4

OH NO, ZOMBIES!

Many of our cherished works of science fiction posit that one day—perhaps very soon—a sudden, global-scale disaster could disrupt the industrial backbone of the civilized world, unraveling the fabric of society and leaving scattered bands of survivors who have to fend for themselves in the smoldering ruins of our cities and towns.

Such literary themes are far older than one might expect; of course, apocalyptic predictions play a central role in many ancient religious texts, but they have a surprisingly rich history in decidedly less metaphysical contexts too. The satirical Greek novel *A True Story*, penned by Lucian of Samosata sometime in the second century CE, deals with belligerent extraterrestrials hell-bent on interplanetary conquest (coveting Venus, of all things). In a similarly anachronistic twist, a 1909 story by E.M. Forster, titled "The Machine Stops," delivers a stern warning about the dangers of

artificial intelligence and advanced technology—with meek humans languishing in the tunnels under the surface of their ravaged planet, interacting with each other mostly through video chat.

Naturally, the doomsday genre follows more often than it leads, constantly reinventing itself to capitalize on contemporary fears and cultural trends. The consequences of nuclear war came to the forefront of post-apocalyptic fiction only after 1945, while the evergreen themes of environmental collapse shifted as if on cue from natural crises to man-made ones around the time of Paul R. Ehrlich's *The Population Bomb*. Copying is common too: George A. Romero's flesh-eating zombies—first of paranormal origin, then reimagined as products of a rabies-like disease—swarmed the literary world at the turn of the 21st century, giving us everything from cheesy comedies to the dazzling social commentary of Max Brooks's epic novel *World War Z* (not to be confused with a loosely related film of the same name).

Whenever science, religion, and politics blend together with our underlying anxieties, from the primordial soup emerge prophets of doom: charismatic leaders who not only believe that bad things can happen to people, but are convinced that the end is nigh. From ancient religious treatises to modern-day TED talks, the formats of their prophecies keep changing, but the track record remains constant: none of the thousands of apocalyptic predictions that have animated the masses throughout the ages has ever come to pass. Perhaps, in time, one will; but until then, buying into their narratives begets nothing but misery.

To be sure, some doomsday prophets use dazzling and convincing science—but just like religion, science isn't immune to being twisted in the service of decidedly unscientific causes and beliefs. Consider the perception of the atom bomb that emerged at the height of the Cold War: the prophecy of a prolonged nuclear winter that snuffs out most life on Earth, leaving a barren radioactive wasteland that would remain inhospitable for thousands of years. This apocalyptic vision took hold not because it was scientifically sound, but because it served important interests. For the military top brass, it boosted the strategy of nuclear deterrence, striking fear in the hearts of rogue nations; and for anti-war and pro-USSR activists in the West, it helped rally the masses against the anti-communist hardliners in the government, portraying them as lunatics who wouldn't hesitate to blow up the planet if it kept the Soviets out of Cuba or Afghanistan.

Except, the prediction was almost certainly not true: a fully fledged thermonuclear exchange would be an unspeakable tragedy and would kill tens of millions, but most of the population would survive, and the survivors would likely face a fairly hospitable world. The hypothesis of nuclear winter—a global cooling event triggered by the smoke from the resulting firestorms—is the most robust aspect of the prediction, but its magnitude and impacts are far from clear.[1] The fears of radiation, on the other hand, seem greatly overstated. About 4,000 deployed nuclear warheads exist in the world, setting an immediate upper bound on the scope of a large-scale

exchange;[2] it's a staggering number, but also not far off from the about 500 atmospheric and 1,500 underground nuclear tests previously conducted by the United States, Russia, and other countries around the globe.[3] The testing had some adverse effects on local populations, but few ecosystem consequences to speak of. In Nevada, you can go on a public tour of the 1,280-foot Sedan Crater left behind by an atomic test. Pregnant women are discouraged from booking the trip, but only because of the high temperatures and the long bus ride.

The observations from Nagasaki and Hiroshima made it clear that the persistent effects of atom bombs are far less pronounced than the consequences of nuclear meltdowns. The initial death toll and the midterm spike in leukemia deaths notwithstanding, life in the two Japanese cities continues without the need to resettle the survivors, and with no marked health consequences for children conceived after the attacks.[4] Meanwhile, the area around the Chernobyl Nuclear Power Plant in Ukraine remains off-limits to humans, with hot spots of fairly high radioactivity.

The difference in outcomes is easy to explain. An atom bomb uses a relatively small amount of fissile material—tens or hundreds of pounds—and has a simple goal: to burn this fuel as quickly and as completely as possible, releasing a tremendous amount of thermal energy. The disaster at Chernobyl, in contrast, involved an uncontrolled fire of almost 200 tons of uranium mixed with graphite, concrete, and other debris, which spewed thick clouds of unburned fuel and fission products for weeks.

And yet, the trope of a 10,000-year post-war nuclear wasteland took on a life of its own, persisting in books, films, and video games. It ended up having real impacts too. On the upside, it might have put some brakes on nuclear proliferation, but on the downside, it deterred governments and individuals from pursuing reasonable strategies that could shield us from harm if the worst came to pass, since the worst was perceived as irredeemably catastrophic. Among the casualties: the sound of oft-ridiculed "duck and cover" advice once taught to schoolchildren,[5] the system of well-stocked civil defense shelters across the nation, and the culture of family-level emergency preparedness promoted and aided by the government.

Just like the portrayal of nuclear war, many other doomsday predictions are based on absurd or exaggerated science, frequently employed to advance a preconceived goal. Other claims in this space focus on events that are quite possible on cosmic timescales, but exceedingly unlikely within the span of our lives; in this category, asteroids and supervolcanoes are of particular note. And a handful of prophecies—such as the fears of malicious artificial intelligence—are simply unknowable, devoid of any quantifiable risk or historical precedent.

That said, behind every exaggeration is a grain of truth that can perhaps alert us to less extreme but more probable outcomes worth accounting for in a level-headed emergency-response plan. With this in mind, let's try to untangle some of the most popular scenarios that keep the doomsday folks up at night.

Uniquely Virulent and Deadly Diseases

Lethal microbes are the staple of modern apocalyptic fiction. From Stephen King's seminal novel *The Stand* to the acclaimed British zombie flick *28 Days Later*, the genre prides itself in taking the rational fear of disease to its logical conclusion: a plague that doesn't simply kill a lot of people, but actually ends the world.

The risk of an apocalypse brought about by a novel pathogen is within the bounds of reason, but empirically, we know that the odds are not high. The worst pandemic on record, the Black Death, didn't even come close. It swept the globe in the 14th century and killed between 30 and 60 percent of the population of Europe,[6] but it didn't seriously threaten mankind's reign. In fact, it had relatively little effect on the social order of the era. In the short haul, it caused substantial hardships for the affected families, but in the long term, some scholars argue that the survivors benefited in several ways. For example, the resulting abundance of resources and the shortage of labor lifted the peasant class, resulting in higher wages, a stronger bargaining position with the feudal lords, and an expansion of (however meager) civil liberties.[7]

For a case study of a more drawn-out epidemic, look no further than smallpox, a disease that haunted humanity from antiquity well into the 20th century. It came and went in numerous waves, but every time it struck, it killed around 30 percent of the infected; the death toll of the virus in the final century prior to its eradication is estimated to be around 500 million people.[8] Yet, once again, human societies functioned—and indeed, progressed in spectacular ways—in the face of this awful and unrelenting adversity.

Neither the Black Death nor smallpox conclusively establishes the upper bound of how terrible a pandemic can be, but they represent upper extremes in an observational data set spanning 2,000 years. Another empirical argument against the prophecy of a doomsday plague comes from the analysis of contemporary, highly lethal diseases such as Ebola: in essence, it appears that if a pathogen kills too many of its hosts too quickly, it isn't able to spread far. Presumably, this is because efficient transmission depends on carriers who are asymptomatic or have only mild symptoms, and who don't attempt to self-isolate. Disorders with drawn-out latent periods, such as prion diseases or AIDS, pose a unique concern—but also afford us ample time to react.*

In the end, it's possible that a highly virulent and deadly disease could sweep the world once more, as discussed in Chapter 3, but the notion of a civilization-ending superbug doesn't seem to be rooted in what we know so

*Prions are a class of incorrectly folded proteins that interfere with the formation of new proteins in the body, effectively propagating the folding defect and causing the death of the affected organism. Because they are known to be transmitted between animals through the consumption of contaminated meat or contact with bodily fluids, potential animal-to-human or human-to-human transmission is of significant concern. At the same time, because prion diseases develop extremely slowly, their study is difficult, and the impacts of an outbreak may not be noticed before too late.

far. We also have no clear evidence of any now-extinct mammals wiped out by ancient pathogens, except for a suspected case of an isolated rat population on Christmas Island[9]—but it can be safely argued that the island rats' understanding of hygiene, sanitation, and infectious disease lagged behind ours.

Runaway Climate Change

Climate change is a fiendishly difficult topic. There's no doubt that the phenomenon is real, but there's profound uncertainty about its eventual impacts and magnitude. In light of this ambiguity, it seems wise for nations to pursue multipronged strategies that pay off no matter what: investing in abundant clean energy, researching greenhouse gas sequestration, and trying to reduce the likelihood and severity of humanitarian crises in the most vulnerable parts of the world. Alas, the debate is bogged down by a mix of counterproductive anti-progress sentiments, wacky conspiracy theories, and idle arguments about the precise extent to which mankind as a whole—or specific nations in particular—are to blame.

Given the uncertain future, some activists try to bolster their case by making the most dire predictions imaginable: a catastrophic positive feedback loop that, after an initial nudge due to human activity, spirals out of control until the planet literally cooks. One such proposed doomsday mechanism involves the release of vast quantities of methane currently stored in ice (*clathrate gun hypothesis*). Another fashionable theory deals with a steep increase in atmospheric humidity, trapping heat, causing even more water to evaporate, and eventually creating a sauna-like environment (*moist greenhouse effect*). That said, despite decades of serious inquiry, no credible models substantiate these predictions—at least, not on timescales of any concern to individual emergency preparedness.[10]

What we do know is that the climate of our planet can change in profound, if less ghastly, ways and that it can happen on timescales shorter than most people expect. A relatively recent and well-documented example is a period known as the Little Ice Age, which brought harsh winters and widespread crop failures to many parts of Europe throughout the 16th century.[11] It's entirely possible that human activities or natural causes—such as a sudden spike in volcanic activity that reduces the amount of sunlight reaching the ground—could trigger comparable or more severe weather phenomena within the next couple of decades too.

If so, the resulting gradual shifts in weather patterns would probably not devastate the highly developed world. In particular, both Europe and North America have extensive technological and financial resources, along with vast expanses of fertile land spanning a variety of climatic zones. Under such a scenario, some local populations would likely experience hardships, and the economic impacts could be felt by millions more—but ultimately, the rich nations have all the means to cope.

The real danger of climate change lies elsewhere: billions of people live in some of the world's poorest countries, often in arid or semi-arid climates

that are unlikely to benefit from the currently observed weather trends. Such populations may have no other place to grow their crops, no means to buy grains from a neighboring state, and no infrastructure to haul the supplies to the families in need; an unprecedented humanitarian crisis could easily ensue if subsistence agriculture in these regions takes a substantial hit. The resulting famine, armed conflict, and mass migration would probably have global spillover effects, making the entire planet more volatile and less free.

The fear of this outcome is perhaps the strongest selfish argument in favor of rich nations providing foreign aid to the developing world; it's also a solid argument against climate policies that curtail industrial progress and economic growth in developing countries. When it comes to personal plans, I feel that flexibility is key. It's difficult to predict the proxy wars that may be fought three decades from now, and it's hard to tell which part of Wyoming will be experiencing more temperate winters and more rain, but a financial safety net and a robust social network are some of the surest ways to maintain the ability to adapt.

Other Planetary-Scale Natural Disasters

Tales of natural disasters are as old as oral tradition itself; many of our most ancient myths recount the floods, droughts, earthquakes, and locusts that haunted early humans, wiped out villages, or brought entire empires to their knees. In the 1960s, the venerable genre expanded to include hitherto unthinkable predictions of environmental crises brought on by people—be it overpopulation, pollution, or resource depletion. To this day, whether it's the asteroid in *Armageddon*, the infertility in *Children of Men*, the cartoonish consumerism of *WALL-E*, or the crop blight in *Interstellar*, the notion of a global cataclysm has remained one of our species' most enduring anxieties.

In contrast to some other topics discussed in this chapter, many of the concerns about ecosystem collapse are rooted in reasonable science and solid historical precedent. For example, massive volcanic activity has been implicated in the Permian extinction event that wiped out 70 percent of vertebrate life about 250 million years ago,[12] and one of the still-active supervolcanoes—the Yellowstone Caldera—is believed to be capable of covering much of the United States in 10 feet of ash.[13] Similarly, the impact of a large asteroid or comet is widely believed to have been the culprit of the Cretaceous–Paleogene extinction that wiped out the dinosaurs,[14] and the pockmarked face of our own moon is a reminder that such cosmic events happen in our neighborhood with some regularity.

That said, while the possibility of a planetary catastrophe cannot be dismissed, all available evidence suggests that the cadence of extinction-type events is extremely long: a disaster that has a 50 percent probability of occurring in the next million years carries less than a 0.01 percent chance of striking within the lifetime of any person born today. In that sense, although a supervolcano or a cosmic collision may be some of the most

profound existential threats to reckon with, they're also relatively distant concerns—and they escape most attempts to meaningfully model or mitigate the impact they may eventually have.

What happens with far more regularity are smaller, regional variations of the same. In 1985, a volcano erupted near Armero, Colombia, killing more than 20,000 residents.[15] A few years earlier, the eruption of Mount St. Helens blanketed several states with ash and necessitated extensive cleanup efforts in the populated parts of Eastern Washington. In 1908, a massive explosion known as the Tunguska event, widely believed to be the result of a large meteorite blowing up in the atmosphere, flattened a remote portion of the Siberian taiga in a radius of about 20 miles. But such events, however frightening, don't spell the end of days. In terms of their impacts and potential countermeasures, they fit squarely with earthquakes, hurricanes, and other run-of-the-mill natural disasters discussed in Chapter 3.

In addition to the canon of natural disasters outlined earlier in this section, voices in the scientific community have warned us against a range of more novel planetary risks. The first wave of such predictions focused on the population growth worries of Ehrlich (see Chapter 1), as well as the "peak oil" hypothesis formulated by M. King Hubbert in 1956—incorrectly predicting an irreversible decline in global oil production capacity starting somewhere in the 1970s, and interpreted as the promise of a dark and energy-starved world.[16] Today, perhaps the most fashionable collapse theory deals with observed declines in the populations of pollinating insects, with potentially dire consequences for agricultural crops. Such worries should not be discounted, but it takes a peculiar brand of pessimism to assume we won't be able to address the risk.

Exotic Physics and Miscellaneous Space Phenomena

Up to this point, our review of doomsday predictions has revolved around a selection of familiar and intuitive topics: violent weather, volcanoes, disease. But a parallel universe of sci-fi plots and quasi-scientific predictions offer far more unusual concepts—magnetic pole reversals, solar flares, gamma ray bursts, microscopic black holes, and vacuum metastability events.

The good news is, almost all such scenarios occupy a spectrum between fantastically unlikely and patently bunk. For example, although the geomagnetic poles of our planet indeed seem to reverse every half a million years or so, it's a very slow process—and one that, despite some early suspicions, doesn't appear to be linked to extinctions or other notable consequences for terrestrial life.[17] Or, take false vacuum decay, the theory that the vacuum we're familiar with isn't the lowest energy state, and that a sufficiently energetic event could lead to a cosmic collapse that profoundly reshapes the universe. It's a provocative concept, but the universe's survival for more than 13 billion years without experiencing this fate suggests that even if the theory is correct, we have relatively little to worry about today.

Among all the popular cosmic threats, one type of space weather event is well within the realm of possibility: a large *coronal mass ejection (CME)*. CMEs

are a recurring phenomenon in which blobs of electrically charged plasma are ejected by the sun and hurled toward Earth. Most of the time, the effects are barely perceptible, manifesting as an increase in the sightings and intensity of the aurora borealis and in transient changes to the propagation of radio waves. In principle, however, an ejection could be powerful enough to create a significant electromagnetic field gradient across the surface of our planet, inducing stray voltages and currents in electrical wires.

Historical records of CMEs are sparse, in part because the use of electricity is a relatively recent phenomenon, but one documented solar storm of 1859 wreaked havoc on telegraph systems around the world. It's widely expected that another severe CME could happen in the near future—various researcher groups estimate the odds to be from 1 to 10 percent per decade.[18] If one does occur, the damage would probably be much worse than 150 years ago; that said, the impacts, although potentially dire, are also easy to overstate. In fiction and in prepper lore, CMEs are often portrayed as civilization-ending events that destroy everything electric or electronic—from personal computers, to cars, to municipal water pumps. Not so: the induced voltage gradients would be proportional to the length of the conductor, and would be fairly insignificant for small devices. The most consequential danger is to the power grid, sections of which stretch for hundreds or thousands of miles. There's also some possibility of secondary damage to any equipment plugged into an outlet at the time of a surge, although ordinary fuses and surge protectors should save many devices from irreversible harm.

The saving grace is that the threat of coronal mass ejections is well understood by grid operators, and that many countries are making investments to manage the risk. It's also worth noting that it takes several days for the ejected particles to reach Earth, and that solar activity is monitored around the clock. In theory, this should give us ample opportunity to prepare—all the way to preemptively shutting off the power for a day or two. All in all, CMEs could cause substantial damage and disruption around the globe, but there are solid reasons to believe we'd be get back on our feet.

Unimpeded Rise of Totalitarian Regimes

Perhaps the most recognizable trope in Western speculative fiction since the second half of the 20th century has been the emergence of collectivist societies in which all independent thought and self-expression is punished or otherwise suppressed. Such works can be broadly divided into two categories. In the first, the societies are operated by murderous regimes that subjugate the population (*V for Vendetta*, *The Hunger Games*, *The Handmaid's Tale*), with the authors borrowing liberally from the imagery, rhetoric, and mannerisms of Nazi Germany. The other category is perhaps more provocative and more varied, imagining citizens who willingly cede control of their lives in exchange for the promise of safety and prosperity (*Gattaca*, *Demolition Man*, *Minority Report*)—only to discover the terrible consequences of this trade.

On one hand, we can hope that society's preoccupation with dystopian fiction is precisely how it can keep totalitarian urges at bay. On the other, I'd posit that few instincts are more powerful than the desire to tell others how to live their lives, and the rewards they'll be entitled to in exchange for their work. In times of prosperity, such instincts can be kept in check with relative ease, but in times of hardship and confusion, strongmen tend to thrive—and liberties, once surrendered, are almost never willingly given back.

Beyond the seductive power of abhorrent ideas and genocidal political movements, their emergence is also fiendishly difficult to anticipate—except from the vantage point of a history book author. Suffice it to say that the eugenics movement was widely endorsed by the scientific community and practiced around the world up until being taken to its logical conclusion in Nazi Germany (and in a handful of places, the idea persisted even longer than that). In 1908, for example, the *Chicago Sunday Tribune* published a full-page article titled "Why Not Improve the Human Race?" The illustration in the middle of the page featured beautiful, young couples portrayed as blossoming flowers, and among them, four grimacing delinquents depicted as prickly shrubs. A towering woman in an academic dress and a mortarboard could be seen reaching out in their direction, holding a sickle and two severed heads in her hand (see Figure 4-1).

Perhaps if it weren't for the madness of the Third Reich, eugenics would prevail today as a respectable field of scientific inquiry and a driver of public policy. Perhaps we narrowly escaped the world of *Gattaca*, where routine genetic testing would determine our job prospects, our right to have children, and our standing in society—and where literature would be cautioning us against the horrors we averted by diligently pursuing such policies.

People, as well as ideas, can be difficult to judge in the moment. Case in point: in 1922, a correspondent for the *New York Times* proclaimed that an up-and-coming German politician by the name of Adolf Hitler seemed like a harmless demagogue:

> Several reliable, well-informed sources confirmed the idea that Hitler's anti-Semitism was not so genuine or violent as it sounded, and that he was merely using anti-Semitic propaganda as a bait to catch masses of followers and keep them aroused, enthusiastic, and in line for the time when his organization is perfected and sufficiently powerful to be employed effectively for political purposes.

In hindsight, of course, we know better, but modern-day critics of this infamous quote can't necessarily offer a reliable analytical framework for telling despots apart from demagogues. Most populists don't become murderous lunatics, and most of the time, political posturing is just that. Knowing whether a politician is merely disagreeable or is the harbinger of doom can be genuinely difficult—to the point where the proclivity to compare one's political opponents to Hitler has become the butt of internet jokes.

The Chicago Sunday Tribune.

Why Not Improve the Human Race?

OTHER ANIMALS AND PLANTS HAVE BEEN IMPROVED BY EVOLUTION AND NOW SCIENTISTS PROPOSE TO DO THE SAME THING WITH MAN.

Expect to Breed Plants or Animals to Order.

Raising Men Like Old Fashioned Farming.

New Ideas Should Be Applied.

Moral and Physical Inheritances Equal.

Should Show How Families Thrive.

Should Not Kill the Unfit.

Fund for Eugenical Research.

Hopes for Control by Government.

From the Chicago Sunday Tribune, *January 26, 1908*

I'm cautiously optimistic about the future of humanity, but I don't have faith in our ability to remember the lessons of history as the accounts are rewritten and retold, and as the visceral atrocities of bygone days are gradually abstracted away and reduced to a sentence or two. In this sense, my greatest fear is that we won't make enough small blunders to keep reminding ourselves of what's right and what's wrong, eventually leading to us repeating some of our greatest mistakes on a much grander scale. This risk I cannot quantify—but I hope it's generations away.

Global Thermonuclear War

The horrors of a large-scale nuclear conflict are difficult to overstate—and yet, as noted earlier in the chapter, we keep finding ways to do just that. For noble but politically tinged reasons, we allowed pundits and science-fiction writers to conjure images of barren radioactive wastelands, dark skies, and dead seas: a post-apocalyptic hellscape where the best one could hope for is swift and merciful death.

To understand the true danger of nuclear warfare, it's best to forget it all and reach for a fantastic, though goofy-sounding, manual titled *Nuclear War Survival Skills*. The book was written in 1979 by Cresson Kearny, a researcher and avid survivalist who worked at the Oak Ridge National Laboratory in Tennessee—and rubbed shoulders with the forefathers of the US nuclear program. It's meant as a civil defense manual of sorts, with plans for makeshift shelters, radiation meters, and water purification techniques, but it's also a treasure trove of factual information about the mechanics of nuclear bombs and their effects on human and animal life. The book is still in print and is also available in the public domain: *https://archive.org/details/NuclearWarSurvivalSkills_201405/*.

Perhaps Kearny's most salient observation is that the atom bomb is not designed to spread radiation—and indeed, this happens only to a limited extent. In its most common mode of operation, the bomb is detonated high above the target, and derives the bulk of its destructive power from the release of a tremendous amount of thermal energy, as mentioned before, with a devastating secondary shockwave caused by the expanding gas. The burst of radiant heat can instantly cause lethal burns and set wooden structures on fire, while the shockwave flattens buildings and uproots trees. This mechanism explains why people who stood in the shadow of a sturdy wall or kneeled in a ditch managed to survive the bombings of Hiroshima and Nagasaki, even as others nearby perished in the blast. The phenomenon also underscores why the "duck and cover" mantra popularized in the 1950s was a pretty solid survival tip—even if the government could never convince anyone.

Of course, radiation released by the bomb is potentially lethal, too, but for many survivors, it's a manageable and short-lived threat. Although people can instantly receive a lethal dose of radiation within a fairly small

zone at the epicenter of a blast, this region is nested deeply within the fiery inferno unleashed by the bomb. A more widespread but more latent threat are the byproducts of the nuclear reaction that are dispersed in the air and slowly settle on the ground over the course of many hours or days—perhaps over the area of the blast, or perhaps tens of miles away. The intense radioactivity of the fallout is a major problem, but also a blessing of sorts: the high rate of decay means that the radiation decreases a hundred-fold within two days, and that it becomes somewhat safe to venture outdoors within a couple of weeks. The survivors would eventually face an elevated rate of cancers and other ailments, but with basic precautions could start rebuilding before too long.

Given that a nuclear strike could be survived by most, it's shameful that governments around the globe continue to maintain massive nuclear arsenals but have given up on their duty to provide basic preparedness instruction to the general population—especially given that no expense is spared in developing elaborate accommodations and nuclear doomsday plans for the thousands of elected officials and career bureaucrats who occupy positions of power. The reasons are as complex as they are depressing; if you want to learn more, look no further than *Raven Rock*, an enjoyable 2017 nonfiction bestseller written by Garrett M. Graff.

Nuclear EMP

In the early years of the US nuclear program, it was discovered that if a nuclear explosion is set off at a very high altitude, the resulting gamma radiation knocks out electrons from the upper atmosphere, forming a layer of charged plasma and sending a flurry of electrons hurling toward the ground at relativistic speeds. This charge separation produces a surprisingly high voltage gradient across hundreds or thousands of miles of land in the shadow of the blast, potentially disrupting electronics, communications, and the power grid in a manner broadly similar to the CME phenomenon discussed earlier in the chapter.

Unfortunately, a dearth of reliable information exists about this effect (known as the *nuclear electromagnetic pulse*, or EMP). Few tests appear to have been conducted by the government, and much of the data remains classified. What is known for certain is that the initial pulse is far more sudden than in the case of solar storms, possibly rendering traditional surge protectors and other automatic safety equipment less effective. Beyond that, perhaps the most compelling analysis comes from a governmental commission formed to study the threat in the mid-2000s. The committee didn't paint a particularly bleak picture, but also didn't discount the threat, noting that "it is not possible to precisely predict the time to restore even minimal electrical service due to an EMP eventuality given the number of unknowns and the vast size and complexity of the system with its consequent fragility and resiliency."[19] In other words, we don't know what we don't know.

In addition to discussing the impacts on the power grid, the commission also considered the risk to vehicles, conducting a series of field experiments with much smaller non-nuclear electromagnetic pulses discharged in the proximity of a car. The report goes on to say this:

> Automobiles were subjected to EMP environments under both engine turned off and engine turned on conditions. No effects were subsequently observed in those automobiles that were not turned on during EMP exposure. The most serious effect observed on running automobiles was that the motors in three cars stopped at field strengths of approximately 30 kV/m or above. In an actual EMP exposure, these vehicles would glide to a stop and require the driver to restart them. Electronics in the dashboard of one automobile were damaged and required repair. Other effects were relatively minor. Twenty-five automobiles exhibited malfunctions that could be considered only a nuisance (e.g., blinking dashboard lights) and did not require driver intervention to correct. Eight of the 37 cars tested did not exhibit any anomalous response.[20]

Because the testing was necessarily limited to non-nuclear EMP pulses, and because of other practical constraints of the setup, these benign results are far from conclusive; both the proponents of EMP doomsday and their detractors cite the study to prove their case.

Perhaps the most pragmatic critique of the EMP threat is simply to consider the geopolitical ramifications of a strike. Deploying an EMP weapon against a nuclear-capable country would almost certainly invite swift and devastating retaliation, putting "conventional" nuclear payloads on the table for the first time after 1945. From that perspective, it's probably not a particularly tempting tool for a surprise attack by a rogue state—not unless hundreds of intercontinental ballistic missiles (ICBMs) aimed at ground targets are flying right behind. And in that particular case, an EMP would not be the most pronounced concern.

Having said that, because the effects of nuclear electromagnetic pulses have much in common with coronal mass ejections, not to mention with power outages and surges caused by storms or lightning strikes, the threat can be addressed to a reasonable extent without necessarily succumbing to doomsday thoughts. Simple measures, ranging from backup power to emergency food supplies, can go a long way.

Ghosts, Bigfoot, and the Coming Robot Apocalypse

The fear of monsters lurking in the dark comes from an era when our ancestors were predators as much as they were prey. The cheap thrills of the supernatural enemy in *The Fog* or the reanimated beasts of *Jurassic Park* probably don't deserve serious scrutiny, but at least one type of modern monster—a human-created rogue artificial intelligence (AI)—keeps many futurists awake at night.

The most basic flavor of the AI doomsday scenario is essentially the plot of the *Terminator* franchise (perhaps minus the time-travel shenanigans): we develop super-intelligent machines that rebel against their creators and wipe out all humanity. Of course, we would build any dangerous AI with safeguards and limitations in place, but if it possesses intelligence far superior to ours, perhaps it wouldn't find it difficult to bypass human-crafted restraints or trick us into altering them in some unintended way.

If not impossible to rule out completely, the prospect of an overtly evil AI is at minimum an unimaginatively reductionist take. A more fascinating threat is that of a machine that doesn't perceive humans as adversaries, but simply misinterprets or disregards our desires and goals. An example is the well-known parable of the paperclip maximizer: a hypothetical autonomous AI designed to continually improve the efficiency of a paperclip production line. The AI expands and improves the operation, developing new assembly methods and new resource extraction and recycling procedures, until it's done converting the entire planet and its many inhabitants into paperclips. The point of the tale is simple: the AI doesn't need to hate you or love you; it suffices that you're made of atoms it has a different use for.

It can be argued that the development of artificial general intelligence (AGI)—a complete "brain in a jar," if you will—would be the point of singularity, a moment in the development of our species where the change is so monumental and so sudden that we can't meaningfully reason about what lies beyond. The extinction of our species is one distinct possibility, but we can imagine many other, more optimistic outcomes—and have no way to truly measure the risk.

Rather than speculate about the consequences, then, perhaps a better question is how far we are from developing this kind of AGI. On this topic, the history of AI research offers a cautionary tale: after the initial exuberance and some stunning early successes of artificial neural networks in the 1950s and 1960s, the field slid into a prolonged "AI winter" of broken promises and constant disappointments. Funding dwindled, and few academics would take pride in associating themselves with the discipline. It wasn't until the late 2000s that AI research made a comeback, aided with vastly superior computing resources and significant refinements to the architecture of neural networks and to deep learning algorithms. But the field focused on humble, utilitarian goals: building systems custom-tailored to perform highly specialized tasks, such as voice recognition, image classification, or the translation of text. Such architectures, although quite successful, still require quite a few quantum leaps to get anywhere close to AGI, and tellingly, the desire to build a digital "brain in a jar" is not an immediate goal for any serious corporate or academic research right now.

Ultimately, I don't think it's possible to meaningfully opine about the timeline or the dangers of AGI; the technology could be 10 years away, or it could take another century or two. Whatever lies ahead, there's not much

we as individuals can do to change the tides. In this regard, I'm reminded of the Serenity Prayer, a popular passage penned by Reinhold Niebuhr in the 1930s and commonly paraphrased as follows:

> Grant me the serenity to accept the things I cannot change,
> courage to change the things I can,
> and wisdom to know the difference.

The Scourge of Extraterrestrials

The final subject of our merry apocalyptic romp is a popular twist on the monster genre: the menace of invaders from outer space. It's one of these unknowable, not-sure-if-you're-serious scenarios that exist in the netherworld between unhinged conspiracy theories, B-grade sci-fi movies, and rational scientific inquiry.

On some level, the absence of extraterrestrials is *weird*. It seems rather unlikely that life evolved on just one out of perhaps 10^{24} planets in the entire universe. One possible rebuttal is that the cosmos is vast, and that harsh constraints limit how quickly it can be traversed; it follows that we might not be alone, but we might very well be too far from any of the thousands or millions of space civilizations out there. But then, the critics argue, shouldn't at least one life-form develop the ability to colonize nearby worlds, and from there, gradually spread to other galaxies? Humans seem to be on the verge of colonizing other planets, and our world has just over 4 billion years under its belt; the universe is much older than that.

A depressing hypothesis accounts for this dilemma: the existence of the Great Filter, some sort of an evolutionary bottleneck that prevents most living creatures from progressing to interstellar travel before going extinct. If such a bottleneck exists, our best hope is that it's behind us, and not that it awaits ahead.

But perhaps our problem is simply the arrogant assumption that other life-forms would be comprehensible or perceptible to humans, let alone interested in the same interplanetary pursuits as we are. Extraterrestrial life may very well exist in different phases of matter (interstellar plasma?), or operate on timescales too slow for us to observe and analyze. In fact, such beings seem more likely than ill-tempered, ray gun–wielding humanoids with a greenish complexion and bug-like eyes.

As some readers must be recognizing in horror, I struggle with the idea of flat-out rejecting extraterrestrial life; that said, I find it much easier to reject the fear of human-like intruders trying to make our planet their own. If such visitors *do* show at our doorstep, perhaps we'd be wise to start shooting and pray for the best; if the history of our species is any indication, encounters with more technologically advanced civilizations seldom end well for the more primitive tribes.

Looking Beyond Doomsday

At times, I feel like a disappointment to the prepper community: I hold an unabashedly optimistic outlook on life. I think the future will be full of wild moments that will bring a fair share of tragedy and senseless suffering, but I also believe our children will probably inherit a more prosperous and harmonious world. As any financial consultant will warn you, past results don't guarantee future returns—but to me, our first 300,000 years on the planet inspire some faith.

This is not to say that we should succumb to wishful thinking; it's just that I'm equally wary of habitual pessimism. Many of the famed doomsday prophets start from the position of being disappointed and disillusioned with humanity, and then work backward from this principle to devise an apocalyptic prediction of the day. It's not that they're *necessarily* wrong, but in practice, because of the lopsided method they follow, they arrive at the wrong conclusions virtually all the time.

If we give in to doom and gloom, the recipe for surviving civilizational collapse is simple: get away from other people and learn to live off the land. It's fairly clear that deprived of their industrial backbone, most of our cities and suburbs couldn't support even a tiny fraction of their current population densities—and in the event of a full-scale collapse, nothing but misery awaits the folks who stay. But then, a preemptive retreat from civilization can greatly increase one's vulnerability to far more prosaic natural disasters. Farmland is susceptible to wildfires and floods, for example, and for many professions, a rural setting offers few career opportunities and little pay.

My advice is simple: if farming is your cup of tea, buy a plot of land in the countryside—but do it because you're in love with the lifestyle, not because you're afraid of the impending doom. Conversely, if that's not your dream come true, it may be best to focus on more substantiated risks—and not let asteroids or space zombies keep you up at night.