Gaining the support of policymakers was widely viewed as challenging but critical for gaining traction on this issue: "The [objective] is to get this on policymakers' radar [and have them] give it the level of seriousness and resources that it deserves." Informants offered a variety of strategies to persuade policymakers of the importance of GCBRs amid competing political priorities. Frequently mentioned was the need to frame the problem in macroeconomic terms (eg, what are the GDP and economic risks of GCBRs? How many jobs could be lost in your district?) and to explain the problem in other tangible ways, such as conveying stories of specific catastrophic scenarios.

Many informants noted the importance of continually educating and informing policymakers. As one summarized:

> "Our elected officials . . . don't really talk about these issues with any degree of urgency because they don't understand them, or they fear them. Improving or increasing the knowledge of key leaders and decision makers will help."

A handful of interviewees felt strongly that it was important to provide policymakers with concrete options and solutions for dealing with GCBRs to avoid feelings of hopelessness:

> "For [low probability, high risk] scenarios, any policymaker is going to throw up their hands . . . and work on something else . . . because it's in the way-too-hard category."

In contrast, the national security community was viewed by several informants as a natural ally in the fight against GCBRs because of their "tolerance for thinking about worst-case catastrophes." It was felt that national security experts would be more receptive to arguments about the disruptive qualities of GCBRs (ie, how they might destabilize national borders) instead of morbidity and mortality.

The need to raise awareness among the public was also widely referenced. Call on the public as "citizens of the world" was the suggestion of one informant who felt that everybody has a role to play, whether in speaking to elected officials or mobilizing their communities. The role of social media (eg, Twitter, Facebook) and popular culture (eg, TV, movies) were both raised as potential tools with which to engage this audience. However, multiple informants acknowledged the risks inherent in communicating to the public, such as inciting unnecessary panic, especially in a climate of "fake news." According to several informants, the trick is "issuing messages in a way that is informative, but at the same time takes a great deal of care not to incite fear to the level of chaos among our public." Failure to strike this balance could result in either GCBR groups being "pigeonholed as doom-and-gloom" organizations or, alternatively, "crying wolf."

As for the public health community, a handful of informants felt the global burden of infectious diseases would be much more salient to public health practitioners than existential scenarios; however, others felt they would be easy to persuade. One US practitioner argued that she had been able to mobilize local medical and public health colleagues to work on health disasters by stressing how their everyday assets would have value in extreme situations. In addition, one informant mentioned the role of nongovernmental organizations (NGOs), which could be related to by tying GCBRs to their specific missions. At least 2 informants mentioned the scientific community or science bloggers, whom they felt would respond well to evidence and scientific arguments.

### The Global North and South have divergent perspectives on GCBRs, to which a communication strategy needs to be sensitive.

A majority of informants who addressed this topic felt the term GCBR—and global health security in general—does not resonate with much of the world; it is a "very westernized" term that has a "certain first-world problem quality to it." Some informants felt it could be perceived as "dismissive" of the everyday health issues facing the populations in the Global South, such as neglected tropical diseases. One interviewee summarized the attitude from developing countries:

> "Look, we don't care that your organization is focused on pandemics or epidemic[s], we care that our kids are dying from infectious diseases [malaria, TB]."

Another informant concluded, "It's only the wealthy nations that have the luxury of thinking about these things."

However, among those informants who recognized the challenges of persuading a Global South audience, the majority nevertheless felt that serious efforts should be made to convince this region to address the issue. At least 2 informants felt that dealing with GCBRs should be framed as a *global* endeavor. To quote one informant:

> "[We need] to persuade all countries that it is in their interest to invest as much as they can afford in what is a global project."

Several informants felt that successfully engaging the Global South necessitated a discussion of the co-benefits of investments in public health services delivery and surveillance to offset existential risks. One informant noted that "if you're better able to deal with cholera or malaria through health system strengthening, you will be better able to deal with new and potentially pandemic diseases that come up." Another explained that we should be solving the everyday epidemics facing the Global South because the same systems will be what is needed "when the big one comes." A handful of informants noted that the Global North also needs to see the importance of building up capacity in the Global South: "The rich world [needs] to invest appropriately, and we can't let the poorest tackle this problem on their own."

# DISCUSSION

## GCBR Communication Dilemmas and How to Manage Them

### PINNING DOWN A MOVING TARGET

As it currently stands, there is no readily shared definition of what constitutes a GCBR among influential professionals knowledgeable about the origins and impacts of extreme biological risks. An amorphous category, GCBR means different things to different people. It will be difficult to mobilize policymakers, practitioners, and the general public without greater scientific consensus and a clearer object of concern. For most subject matter experts who are thinking about GCBRs, that which comes readily to mind are well-known naturally occurring pandemics, such as the Spanish Flu and the Black Death, and the certain prospect of another influenza pandemic.

Yet, individuals who are familiar with advances in bioscience and biotechnology warn that engineered pathogens have an even greater potential to threaten the human species. A bias toward thinking about GCBRs solely in terms of naturally occurring threats could leave society flatfooted in its ability to mitigate future biothreats consciously designed to cause extreme human health or other effects. At the same time, diverse experts hold a common conviction that biological threats are forever evolving because of the dynamic and intertwined domains of microbiology, ecology, society, and technology.

#### Build up the interdisciplinary science behind GCBRs.

Individuals with specialized knowledge about catastrophic, potentially existential biorisks—for example, how they emerge and spread, what consequences they have and for whom, and which policies and practices may attenuate their impacts—are housed in different disciplines, with rare opportunities to interact and develop a comprehensive picture of GCBRs. Many interviewees argued that getting the science "right" is a fundamental step toward credibly portraying GCBRs as a problem worth solving. The relevant science behind GCBRs includes microbiology, epidemiology, economics, ecology, public health, medicine, history, and social and behavioral sciences. Interdisciplinary cooperation has been instrumental for characterizing other extreme threats and potential mitigation options.[42-44] Similar community-building activities are necessary to produce the knowledge base around which to mobilize an appropriate societal response to GCBRs. Interdisciplinary working groups can help overcome any tendency to represent GCBRs in strictly health terms (ie, morbidity and mortality levels) as well as open up mitigation opportunities outside of narrow medical and public health ones, including those that address conditions making certain populations more vulnerable to impacts.

#### Illustrate GCBRs through a discrete set of scenarios.

A first endeavor for an interdisciplinary working group would be to generate a finite set of GCBR scenarios to make impacts concrete and immediately salient, diminishing the perception that a species-level threat to humanity is a remote possibility. Allowing for several scenarios could also capture a range of situations that subject matter experts envision as constituting a GCBR. Candidates, for instance, include an acute onset natural pandemic among humans (eg, influenza pandemic); a slow onset natural pandemic among humans (eg, HIV/AIDS); a plant or animal pathogen that, coupled with socioeconomic and politically based vulnerability, leads to widespread famine; and an acute onset human pandemic involving a bioengineered pathogen for which no medical countermeasure exists. Whatever the initial set of illustrative scenarios, it will be important to represent GCBRs as both certain and familiar (like an influenza pandemic) and uncertain and novel (as in an emergent disease in connection with climate change or the malicious application of bioscientific advances). As one interviewee remarked, "We don't know what the problem will look like in year 2100."

## INVESTING A FRACTURED WORLD IN A GLOBAL PROBLEM

GCBRs are a problem at various scales—local, national, regional, global. A GCBR can start anywhere and potentially affect everywhere. The human population as a whole may be at risk, but there is no one organization charged with protecting the well-being of the entire species. Various nations come to the problem of GCBRs with their existing health burdens, uneven outbreak management capacities, and larger economic and political challenges. The term GCBR, as a number of key informants noted, has different salience for the Global North and Global South, and it is potentially polarizing because the Global South's endemic infectious disease problems are not typically included in the core idea. GCBR, in the minds of some interviewees, is also an awkward term whose meaning is not readily translated—a poor rallying cry when a global response is necessary.

### Single out a pandemic as the specific problem that all nations share.

In the interest of making mitigation both a concrete and proximate objective for diverse nations, it would be useful to rely on "pandemic" as the metaphor for the larger problem of GCBRs. While GCBR may be comprehensive and flexible as an umbrella category, as key informants noted, the term is vague, nonspecific, and subject to interpretation. In contrast, the concept of a pandemic has increasing salience for the international community, and it provides an explicit target around which to assign discrete prevention, preparedness, response, and recovery activities. The problem of a pandemic captures both the certain prospect of a worldwide influenza epidemic and the growing possibility of an accidentally or deliberately released bioengineered pathogen that has significant consequences.

### Engage individual countries on the issue of pandemics on their own terms.

While GCBRs are a problem for the human species as a whole, national self-interests will necessarily drive mitigation activities. Issue advocates should be prepared to engage international partners on the problem on their own terms, while still emphasizing the global perspective.

## OFFERING HOPE WHEN THE SITUATION IS BLEAK

As a societal priority competing for scarce resources, GCBRs are easy to dismiss on 2 counts. Even if catastrophic, GCBRs are nonetheless an infrequent occurrence, and more immediately pressing problems can crowd them out on the public agenda. At the same time, both policymakers and the public may perceive GCBRs as insurmountable, given the scale and scope of possible impacts. To keep individuals from writing off GCBRs as a problem not worth addressing, advocates should frame the issue as urgent *and* solvable. Best practices in communicating readiness for low-probability, high-consequence events underscore the importance of presenting people with specific actions that they can undertake to protect themselves.[45] Alarming statistics and gruesome images do not motivate people to prepare for disasters; what does is an explicit plan of action along with an explanation as to why it helps.

### Characterize a *biological* GCR as a tractable problem.

GCR is a category gaining more traction in some quarters. Frequently used to illustrate the GCR category, pandemics benefit from this association in that more people are becoming aware of their significance. Nonetheless, when juxtaposed against asteroid impact, super volcanos, and other GCR scenarios in which successful human intervention is unlikely, pandemics inadvertently gain a reputation as inherently ungovernable. Issue advocates should cast GCBRs as exceptional in their plasticity: Pandemics exist at the interface of pathogen, society, technology, and ecology, and as a result are more tractable than other GCRs.

## Outline the routine co-benefits of investing in pandemic preparedness.

Explaining how investments for uncommon events such as an influenza pandemic also generate short-term gains would be an essential communication strategy for mobilizing allies to work on GCBRs, according to many informants. This is especially true in the case of developing nations for which current disease burdens already drastically curtail the human potential of their populations. Steps to mitigate more familiar disease outbreaks and newly emergent infectious diseases—enhancing surveillance systems, swiftly developing effective medical countermeasures, improving access to medications and vaccines, strengthening animal health systems, communicating risk effectively, engaging civil society in disease control campaigns, and more—help build the capacity needed to confront a nascent pandemic.

## Emphasize nonhealth leverage points for mitigating pandemics.

Health system readiness and response is essential to mitigating potential impacts, but a pandemic can have dramatic and cascading effects for political, economic, and social systems. Framing a pandemic as more than a human health threat can broaden the set of interested stakeholders—for example, in the case of industry, how to attenuate workforce depletion and disrupted supply chains; in the case of agriculture, how to tend animal herds, sow and reap crops, and maintain equipment, despite limited numbers of farmhands; in the case of finance, how to sustain cash distribution systems, electronic check payment systems, and retail banking services; in the case of law enforcement, courts, and corrections, how to respond to emergency calls, which are likely to increase during the crisis period, process arrestees, and try cases when critical personnel are scarce; in the case of national defense, how to sustain combat readiness and to balance military missions with humanitarian relief endeavors during an extended period of curtailed manpower.

# Communicating About a Catastrophic or Existential Risk Effectively:

## Insights from the Cases of Nuclear Winter, Bioterrorism, and Climate Change

Part 1 of this study entailed asking relevant experts to define and delimit the problem of global catastrophic biological risks and to identify potential challenges in portraying that problem to others. Building on that base, Part 2 explores other times in history when it became essential to alert policymakers, practitioners, and the public to the possibility of a catastrophic or existential threat. The goal was to discern potential strategic communication lessons applicable to the GCBR case.

A "best practices" communication literature now exists on how to motivate people to prepare in advance for a low-probability, high-consequence event like a hurricane or earthquake and on how to issue warnings during an unfolding disaster in ways that prompt people to take a recommended protective action.[45-52] GCBRs, however, potentially pose a different kind of risk communication problem due to scale—that is, they can affect the human species as a whole or radically change the course of human civilization.

To explore whether there are communication principles that pertain specifically to a catastrophic or existential risk, the study examined 3 global scale threats from the perspective of experts who played a key role in first characterizing the risk and then moving it into the public domain: nuclear winter, bioterrorism, and climate change. The study adopted the notion of *epistemic community* in bounding the 3 cases for examination: a thought community or network of experts, often with a shared worldview, who apply their knowledge to uncover a problem and use their authoritative standing to trigger social awareness and action.[32-35] Through their technical astuteness and social influence, an epistemic community facilitates the public recognition of a threat to the common good.

## METHODS

The project team conducted case study analyses of select historic moments in which an epistemic community first coalesced to define and delimit a catastrophic or existential risk that they wanted on the public agenda. The team chose contemporary cases in which influential members of the epistemic community were still living and available for interviews: nuclear winter, bioterrorism, and climate change. Teams of 2 researchers were established for each case study. Each team used secondary sources identified through an array of search engines to gain greater familiarity with the larger historic context and to identify potential key informants.

Usually lasting an hour, key informant interviews were conducted by telephone in April and May 2018: nuclear winter ($n$ = 7), bioterrorism ($n$ = 7), and climate change ($n$ = 6). Interviewees typically were esteemed individuals who had developed and/or conveyed the original scientific analyses attesting to the risk and who exerted further influence in mobilizing fellow technical experts, political activists, and political authorities around the issue. Interviewees were identified during the literature review period and supplemented through snowball sampling.

Each interviewee answered questions regarding: motivations on taking a public stand; sources of influence when conducting outreach; communication strategies, challenges, and successes; and reflections on unique aspects of existential risk communication. A summary report was prepared for each interview, which was also audiotaped and transcribed. Each research team reviewed the interview data for prevalent themes bearing on challenges in communicating about globally catastrophic, potentially existential risk.

For each case study, the team prepared a brief background section followed by observations about global risk communication challenges, based on interviewee reflections. The background materials provide some context for the reader, in support of the project's analysis; they are not intended to be comprehensive accounts of all players and circumstances during that moment in history and science.

# CASE STUDY: NUCLEAR WINTER

## Background

Before it became a household term, the concept of nuclear winter was born in the minds of an interdisciplinary team of climate scientists. In 1982, Richard Turco, Brian Toon, Thomas Ackerman, James Pollack, and Carl Sagan (known colloquially as the "TTAPS" group) used computer models and atmospheric data to conclude that an exchange of nuclear weapons between the United States and the Soviet Union would have dramatic effects on the Earth's climate.

Atmospheric scientists by training—except for Sagan, an astrophysicist—members of TTAPS previously studied the atmosphere of the Earth, Mars, Venus, and other planets, including the impact of dust storms and clouds on the climate.[53] In 1980, scientific evidence by Luis Alvarez et al concluded that an asteroid impact caused the mass extinction of the dinosaurs by throwing up enough dust into the Earth's atmosphere to block sunlight.[54] In 1982-83, chemists Paul Crutzen and John Birks theorized the potential impacts on the Earth's climate of soot and smoke due to massive forest and industrial fires resulting from a nuclear war.[55]

Intrigued by both Crutzen's and Alvarez's pioneering work in this area, the TTAPS group explored the hypothetical impact on Earth's climate from nuclear war. In October 1983, they shared their findings with the scientific community in an unpublished manuscript at a 2-day conference in Washington, DC: the Conference on the Long-term Worldwide Biological Consequences of Nuclear War.[44] The TTAPS papers showed that dust, smoke, and soot launched into the air from fires following repeat missile strikes on major cities would cause a reduction in global temperatures of 15 degrees Celsius or more. This result would be what they termed "nuclear winter," a period characterized by freezing temperatures, darkness, famine, and mass extinction. Their findings were summarized in a December 1983 issue of *Science* magazine:

> "For many simulated exchanges of several thousand megatons, in which dust and smoke are generated and encircle the earth within 1 to 2 weeks, average light levels can be reduced to a few percent of ambient and land temperatures can reach –15° to –25°C. . . . When combined with the prompt destruction from nuclear blast, fires, and fallout and the later enhancement of solar ultraviolet radiation due to ozone depletion, long-term exposure to cold, dark, and radioactivity could pose a serious threat to human survivors and to other species."[56]

While some scientists at the conference took issue with certain assumptions used in the models and felt that the effects on the Earth's climate were exaggerated, most participants agreed that a nuclear exchange would bring about not a global warming, but a global cooling.[55] Even a modest exchange of nuclear weapons, rather than a full-scale nuclear war, could potentially have catastrophic effects on the Earth's climate.

While the scientific community debated the technical aspects of the research, it was not until October 1983 that the public was introduced to the nuclear winter hypothesis in a special report by Carl Sagan in *Parade* magazine.[57] An effective science communicator and an accomplished scientist in his own right, with a dedicated following from his television show *Cosmos*, Sagan believed nuclear weapons represented a grave threat to humanity. Even though some scientists quietly expressed concern over Sagan's outspoken nature, antinuclear advocacy, and "cherry picking" of the most extreme nuclear winter models,[58] his scientific authority and public persona helped to make the TTAPS findings a topic of national conversation. By the time the TTAPS paper was officially published in *Science* 2 months later, in December 1983, the American public was already familiar with nuclear winter and associated it with Sagan's brand of political activism.[57]

Meanwhile, scientists continued to study the climactic and biological effects of nuclear winter. Biologists Paul Ehrlich, Mark Harwell, and others theorized that a nuclear winter would put the entire planet at risk from destruction of environmental, biological, and agricultural ecosystems.[59] In addition to devastating the nuclear weapons states directly via blast damage, fire, and radiation, a nuclear war would potentially have noncombatant states facing even greater losses from famine and other biosphere disruptions. "If, as now seems possible, the Southern Hemisphere were affected also, global disruption of the biosphere could ensue. . . . The extinction of a large fraction of the Earth's animals, plants, and microorganisms seems possible," Ehrlich et al wrote in the December 1983 issue of *Science*.[59]

It was not long before backlash came from policymakers in Washington. Toon, Ackerman, and Pollack all worked for NASA, which threatened to pull their research funding to avoid antagonizing the Reagan administration. The Pentagon under Reagan was escalating the nuclear arms race and supported development of the Strategic Defense Initiative (SDI), led by physicist Edward Teller, who strongly disagreed with the nuclear winter hypothesis. Concurrently, other scientists, including Starley Thompson and Stephen Schneider, argued that the effects of nuclear winter were vastly overstated.[60] There was simply not enough precision in the models to instill a high degree of confidence in the predictions. Instead of a nuclear winter, a "nuclear autumn" would ensue, whose effects, though serious, were less catastrophic than those envisioned by the TTAPS models. Yet, Sagan maneuvered to keep the debate in the national spotlight, making TV appearances on ABC[61] and testifying before Congress in 1984 against Edward Teller.[57]

Over the next decade, several large studies were carried out to validate the earlier findings pertaining to the physical, biological, and humanitarian consequences of nuclear winter.[44] These projects brought together impressive interdisciplinary teams of scientists, including physicists, astronomers, geologists, meteorologists, chemists, and experts from other disciplines. The first of these was the National Academy of Sciences account of nuclear winter, which was published in 1984. It elaborated on earlier contributions made by TTAPS, but questions lingered over the confidence of the predictions. The other major project was conducted under the auspices of the SCOPE (Scientific Committee on Problems of the Environment), a major interdisciplinary and international endeavor that involved a series of scientific workshops over several years. The first SCOPE report was published in 1985 on the atmospheric effects of nuclear winter, followed by a report on the biological and ecological consequences and other topics. The SCOPE series generated growing scientific consensus on the validity of nuclear winter theory. In addition to the research carried out by physical and biological scientists, medical and public health researchers began to consider the humanitarian consequences of nuclear winter.

The nuclear winter debate ultimately made its way into the hands of world leaders. In a 1988 meeting with Ronald Reagan, Soviet Premier Mikhail Gorbachev cited nuclear winter as influential in his decision to end nuclear proliferation.[57] A year before, the US and the USSR had ratified the INF Treaty, which would eliminate all short- and medium-range nuclear missiles.

Despite the end of the Cold War and the dismantling of tens of thousands of nuclear weapons, nuclear stockpiles of today remain sufficiently high to bring about a nuclear winter scenario. Updated models by Brian Toon and meteorologist Alan Robock show that even a small nuclear war between India and Pakistan, or the United States and North Korea, could block out the sun, reduce crop yields, and lead to global starvation.[62] These scientists and others have continued to raise public awareness (eg, at TED Talks) and communicate the risks to a targeted audience, including Congress. From its origins in a small community of climate scientists, nuclear winter erupted onto the global political arena to forever alter the debate over nuclear weapons science and policy.


## NUCLEAR WINTER OBSERVATIONS

### Audience receptivity to nuclear winter risk messaging was heavily dependent on the overarching political climate.

The ability to communicate about existential risks is strongly influenced by political context and prevailing societal attitudes. One informant observed that the public was "primed" to think about the large-scale environmental impacts of nuclear winter because of the global environmental movement, which occurred throughout the 1960s, 1970s, and 1980s. Nuclear winter advocacy benefited from a wave of environmental activists, such as Rachel Carson and her 1962 book *Silent Spring*, which raised awareness of man-made environmental risks.

Environmental conservation dovetailed with another movement sweeping the nation in the 1980s: nuclear disarmament. For example, the Nuclear Weapons Freeze Campaign encouraged the United States and the Soviet Union to stop nuclear weapons testing and production, and it led to marches and demonstrations throughout the country. These developments generated a conducive political climate in which communication about the risks of nuclear winter could be favorably received and adapted by the public as part of a wider campaign against nuclear proliferation. "It was in the air," summarized one informant, referring to the general atmosphere of anti–nuclear weapons activism of the 1980s. More recently, the prospect of nuclear war between the United States and North Korea under a Trump presidency may serve to temporarily put the threat of nuclear winter into the spotlight.

However, political currents also presented an obstacle to nuclear winter research activities and communication. Specifically, nuclear winter theory was anathema to the Reagan White House and its hawkish stance toward nuclear weapons, which included development of the Strategic Defense Initiative, or Star Wars. Federal agencies under Reagan, including NASA, NOAA, and NSF, were all less likely to fund research on nuclear winter in the 1980s. One informant expressed his frustration when a research grant from the Defense Nuclear Agency to study the effects of smoke on surface temperatures was withdrawn because it "supported nuclear winter theory." Another informant, then a contractor for NASA, recalled the night before a 1982 scientific conference when he received a call from a NASA administrator telling him not to present his unpublished nuclear winter findings because of potential backlash from senior Reagan administration officials. A third informant, in referencing this incident, cited "a constant fear of working on [nuclear winter] by most people because they're afraid their budgets will be cut or their middle managers will not want them to work on it." When Reagan-era funding for nuclear winter research dried up, some researchers were able to secure new sources of grant funding from philanthropic organizations and other independent entities.

> Framing nuclear winter in terms of cascading planetary effects, rather than concrete impacts on human lives, led to an altered threat perception that motivated some to act while demotivating others.

Since their invention and use in the 1940s, atomic weapons have been feared for their destructive potential and ability to cause dramatic morbidity and mortality. However, nuclear winter theory changed the public perception surrounding the threat of nuclear weapons by highlighting their ability to harm the planet, including the possible extinction of the human species. The knowledge that a nuclear exchange between the Cold War powers could lead to damage on a planetary scale generated a newfound urgency in some circles to dismantle nuclear weapons stockpiles.

One informant recalled a 1989 presentation at the United Nations General Assembly in New York on the threat of nuclear winter. "There was an absolutely chill effect" among the delegates on learning that a nuclear war between the US and the USSR might have a profound impact on their national interests. This effect was particularly noted among noncombatant countries and nations in the Southern Hemisphere. Another informant observed that, framed in this way, "[nuclear weapons use] becomes a global problem" that threatened not only those living in cities in the US, Europe, and Asia directly via explosion, but indeed the entire planet.

For other audiences, however, framing nuclear winter in planetary terms served as an obstacle to meaningful action by making the problem appear too abstract and unsolvable. One informant from the medical and humanitarian community felt that the public reacted more viscerally to fears of instant death and destruction from nuclear firestorms than long-term suffering resulting from famine or other effects of nuclear winter. For audiences already saturated with messages about the dangers of nuclear warfare, the nuclear winter scenario may have been too much to process: "gilding the lily." By contrast, keeping the focus on the humanitarian consequences following the bombing of major cities like Boston, New York, Washington, and other centers of power served to heighten the immediacy of nuclear war, thereby more effectively mobilizing public outcry. Similarly, public reaction to the threat of nuclear winter was reportedly heightened by research exploring how a small-scale nuclear strike in one part of the world might lead to rising food prices in another part of the world, adding greater immediacy to the threat.

### Individuals faced a professional tension between their perceived role as scientists and their perceived role as advocates for a public policy issue.

There is a balance between maintaining one's credibility as a scientist while also speaking truth in the public arena. This dilemma surfaced when early nuclear winter scientists began to advocate in public for nuclear disarmament as a logical policy implication of their research. One informant explained his reluctance to adopt an advocacy role out of fear that doing so would be detrimental to his professional career and future research and funding opportunities: "If you do cross that line, you're going to be ridiculed, [and] your professional standing will go down in general." It was seen as "suicidal" to one's career for a junior scientist to speak out on nuclear policy, which is better left to journalists, politicians, and other professionals. A tenured faculty member may be less likely to receive condemnation from his or her peers.

This tension was perhaps best encapsulated by the outsized efforts of Carl Sagan to communicate about the threat of nuclear winter. A skilled science communicator with an impressive technical background and far-reaching connections in government and academia, Sagan is widely credited with raising public awareness of the dangers of nuclear winter, along with fellow luminary Paul Ehrlich. At the same time, nuclear winter arguably became associated with Sagan's brand of political advocacy. One informant observed that Sagan as the face of nuclear winter "automatically made people suspect it" as an ideologically driven project. As a result, Sagan's myriad public appearances may have "undermined the message unnecessarily." His outspoken stance against nuclear weapons was reportedly frowned on by fellow scientists.

This perception of bias was not helped when both Sagan's and Ehrlich's team studies used extreme reference scenarios in the December 1983 issue of *Science* magazine. For example, TTAPS assumed a 5,000-megaton nuclear weapon exchange, while Ehrlich et al used a 10,000-megaton base figure, because they "wished to impress decision-makers with the seriousness of long-term effects."[59] However, focusing on the worst-case scenario was criticized by fellow scientists as manipulative and damaging to these studies' credibility.

### Scientists faced a tension over when to communicate new findings to a mass audience. A stance of "getting the science right" could enhance credibility but potentially delay timely policy action.

Science is an ongoing process of inquiry marked by continual peer review. There is rarely 100% certainty or full scientific consensus, especially with regard to predictive models like those used to forecast nuclear winter. The tendency for scientists to seek a very high confidence level may have delayed timely policy action in this area. A frequently cited example is a 1986 article in *Foreign Affairs* by Starley Thompson and Stephen Schneider, who coined the term "nuclear autumn" to describe their belief that the TTAPS nuclear winter models were exaggerated (even though they agreed the climactic consequences of nuclear war would still be significant).[60] The debate they sparked likely undermined the public perception of nuclear winter as robust science. The tendency of scientists to argue over the unknown facts of the case rather than the known facts led to the perception that researchers were less confident in the science behind nuclear winter than they really were.

On the other hand, some felt the early nuclear winter scientists were too quick to bring the nuclear winter predictions to the public before the theory was rigorously peer tested. Specifically, Carl Sagan unveiled the nuclear winter concept in the popular magazine *Parade* in October 1983, 3 months before the TTAPS group officially published their findings in the peer-reviewed magazine *Science*. Combined with Sagan's well-known political tendencies, publicizing nuclear winter before the completion of the peer-review process opened the door to accusations that the research was not as robust as it should have been.[57,58] Despite an impressive interdisciplinary process led by Sagan and Ehrlich at the October 1983 Conference in Washington, DC, there were nagging complaints that the physical and biological scientists rushed to produce their findings at the expense of social scientists and others who did not have adequate time to review the research and "had to play catch-up" in the coming years via their participation in the SCOPE project and other workshops.

# CASE STUDY: BIOTERRORISM

## Background

In 1972, 140 countries signed the Biological Weapons and Toxin Convention (BWC), agreeing to abandon state development, production, and possession of biological weapons for hostile or offensive purposes. The Soviet Union and its Cold War rival, the United States, both ratified the BWC. However, with no verification measures in place, the Soviets continued to build up their biological weapons into an extensive program. In the early 1990s, at the end of the Cold War, US intelligence officials learned about the Soviets' bioweapons program. Additionally, in carrying out disarmament activities in Iraq at the end of the Gulf War, the United Nations Special Commission also uncovered that country's massive bioweapons program (again, despite Iraq's having ratified the BWC).

As investigations continued into the mid-1990s, an even greater and more advanced Iraqi bioweapons program came to light. With these revelations, security and intelligence communities in the United States increasingly focused their attention on the threats posed by weapons of mass destruction—including nuclear, chemical, and, to a lesser extent, biological weapons—and the possible use of such weapons by rogue states or global terrorist organizations.[63,64]

Terrorist attacks carried out by non-state actors within the United States and abroad further heightened anxieties around bioterrorism. In September 1984, members of a cult known as the Rajneesh movement carried out a biological attack in The Dalles, Oregon, by deliberately contaminating restaurant food with *Salmonella typhimurium*. This act led to 751 cases of non-fatal food poisoning.[65] This was one of the first and largest biological attacks to take place in the United States. On March 20, 1995, Aum Shinrikyō, a cult group in Japan, released sarin gas on 3 lines of the Tokyo subway, killing 12 and severely injuring 50. This came after previous attempts by the group to release aerosols of botulinum toxin in downtown Tokyo and at US military installations, which began in 1990.[66] These incidents demonstrated the ease with which non-state groups could obtain lethal biological and chemical agents and carry out an attack afflicting hundreds of people.

D. A. Henderson was an early and vocal advocate for attending to bioterrorism as a public health and civilian medical concern. In the early and mid-1990s, medical and public health communities remained largely absent from discussions of bioterrorism, which was considered much more the purview of security, intelligence, and law enforcement at the time.[67] Henderson, who ran the World Health Organization's global Smallpox Eradication Campaign from 1966 to 1977, was familiar with the effects of infectious agents like smallpox and the medical countermeasures required to respond to such biological threats. Aside from this scientific and public health expertise, Henderson held leadership positions in federal health and science agencies in the first half of the 1990s, including the Office of Science and Technology Policy and the Department of Health and Human Services.

Drawing on these experiences and networks, Henderson founded the Johns Hopkins Center for Civilian Biodefense Strategies in 1998 as a think tank and platform for raising awareness about bioterrorism and related biological threats. Members of the center engaged in various educational and awareness-raising activities, including convening a Working Group on Civilian Biodefense that developed recommendations for medical and public health countermeasures against candidate agents for a possible biological attack. They also organized tabletop scenarios such as Dark Winter—a simulated smallpox attack on the United States—for national security experts and government officials to reveal the potential effects of and the country's vulnerabilities to a hypothetical biological attack.

A few short years after Henderson initiated these foundational efforts to bolster the United States' biosecurity capacities, what previously seemed like an implausible possibility soon manifested as an indisputable national security threat. Beginning in mid-September 2001, letters containing anthrax spores were mailed to the Washington, DC, offices of 2 US senators, Tom Daschle and Patrick Leahy, as well as to several news media offices in West Palm Beach, Florida, and New York City, resulting in 5 deaths and 17 nonfatal infections.

Following the attacks, Dr. Anthony S. Fauci, director of the National Institute of Allergy and Infectious Diseases, identified stark deficiencies in the United States' ability to detect emergent biological threats and decontaminate affected facilities, as well as failures to coordinate investigative efforts among law enforcement, intelligence, and public health agencies.[68] The attacks also underscored the challenges posed by the bioterrorist threat to frontline clinicians, highlighting the need for effective surveillance and diagnostic tools, systems supporting mass medical care, and resources to rapidly distribute and administer medical countermeasures.[69,70] Seeking to close these gaps in the years following the anthrax attacks, the US government enacted the Project Bioshield Act (2004) and the Pandemic and All-Hazards Preparedness Act (2006) to accelerate medical countermeasure development and provide programmatic support for national biodefense efforts.

Though the Bush and Obama administrations largely embraced and supported these investments in national biodefense, the adoption of health as a national security priority has sparked considerable debate among public health practitioners about the so-called "securitization" of health and whether such an approach might, in fact, jeopardize public well-being.[71] Critics of health security posit, for example, that research and development efforts around anthrax, smallpox, and other pathogens with the potential for weaponization divert resources from efforts to combat higher-probability health threats that already kill in large numbers, such as HIV/AIDS, tuberculosis, malaria, and noncommunicable diseases.

Some life scientists have also decried federal biodefense spending, contending that investments in biodefense have resulted in cuts to funding for critical basic research activities.[72] Two prominent public health scholars, Barry Levy and Victor Sidel, argued that war in Iraq and Afghanistan has diverted resources and funds from efforts to mitigate domestic public health problems (eg, tobacco use, medical care for veterans), lend support for global health initiatives (eg, ensuring access to clean water, childhood immunization), and execute effective responses to domestic public health emergencies such as Hurricane Katrina. Sidel further expressed concern that certain biodefense measures—such as taking steps to minimize the health consequences of a deliberate attack—could potentially spark enemy suspicions of offensive capabilities or provoke adversaries into developing new weapons.[73] Other public health experts, however—notably, D. A. Henderson—eschewed the notion that preparing for attacks involving biological weapons implicitly condones their use and worked to dismantle the moral taboos around the public health and medical communities' involvement in biosecurity and biodefense efforts.

In addition to the anthrax attacks—which were a watershed moment in raising the profile of deliberate biological threats to public health and national security—numerous naturally occurring infectious disease crises in the years following the attacks have further illustrated the consequences associated with catastrophic biological threats, while simultaneously underscoring deficiencies in the United States' national biosecurity capacities.

The 2002-04 outbreak of severe acute respiratory syndrome (SARS), for example, highlighted the economic impacts of a novel, emerging zoonosis with no known countermeasure, whose transmission could be catalyzed by travel and commercial activity and which generated considerable public anxiety. These challenges subsequently reemerged during the 2009 H1N1 influenza pandemic; in 2012, during the Middle East respiratory syndrome (MERS) outbreak; and again, in 2013, with the emergence and spread of the Zika virus. Finally, the 2014 West Africa Ebola epidemic illustrated the potential for even a known—albeit neglected—infectious disease to cause unforeseen levels of morbidity and mortality, destabilize economies, jeopardize trust in public institutions, and incite global panic.

Though naturally emerging outbreaks have dominated the focus of efforts to strengthen biosecurity in recent years, emerging and evolving technologies could soon catalyze renewed efforts to mitigate and counter the threat of deliberate misuse. As applications of biotechnology become increasingly ubiquitous and democratized—and barriers to accessing biological materials, expertise, and scientific equipment are further dismantled—opportunities for deliberate and accidental misuse of biotechnology will likely continue to emerge. Several recent developments illustrate the threats associated with advances in the life sciences. These include but are not limited to: so-called gain-of-function experiments, such as those performed on the H5N1 influenza virus to identify mutations enabling airborne transmission between ferrets; synthesis of potentially dangerous pathogens, such as a recent effort involving de novo reconstruction of horsepox virus; and the creation of entirely new organisms, as illustrated by the J. Craig Venter Institute's efforts to build a novel bacterial cell with a synthetic genome.[74-76]

Advances such as those described above hold enormous promise for revolutionizing medicine, biotechnology, and energy while also generating concomitant biosecurity and biosafety risks. As such, the US government has taken critical steps toward formulating risk mitigation policies aimed at countering emerging and evolving biological threats. The so-called Fink report, for example, put forth recommendations for minimizing the threat of bioterrorism without stifling scientific innovation.[77] Additionally, the National Science Advisory Board for Biosecurity has provided decision makers with guidance on overseeing and addressing the national security implications of federally supported dual-use biological research. Finally, in December 2017, the US government issued a new policy on oversight of research involving enhanced potential pandemic pathogens, ending a 3-year federal moratorium on funding new gain-of-function studies on influenza, SARS, and MERS.[78]

## BIOTERRORISM OBSERVATIONS

### Absent an actual incident, communicators found it difficult to mobilize allies and raise awareness about the threat of bioterrorism.

Prior to the 9/11 terrorist attack and subsequent anthrax attacks, politicians and the public did not pay much attention to threats of biological terrorism, and the burgeoning community trying to raise awareness about this threat found it difficult to communicate its urgency to nonexpert groups. Many informants felt these major crises of 2001, however, significantly heightened politicians' and the public's awareness of the threat of bioterrorism. These events lent a new sense of urgency to understanding and preparing for bioterrorist threats, and many politicians, the media, and members of the public sought information about their vulnerability and how to protect themselves.

The fact that this threat no longer seemed to be a "low-probability" threat made it easier for some informants to communicate. One informant described how he found it difficult to get appointments with senior staffers before 9/11, but on September 12, 2001, congressional representatives began reaching out to him about biosecurity issues. Another informant even considered the anthrax letters to be more influential in raising awareness and mobilizing action than his own communication efforts. Some key informants expressed that many of the hurdles they initially faced in communicating about bioterrorist threats are now gone because of the impacts of the anthrax attacks.

### Individuals heard warnings about the threat of bioterrorism through a filter of their own perspectives, priorities, and knowledge, prompting communicators to customize their outreach efforts.

Those who tried to raise awareness about the threat of biological terrorism had to communicate their messages to multiple groups, including nonexpert groups who did not know very much about the threat. These audiences had different interests and priorities and varying levels of knowledge that influenced their receptivity to certain messages and communication strategies. Informants found that congressional representatives and other politicians prioritized getting re-elected and were thus concerned mainly with how biological threats affected their district in hearings on the subject. Therefore, these informants found it more effective to give politicians a short list of things they needed to know, rather than address the complexity of biological threats as they might with the scientific community, and then connect these points to interests of their districts or states. Some also felt that politicians' lack of knowledge about the technical aspects of biological weapons and terrorism kept them from giving more attention to it: "I think that if members of Congress truly understood the threat . . . they would put more resources to make us better prepared."

Similarly, when speaking to a more general audience, informants described the need to use simple language to describe the technical aspects of biological threats. When communicating with the media, informants found that they appreciated a "just the facts, ma'am" approach; people liked hearing facts and appreciated if these were presented in a way that made sense to them. One informant also stressed the need to build a working relationship with the media and make their job easier by, for example, writing and rehearsing key questions that would effectively communicate the message in a short news segment, so they could act as force multipliers in raising awareness about the bioterrorist threat.

> Presenting bioterrorism as a concrete and urgent threat elicited a more favorable response, especially when accompanied with a solution.

Many key informants and their colleagues used physical illustrations to communicate the danger of biological agents to the public, politicians, and other nonexpert groups. In other words, they tried to get audiences to "live" the threat. One informant described how, when he gave talks to politicians, he would bring in a bottle of innocuous white powder to demonstrate the ease of transporting anthrax through existing security systems. Another informant described how then–Secretary of Defense William Cohen appeared on television with a 5-pound bag of sugar to illustrate how little anthrax it took to seriously affect a highly populated urban center—a tactic the informant described as "transformative."

Informants also conducted tabletop exercises and worked through hypothetical bioterrorist attack scenarios, such as Dark Winter, with senior leaders in government and law enforcement to demonstrate the consequences of a deliberate biological attack and highlight leaders' lack of preparedness to mitigate such an attack. Informants described these scenarios as being particularly influential in raising awareness about bioterrorism.

At the same time, informants felt that one could not just talk about the dangers without providing concrete recommendations for subsequent action, as doing so could elicit accusations of fearmongering. One informant felt that presenting simple remedial actions to the public, media, and politician audiences was an especially important form of effective communication, describing this approach as "hurt 'em and heal 'em": make audiences aware of the potential consequences of inaction, followed by a set of actionable next steps. Another informant corroborated this approach, stating that efforts to raise awareness of existential threats obligates communicators to concomitantly consider prevention and mitigation strategies.

### Given the complexity of biological threats and their management, subject matter experts sometimes found it difficult to communicate to nonscientific audiences.

Biological threats present special communication challenges due to the diversity and complexity of biological agents that might be used in a bioterrorist event. These qualities can make it difficult for nonexpert groups to understand biological threats and their implications, including the differing speeds and scales at which agents such as anthrax, ricin, or synthesized smallpox virus released in different formulations would affect populations. Since there was not a strong consensus in the biodefense field in the early years about communicating this threat, especially between groups focused mostly on naturally occurring as opposed to deliberate biological threats, it was difficult to convince members of Congress to attend to low-probability, high-impact biological events.

One informant noted that even more recently, Chairman of the Senate Intelligence Committee Richard Burr claimed that only about 5 members of Congress truly understand biological threats. Such uncertainty and unfamiliarity with the subject led to confusion during actual biological attacks. For example, Tommy Thompson, who served as Secretary of Health and Human Services during the 2001 anthrax attacks, went on *60 Minutes* to discuss anthrax without sufficient knowledge about the agent and mistakenly said that anthrax could be spread through water. Some informants felt that constant revision of recommendations for mitigating the threat of anthrax—a problem exacerbated by the spread of misinformation—gave the impression that authorities were contradicting themselves and threatened their credibility as reliable sources of information.

To overcome these challenges, key informants felt that one needed to be as clear about the facts and unknowns of the crisis as possible to build trust among the media and the public. Experts held press briefings, seminars, bioterrorism drills, and other speaking engagements for politicians and the media to educate these groups on biological threats and demonstrate their authority to speak on the issue in the process. Establishing scientific and technical authority before and not just during a crisis, one informant expressed, was important to securing the trust of nonexpert groups as well.

### Interpersonal relationships—not just professional command of the technical facts—were influential in raising awareness about the bioterrorist threat.

The threat of bioterrorism engages various expert groups and audiences. Some informants reported being better positioned and capable of communicating about the threat in certain ways than others. For example, those working in government agencies, such as the Department of Defense, used their position to communicate internally to organize fractured coalitions within the bureaucracy of federal government. One informant embraced his background in public relations to focus on communicating with the media and the public. Other informants, however, found it more effective to build personal relationships and communicate with key stakeholders and decision makers in government to raise awareness about the bioterrorist threat. Such efforts helped reach politicians working across party lines because they were grounded in personal relationships. Whether informants directed their efforts to personal contacts or to large groups, many related that these approaches to communication were complementary and necessary for reaching a broad range of stakeholders. They also acknowledged that the qualities of particular communicators made a difference to getting the message across. In other words, successful communication depends not just on the message but on the communicator as well.

# CASE STUDY: CLIMATE CHANGE

## Background

Long before modern scientific practices, and as far back as even the ancient Greek philosopher Aristotle, humans suspected that they themselves could alter the climate of a given location.[79] For example, settlers residing in the eastern United States in the early 1800s believed that clearing the forests had led to warmer and milder temperatures in the region.[79] While there were some who disagreed with these ideas, most individuals agreed that humans could not affect the global climate as a whole. As the world progressed through the 19th century, the lack of detectable long-term changes in the climate—coupled with a lack of explanation of how climate change could occur, if it were in fact occurring—had turned most scientific opinions "decisively against any belief in a human influence on climate."[79]

It was not until the discovery of the ice ages in the mid-1800s that many scientists began to wonder what could possibly cause such a dramatic change in the Earth's climate. Swedish scientist Svante Arrhenius proposed one theory, which would later become known as the "greenhouse effect," in the late 19th century. This theory—which at the time gained little traction—was that, through the burning of fossil fuels, carbon dioxide ($CO_2$) could build up in the atmosphere and cause an increase in global temperatures.[79] However, at the time, even those who did believe in changing temperatures—including Arrhenius—thought that it could benefit, rather than harm, the human population.[80]

It was not until the late 1930s and 1940s that the idea of the greenhouse effect was again raised, this time by a steam engineer named Guy Callendar. Although much of his calculations would ultimately be found to be incorrect, he reignited this debate at a crucial point in time: the beginning of the Cold War.

The onset of the Cold War in 1947 sparked large increases in government spending in scientific research. Military agencies became interested in areas of climatology and geophysics with the idea that such knowledge would aid in potential battle strategies and give the United States a leg up on its adversaries.[80,81] One scientist, Charles Keeling, was able to meticulously calculate the amount of atmospheric $CO_2$ at Mauna Observatory in Hawaii and found that it was, in fact, rising, much like Callendar and Arrhenius had postulated.[79] Importantly, these early measurements established a baseline $CO_2$ concentration for future comparisons that continue to this day—measurements that are known as the Keeling Curves.[82]

Throughout the 1950s, 1960s, and 1970s, evidence continued to mount that supported the greenhouse gas theory; worried scientists began to meet at various scientific conferences and workshops to contemplate policy actions, and several turned to the UN to voice their increasing concerns. Their demands led to the 1978 International Workshop on Climate Issues in Vienna, followed shortly thereafter by the World Climate Conference in Geneva in 1979, although little resulted from this conference other than the consensus that $CO_2$ might be the cause of climate change.[83] However, one structural body that did arise out of these conferences was the World Climate Program (WCP), which had the goal of increasing understanding of the climate and applying that knowledge to those suffering from its effects.[84]

Much of the scientists' concerns had been spurred by the realization that climate change could have drastic long-term effects on both human health and the ecosystem. For example, in 1983, the National Academies Press published a report titled *Changing Climate: Report of the Carbon Dioxide Assessment Committee*, which reviewed the effects $CO_2$ could have on the climate. Findings included shifts in temperature and rainfall, changes in crop yield, decreases in water supplies, rising sea waters, extreme summer temperatures, and changing distributions of insect vectors known to transmit human disease.[85]

In 1981, James Hansen and his colleagues at the NASA Institute for Space Studies published a report in *Science* that showed that the Earth has warmed by 0.4 degrees Celsius over the past century—a measure that was "consistent with the calculated greenhouse effect due to measured increases of atmospheric carbon dioxide."[86] Additionally, reports began showing that other gases could be contributing as much as 40% of the total warming.[87] In 1985, Ramanathan published a study showing the importance of other trace gases that could amplify warming caused by $CO_2$ and asserting that these gases "are just as important as that of $CO_2$ increase in determining the climate change of the future or past 100 years."[88] This meant that the effects of global warming could come twice as fast as initially expected.[80] No longer was global warming talked about as a threat in the distant future, but as a threat that would become apparent much sooner.

It was not until the summer of 1988 that the threat of climate change began to garner widespread attention. That summer had been unseasonably hot, and on June 23, Hansen would relay the information he had published in *Science* in 1981, stating that "the greenhouse effect has been detected, and it is changing our climate now."[89] From that point forward, the number of newspaper articles published about climate change skyrocketed, and climate change finally began to move into the spotlight.[90]

In 1988, the World Conference on the Changing Atmosphere: Implications for Global Security (known as the Toronto conference) took place in Toronto with hundreds of scientists in attendance representing various governments. For the first time, a group of distinguished scientists concluded "that the changes in the atmosphere due to human pollution represents a major threat to international security and are already having harmful consequences over many parts of the globe" and called on the governments of the world to begin reducing greenhouse gas emissions.[84] This was followed by the formation of the Intergovernmental Panel on Climate Change (IPCC). The IPCC, which continues to this day, is an international body that "provide[s] policymakers with regular assessments of the scientific basis of climate change, its impacts and future risks, and options for adaptation and mitigation."[42]

The rise of the climate change movement has not been an easy one, and public, media, and political interest in this threat tends to wax and wane, often based on the occurrence of extreme weather events and the interests of current government leaders. For example, shortly after the sudden increase in interest due to Hansen's testimony in 1988, public concerns began to waver, and media reports declined as the heat of that summer became a distant memory. However, climate change has continued to be covered by the media, and the scientific community has continued to raise awareness and publish their findings, even as the issue has become increasingly politicized.

Unlike nuclear winter and bioterrorism, which have a more clearly delineated timeline of when it became necessary to raise the alarm about these existential threats, the climate change movement has been more protracted. Simply put, it has been an aggregate of increasingly compelling evidence and of an epistemic community dedicated to raising awareness about a less visible but equally concerning threat.

## CLIMATE CHANGE OBSERVATIONS

### The dangers of global warming are not always immediately apparent, both in time and place, making it difficult to galvanize public interest.

After the bombing of Hiroshima in 1945, the public had a visual example of what an atomic war would mean for the whole of civilization, evoking fears that the end of the world could be near and that no person was immune to the devastation that could result. These fears were renewed during the Cuban missile crisis in the 1960s and again during the Reagan administration in the 1980s. Fear of nuclear war was reflected in the production of comic strips, books, and movies—some more realistic than others—that depicted the horrors of nuclear war, including monsters, wastelands, and the total destruction of humanity.

Global warming, however, was a far-off threat that lacked immediacy and short-term consequences, thus making it challenging to push public awareness into action. Many felt that the impacts were so far off that it would have little effect on themselves or their families—a communication challenge that continues to this day. This phenomenon of discounting far-off threats was one of many psychological barriers—or "dragons of inaction"—highlighted by psychologist Robert Gifford that limit climate change mitigation and adaptation.[91] As one participant aptly noted:

> "But so far [global warming] isn't affecting people enough. It's not an imminent threat. When I was a kid, I was well aware that a nuclear war could happen in the next day, the day after. If could happen at any time. Global warming isn't like that. . . . It's just not like oh, my God, I'm going to get blown up tomorrow. So, there's this remoteness in time."

Participants also noted that even with increasing evidence that global warming is, in fact, occurring, there still remains a lack of public and political interest, in part because most of the people and areas affected are remote and in lower-resource countries. This "social remoteness," as one participant termed it, has proved to be a difficult challenge to overcome in raising awareness—and more importantly action—around global warming.

One way to overcome this barrier, as suggested by that same participant, is to "talk very practical pocketbook backyard issues," such as the dying of coral reefs or forest fires and the associated economic impacts, which seem to resonate better with audiences than discussing the larger downstream effects, such as species extinctions. Another participant noted that recent events like Hurricanes Katrina and Sandy have started to raise concerns regarding global warming even among the most skeptical audiences. However, without a "smoking gun," it remains challenging and complicated to garner public interest and the motivation to change.

### People must be presented with tangible, actionable advice to mitigate the threat of global warming, or they begin to feel that the problem is too overwhelming and intractable.

Raising awareness about global warming is not enough to motivate the public to address this threat. Rather, the problem must be made relevant to them and they must be provided with tangible, actionable advice on how to mitigate global warming. Participants heavily emphasized the need "to talk to people about reality as they see it," particularly because many of the impacts may be visible but not readily attributable to global warming (eg, hurricanes, drought, wildfires). Once the issue has been acknowledged, then work can begin to address it.

Informants stressed the importance of providing practical steps and solutions to the public when addressing global warming, and they cautioned that using scare tactics could hinder rather than motivate change. Fear-inducing messages and images have often been used when communicating to the public about global warming to dramatize the problem and attract attention.[92] However, some studies have found this to be counterproductive, and the result is to instead distance people from the issue and promote a sense of fatalism that causes them to disengage.[92,93] One participant echoed this sentiment, noting:

> "One has to be careful of scaring the hell out of people. . . . You also have to show that there are solutions. Otherwise people go, 'oh, my God, it's too big for me to grasp. I'm giving up. I can't even think about it.'"

Providing people with actionable solutions, such as recycling, made the problem much easier to handle, rather than presenting the "doom and gloom" scenario. Another participant said that people, in general, want to make the planet a better place and that they just need to know how to make it happen. Another interviewee detailed how, when talking to the public and students about global warming, he always first presents the potential impact of the threat but finishes the discussion on an upbeat note, underscoring that it is not too late to prevent catastrophic damage.

### Contradictory messages from scientists confused the public and undermined efforts to raise awareness about the threat of climate change.

One of the more salient issues early climate scientists faced when advocating in regard to climate change was widespread lack of understanding of the climate system itself. With this came various counterarguments to the position that the problem is largely driven by human actions.

Early on, the entire edifice of the effects of $CO_2$ on global warming relied heavily on inadequate measurement techniques as well as simplistic computer models that left out important variables. Many in the scientific community raised valid concerns about the accuracy of such models. One key informant commented, "You really had to push the model to get it to represent the present climate," and after that, "How did you know that this would still be accurate when doubling carbon dioxide?"

Other respectable arguments attributed the rising temperature to increased solar activity;[94] at the time, the solar activity curve closely matched the temperature curve. Several theories arose attempting to explain this peculiar correlation, and because of limited understanding of the atmosphere, they had to be taken seriously. Indeed, many of these theories might still be taken seriously today, but the solar activity curve after the 1970s has been on a steady decline while the temperature curve continues to rise.

Another counterargument to anthropogenic climate change included the idea that the increased temperature was somehow related to the clouds.[95] Did increased cloud coverage affect the Earth's temperature? Did the clouds trap radiation, thus leading to warming, or do the clouds reflect sunlight back into space and thus lead to a cooling effect? Many at the time believed that clouds would have an overall cooling effect that would largely cancel out much human-caused global warming. Decades of research has now shown that clouds may be amplifying the effects of global warming, but some scientists remain unconvinced.

Mounting scientific evidence eventually led to several national and international meetings, which ultimately led to a global consensus that the threat of climate change is here. This intergovernmental consensus gave credence to the idea that this was a global issue that would require global involvement to combat.

➢ The drivers of climate (eg, fossil fuels) are innately intertwined with economic enterprise, and advocating for changes to mitigate the threat of climate change pitted scientists against the economic interests of corporations, leaders, and entire countries.

Since the 18th century, modern economies have relied heavily on fossil fuels. However, by the late 1900s, the burgeoning scientific evidence on the role fossil fuels play in driving climate change had reached a new high. Fearful of stricter regulations, those in the fossil fuel industry "purposefully created think tanks, intentionally misleading messages, . . . and persistent lobbying of politicians" in an attempt to undermine those fighting the threat of climate change.[96]

Accepting the dangers of other existential threats such as asteroids or even infectious diseases does not innately lead to economic disadvantages. However, if countries were to accept the realities of climate change, it meant that efforts to mitigate the threat would likely lead to changes in energy consumption and potential economic loss. This made the discussion and search for potential solutions much more difficult for climate change than for other existential threats.

Fossil fuel industries have even been able to recruit reputable scientists such as Richard Lindzen, a former professor of meteorology at the Massachusetts Institute of Technology. [97] Lindzen published several articles through the Cato Institute—a conservative think tank that has received over $100,000 from oil companies including ExxonMobil—which serve to express the "uncertainty" of the global warming issue. Lindzen also serves as an advisor to the $CO_2$ Coalition, a group promoting the benefits of atmospheric carbon dioxide.

A 2000 study by McCright and Dunlap[98] analyzed publications from conservative US think tanks between 1990 and 1997 and found that, of the 224 publications found, 159 sought to discredit the prevailing arguments for climate change. A follow-up study[99] in 2012 found that 90% of climate change denial books do not undergo peer review, allowing authors to "recycle scientifically unfounded claims." Additionally, in July 2015, the Union of Concerned Scientists published *The Climate Deception Dossiers*,[100] a collection of documents that illuminates the deceptive tactics fossil-fuel companies have used over the past 3 decades to mislead the general public concerning the role fossil fuels play in driving climate change.

# DISCUSSION

## Offsetting the Tensions in Risk Communication About the Very Worst Cases

### SUSTAINING INFLUENCE AS POLITICAL AND CULTURAL WINDS SHIFT

Underlying political currents and social attitudes, as well as erupting crises, influence the extent to which people acknowledge and act on existential risk. Environmental and nuclear disarmament movements, including the values and knowledge they propagated, heightened recognition of the threat posed by nuclear winter. On the other hand, political climate also stymied awareness about existential threats, as in the antagonism of a hawkish administration toward nuclear winter science or that of fossil fuel interests toward climate change predictions. Current events and crises have made predicted and personally remote existential threats more real, immediate, and urgent: the 1988 heat wave that embodied the greenhouse effect described by Hansen; Hurricanes Katrina and Sandy, which concretized the disastrous effects of a changing climate; the 2001 anthrax letter attacks, which exemplified a deliberate outbreak; and the US-North Korea nuclear standoff, which reignited interest in nuclear winter theories.

➢ Tie the problem to current events and ally with other movements.

Communicators about existential risk should be acutely aware of underlying political currents that might jeopardize the sustainability of the message. To assure that messages about an existential risk continue to resonate, communicators should highlight their relevance to current events—such as the dangers of nuclear war between the US and North Korea when one is raising awareness about nuclear winter. In order to help weather the vicissitudes of political events, existential risk communicators should build alliances with individuals working in government, the media, academia, and philanthropic organizations in order to ensure the sustainability of the message in the long term.

### Capitalize on the attention that a crisis confers upon an issue.

During a crisis or "focusing event," advocates on existential issues should make the connections between the crisis and the existential risk vivid to the public and to the policymaking community.[101] In an everyday context, issue advocates can work to refine depictions of the existential risk and to develop concrete options for mitigation. When a relevant crisis erupts, given the public's and policymakers' concrete understanding of the immediate event, scientists and advocates can interject their account of the longer-term existential problem and its solutions into the public discourse.

## IMPARTING TRUTH WHEN SCIENCE IS IMPERFECT

Scientists have been at the forefront of uncovering and communicating existential risk, empowered by expertise in the natural world, social positions of authority, claims to objective knowledge, and global professional networks. Evidence of an existential threat comes through science: the epidemiology of smallpox, the atmospheric study of dust and smoke, the climate science behind the greenhouse effect, and so on. Scientific authorities who have entered the public domain to raise the alarm about existential risk, however, have encountered significant barriers in translating technical knowledge into social action. To claim a true representation of the problem, scientists work to avoid bias and achieve agreement about the validity of findings. On this basis, nuclear winter theorists were criticized for stepping outside the role of neutral observers and into the politically charged arena of nuclear policy. In all cases, competing theories and claims of scientific uncertainty (eg, nuclear autumn, securitized public health, human role in global warming) threatened confidence in the existential risk assessment. Lastly, experts have struggled to prove an existential risk, hampered by their own technical idioms and audiences with varying degrees of education and knowledge about the physics, the climate system, infectious diseases, and so on.

### For the evidence standard, stress having a scientific quorum, not absolute consensus.

When communicating about an existential risk, scientific consensus is helpful but not required. The nature of science assumes there will inevitably be disagreement, and a small number of critics will always question the science. However, ensuring a robust scientific discussion and publication in multiple peer-reviewed journals prior to entering the public sphere can help to insulate the movement from criticism. Adopting an interdisciplinary process, which should include a variety of technical experts with diverse backgrounds, experiences, and nationalities, at the earliest possible stage can ensure the credibility of the science and larger success of communication efforts.

### Cultivate able science communicators.

Campaigns to raise awareness about an existential risk should identify strong scientific communicators with a technical background in the subject being articulated. This can help to disseminate the findings as widely as possible. However, it will be difficult to disentangle this individual's personal values, beliefs, and politics from the message being conveyed. To strengthen credibility and minimize accusations of bias, communicators should be transparent about their underlying values, political beliefs, and conflicts of interest.

## REMAINING CONSTRUCTIVE ABOUT A CATASTROPHIC SCENARIO

Warnings about existential risks have been more influential when public and political audiences feel that they have the knowledge and opportunity to alter the outcome. Individuals advocating for greater attention to the bioterrorist threat employed a "hurt 'em and heal 'em" communication strategy—that is, they detailed both the problem and some solutions, exerting more influence on the directions of policy and practice. The nuclear winter concept gained traction more readily at a time when the nuclear disarmament movement presented a clear path toward averting this existential risk. Advocates working on climate change have discovered the limits to "doom and gloom" scenarios in generating social change and consciously worked to provide audiences with tangible solutions and a sense of self-efficacy in the face of a larger-than-life threat.

### Outline the costs of inaction and specify actions to take.

Proof of an existential risk does not, on its own, prompt social change. People require confidence in their ability to exert control in a situation. By outlining specific mitigation options and/or concrete processes by which those options can be developed, existential risk communicators can more readily mobilize policymakers and the public to concentrate their attention, time, and resources on the problem.

### Avoid extreme cases to illustrate the problem.

Delivering fear-instilling messages and depicting extreme scenarios in the hope of shocking people into awareness and action can be counterproductive by promoting a sense of helplessness. Predictive models of an existential risk should include middle-of-the-road scenarios instead of focusing solely on the "worst-case" scenarios. In representing an existential risk, communicators should frame the risk as grave yet tractable.

## LOCATING REMOTE RISK IN THE HERE AND NOW

People postpone action on an existential threat because the consequences are perceived as remote—happening rarely, in the distant future, or to someone somewhere else. Much of the world discounted the consequences of a US-Soviet nuclear exchange, assuming the 2 superpowers threatened only themselves. The nuclear winter scenario, however, triggered broader interest in nuclear disarmament because planetary cooling was seen to jeopardize every nation's interests. An impediment to the success of the climate change movement has been that the effects of global warming are protracted, lack immediacy, and are experienced more acutely in low-resource countries with limited political and economic pull. Worried about bioterrorism, public health and medical experts struggled to convince policymakers of the dangerous and disruptive effects of a deliberate outbreak, until the dissemination of anthrax-laden letters shut down government, rattled the public, and overwhelmed health agencies.

### Balance a planetary "we" with a self-interested "me."

Existential risks entail threats to the species and to whole populations: The common good is at stake. Yet, individuals live in specific circumstances that drive self-identity, create social obligations, and confer differential economic and political power. Communicators of existential risk should strive to portray a global community at risk but also appeal to the self-interests of the audience whose behavior that they seek to influence. Bioterrorist experts, for example, made efforts to concretize the consequences of a deliberate attack in terms of a politician's own district or a bureaucrat's realm of responsibility. Climate change experts are framing the protracted effects of global warming in terms of "very practical pocketbook" issues: for example, the loss of tourist income in areas of dying coral reefs.

### Enlist issue champions who can personalize the problem.

The persuasiveness of an argument about an existential risk and its mitigation is not a function of compelling evidence alone; it also depends on the trust and faith accorded the messenger. Existential risk communicators who connect with their audiences on a personal level find more receptive ears—from Carl Sagan, who was able to engage mass audiences in the case of nuclear winter on the basis of the popular *Cosmos* series, to D. A. Henderson and other bioterrorist experts who reached out to associates in government, medicine, and public health to convey their grave concerns directly.

# Recommendations on How to Heighten Awareness and Motivate Action Around GCBRs

Parts 1 and 2 of this report present the findings of a multiphase research project to help inform the development of a strategic approach for communicating about global catastrophic biological risks. First, we sought to elicit the attitudes and assumptions that influential individuals in science, policy, and practice circles now hold regarding GCBRs. Knowing major ideas in common, diverging points of view, and the rationale behind them can enable issue advocates to define GCBR in more meaningful terms and to spur and strengthen commitment to risk reduction more readily. Second, we analyzed other times in history when it became necessary to alert policymakers, practitioners, and the public to the possibility of an existential or catastrophic threat, to uncover how others have communicated about the unthinkable without shutting down the conversation and successfully garnered public attention and action.

Here, in Part 3, we distill communication recommendations on how better to heighten awareness and motivate action around globally catastrophic, potentially existential biorisks, informed by the views of specialists on diverse GCBR aspects and the experiences of historic actors who have helped move other global scale threats onto the public stage.

Intended end-users of the recommendations below include subject matter experts who wish to use their technical acumen and social standing to prompt a greater societal response to GCBRs and to enlist more colleagues in doing so, philanthropists who seek to deepen the impact of their initiatives in fields that touch on GCBRs such as health and security from individual to global levels, and political advocates who hope to make the case more successfully for applying a portion of public resources to help mitigate the risk of a globally catastrophic biological event.

## Cast GCBRs as a concrete, present-day, directly personal problem, diminishing any perceived remoteness.

Individuals put off acting on a significant threat seen to be remote—that is, occurring rarely, in the far-off future, or to others in distant places. Issue advocates should tie GCBRs to the immediate context and concerns of the individuals and institutions they seek to influence, drawing on specific concrete scenarios to make the risk more tangible.

**Single out pandemics as the memorable stand-in for GCBRs as a whole.** To make risk reduction a concrete and proximate goal for diverse nations, it is useful to capitalize on the increasing salience of the idea of a pandemic. Moreover, "pandemic" captures both the certain prospect of a worldwide influenza outbreak and the growing risk of an accidental or deliberate release of a bioengineered pathogen of pandemic potential (a situation that is still underappreciated).

**Relate the GCBR issue to current happenings.** To assure the sustainability of GCBR communication amidst shifting political and cultural currents, issue advocates should highlight the issue's relevance to contemporary events. They should also ally themselves with groups representing adjacent interests to exchange information, ideas, and innovation.

**Draw on the clarity that a relevant crisis brings to the GCBR issue.** During a crisis, people more readily seek out answers for risks they otherwise consider remote. An outbreak of a novel and lethal pathogen, for instance, can deepen understanding about the character or probability of infectious disease crises, the vulnerability and limits of the systems on which we rely to deal with them, and the need to act collectively to avert a GCB event in the future.

**Balance a planetary "we" with a self-interested "me."** The world's well-being is at stake in the case of a GCBR, yet individuals and institutions are still located in specific contexts that drive self-identity, social obligations, and differential rates of economic and political power. GCBR issue advocates should appeal to the self-interests of the broader parties they seek to enlist in understanding and mitigating the threat; stand in their shoes to understand what their concerns are and how the GCBR issue relates to them.

## Present GCBRs as a challenge where solutions are possible, enhancing a sense of self-efficacy.

Warnings about catastrophic, potentially existential risks are more successful when public and political audiences feel that they have the knowledge and the chance to make a difference. Communicators should use a solutions-oriented narrative to keep people from dismissing GCBRs as a hopeless cause.

**Outline how and why it is possible to alter the outcome of a GCBR.** People require confidence in their ability to exercise control in a threatening situation. GCBR issue advocates should work to outline specific risk reduction approaches and a concrete path for developing an overall plan of action.

**Be prudent about projecting radical GCBR outcomes.** Using the most extreme cases to shock people into awareness and action has the potential to backfire, by inadvertently seeding hopeless and fatalistic outlooks. GCBR models should incorporate and report out middle- of-the-road scenarios that depict both the gravity and the tractability of the situation.

Spotlight the routine co-benefits of investing in GCBR mitigation. Explaining the immediate return on investments made in anticipation of a GCB event can enable stewards of scarce resources to justify expenditures of time, energy, and money on a threat perceived as remote in comparison to immediately pressing concerns.

Identify leverage points in non-health arenas for mitigating a GCBR. Strong medical and public health capacities are essential to mitigating a GCBR, but to diminish the repercussions of a global biorisk for political, economic, and social systems will require the efforts of a broad set of stakeholders from government, industry, nonprofits, and civil society.

## Strengthen and share the science of GCBRs and their mitigation in meaningful ways.

GCBRs are an emergent concern that does not yet have a broad epistemic community or an established research agenda. A discrete group of scientists, public health professionals, and think tank experts have begun to study and discuss related issues, but these professionals are not well distributed across disciplines or world regions. Community- and capacity-building activities among scholars entrusted with characterizing GCBRs and their mitigation can help mobilize a broader societal response that is commensurate with the danger posed by extreme biorisks.

Advance an interdisciplinary science of GCBRs and their mitigation. Experts on how extreme biothreats emerge and spread, what consequences they have and for whom, and which policies and practices may reduce their impacts come from different disciplines and have few occasions to collaborate in credible and holistic depictions of the problem and solutions. Building up an interdisciplinary network of scholars can advance the knowledge base around which to prompt appropriate actions including those that can be taken by non-health sectors in anticipation of a GCBR and those that address the vulnerability of the human host as well as the virulence and transmissibility of the pathogen.

Foster a global network of GCBR experts. Binding the destinies of the world's populations together, a GCB event can start anywhere and potentially affect everywhere. Yet, current GCBR discourse emanates mostly from a small number of organizations in Europe and the United States, and health security more broadly has different salience for the Global North and Global South. Fostering a genuinely international community of GCBR scholars can help build capacity both within and across nations to advance the knowledge needed to understand, communicate, and manage global biorisks.

Continually update risk assessment and risk reduction strategies. Diverse experts concur that biological risks are ever evolving, and that novel social, ecological, and technological conditions (and their interplay) are magnifying the chances and consequences of a global incident. Efforts to consolidate a wider network of GCBR scholars should support periodic assessments of the field to permit course correction and adaptation to new developments.

Enlist and enable subject matter experts as able GCBR communicators. Technical experts are important allies in making GCBRs a higher priority in the public domain, commanding both scientific fact and social standing. To overcome any hurdles to communicating about GCBRs to a broad audience due to their specialized idiom and communication norms, interested scientists should have access to resources (eg, media training, science writer collaborators) that enable them to convey their technical knowledge in meaningful terms.

The recommendations above represent a first step in the development of a more strategic approach to communicating about GCBRs, so as to prompt greater awareness and action about the threat; they bear on what to communicate (ie, the science behind the problem and its solutions) as well as how to communicate (ie, the framing, tone, and emphasis delivered in a narrative). We hope that this advice, informed by the insights of specialists on GCBR aspects as well as thought leaders who have warned about other global threats in the past, helps advance the public dialogue about extreme biological threats.

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