

The Risk of Nuclear Winter

By Seth Baum

Since the early 1980s, the world has known that a large nuclear war could cause severe global environmental effects, including dramatic cooling of surface temperatures, declines in precipitation, and increased ultraviolet radiation. The term nuclear winter was coined specifically to refer to cooling that result in winter-like temperatures occurring year-round. Regardless of whether such temperatures are reached, there would be severe consequences for humanity. But how severe would those consequences be? And what should the world be doing about it?

To the first question, the short answer is nobody knows. The total human impacts of nuclear winter are both uncertain and under-studied. In light of the uncertainty, a risk perspective is warranted that considers the breadth of possible impacts, weighted by their probability. More research on the impacts would be very helpful, but we can meanwhile make some general conclusions. That is enough to start answering the second question, what we should do. In regards to what we should do, nuclear winter has some interesting and important policy implications.

Today, nuclear winter is not a hot topic but this was not always the case: it was international headline news in the 1980s. There were conferences, Congressional hearings, voluminous scientific research, television specials, and more. The story is expertly captured by Lawrence Badash in his book *A Nuclear Winter's Tale*.¹ Much of the 1980s attention to nuclear winter was driven by the enthusiastic efforts of Carl Sagan, then at the height of his popularity. But underlying it all was the fear of nuclear war, stoked by some of the tensest moments of the Cold War.

When the Cold War ended, so too did attention to nuclear winter. That started to change in 2007, with a new line of nuclear winter research² that uses advanced climate models developed for the study of global warming. Relative to the 1980s research, the new research found that the smoke from nuclear firestorms would travel higher up in the atmosphere, causing nuclear winter to last longer. This research also found dangerous effects from smaller nuclear wars, such as an India-Pakistan nuclear war detonating "only" 100 total nuclear weapons. Two groups—one in the United States³ and

¹ Lawrence Badash, *A Nuclear Winter's Tale: Science and Politics in the 1980s* (Cambridge, MA: MIT Press, 2009).

² O.B. Toon, R.P. Turco, A. Robock, C. Bardeen, L. Oman and G. L. Stenchikov, "Atmospheric Effects and Societal Consequences of Regional Scale Nuclear Conflicts and Acts of Individual Nuclear Terrorism," *Atmospheric Chemistry and Physics*, Vol. 7 (19 April 2007); Alan Robock, Luke Oman, Georgiy L. Stenchikov, "Nuclear Winter Revisited with a Modern Climate Model and Current Nuclear Arsenals: Still Catastrophic Consequences," *Journal of Geophysical Research*, Vol. 112, No. D13107 (6 July 2007).

³ Ibid.

one in Switzerland⁴—have found similar results using different climate models, lending further support to the validity of the research.

Some new research has also examined the human impacts of nuclear winter. Researchers simulated agricultural crop growth in the aftermath of a 100-weapon India-Pakistan nuclear war.⁵ The results are startling- the scenario could cause agriculture productivity to decline by around 10 to 40 percent for several years after the war. The studies looked at major staple crops in China and the United States, two of the largest food producers. Other countries and other crops would likely face similar declines.

Following such crop declines, severe global famine could ensue. One study estimated the total extent of the famine by comparing crop declines to global malnourishment data.⁶ When food becomes scarce, the poor and malnourished are typically hit the hardest. This study estimated two billion people at risk of starvation. And this is from the 100-weapon India-Pakistan nuclear war scenario. Larger nuclear wars would have more severe impacts.

This is where the recent research stops. To the best of my knowledge there are no recent studies examining the secondary effects of famines, such as disease outbreaks and violent conflicts. There are no recent studies examining the human impacts of ultraviolet radiation. That would include an increased medical burden in skin cancer and other diseases. It would also include further loss of agriculture ecosystem services as the ultraviolet radiation harms plants and animals. At this time, we can only make educated guesses about what these impacts would be, informed in part by what research was published 30 years ago.

When analyzing the risk of nuclear winter, one question is of paramount importance: Would there be permanent harm to human civilization? Humanity could have a very bright future ahead; to dim that future is the worst thing nuclear winter could do. It is vastly worse than a few billion deaths from starvation. Not that a few billion deaths is trivial—obviously it isn't—but it is tiny compared to the loss of future generations.

Carl Sagan was one of the first people to recognize this point in a commentary he wrote on nuclear winter for *Foreign Affairs*.⁷ Sagan believed nuclear winter could cause human extinction, in which case

⁴ A. Stenke, C. R. Hoyle, B. Luo, E. Rozanov, J. Gröbner, L. Maag, S. Brönnimann, and T. Peter, "Climate and Chemistry Effects of a Regional Scale Nuclear Conflict," *Atmospheric Chemistry and Physics*, Vol. 13, No. 19 (2013), pp. 9713–29.

⁵ Lili Xia and Alan Robock, "Impacts of a Nuclear War in South Asia on Rice Production in Mainland China," *Climatic Change*, Vol. 116 (5 May 2012), pp. 357–72; Mutlu Özdoğan, Alan Robock, and Christopher Kucharik, "Impacts of a Nuclear War in South Asia on Soybean and Maize Production in the Midwest United States," *Climatic Change*, Vol. 116 (22 June 2012), pp. 373–87.

⁶ Ira Helfand, "Nuclear Famine: Two Billion People at Risk," International Physicians for the Prevention of Nuclear War (November 2013), <http://www.ippnw.org/pdf/nuclear-famine-two-billion-at-risk-2013.pdf>.

⁷ Carl Sagan, "Nuclear War and Climatic Catastrophe: Some Policy Implications," *Foreign Affairs*, Vol. 62, No. 2 (Winter 1983), pp. 257–92.

all members of future generations would be lost. He argued that this made nuclear winter vastly more important than the direct effects of nuclear war, which could, in his words, “kill ‘only’ hundreds of millions of people.”

Sagan was however, right that human extinction would cause permanent harm to human civilization. It is debatable whether nuclear winter could cause human extinction. Alan Robock, a leader of the recent nuclear winter research, believes it is unlikely. He writes: “Especially in Australia and New Zealand, humans would have a better chance to survive.”⁸ This is hardly a cheerful statement, and it leaves open the chance of human extinction. I think that’s the best way of looking at it. Given all the uncertainty and the limited available research, it is impossible to rule out the possibility of human extinction. I don’t have a good answer for how likely it is. But the possibility should not be dismissed.

Even if some humans survive, there could still be permanent harm to human civilization. Small patches of survivors would be extremely vulnerable to subsequent disasters. They also could not keep up the massively complex civilization we enjoy today. It would be a long and uncertain rebuilding process and survivors might never get civilization back to where it is now. More importantly, they might never get civilization to where we now stand poised to take it in the future. Our potentially bright future could be forever dimmed.⁹ Nuclear winter is a very large and serious risk. But that on its own doesn’t mean much—just another thing to worry about. What’s really important are the implications of nuclear winter for public policy and private action.

In some ways, nuclear winter doesn’t change nuclear weapons policy all that much. Everyone already knew that nuclear war would be highly catastrophic. Nuclear winter means that nuclear war is even more catastrophic, but that only reinforces policies that have long been in place, from deterrence to disarmament. Indeed, military officials have sometimes reacted to nuclear winter by saying that it just makes their nuclear deterrence policies that much more effective.¹⁰ Disarmament advocates similarly cite nuclear winter as justifying their policy goals. But the basic structure of the policy debates is unchanged.

In other ways, nuclear winter changes nuclear weapons policy quite dramatically. Because of nuclear winter, noncombatant states may be severely harmed by nuclear war. Nuclear winter gives every

⁸ Why Australia and New Zealand? A nuclear war would presumably occur mainly or entirely in the northern hemisphere. The southern hemisphere would still experience environmental disruption, but it would not be as severe. Australia and New Zealand further benefit from their adjacent waters, which further soften the effect. See Alan Robock, “Nuclear Winter,” *Wiley Interdisciplinary Reviews: Climate Change*, Vol. 1, No. 3 (May/June 2010), pp. 418–27. Quote at p. 424.

⁹ Timothy M. Maher Jr. and Seth D. Baum, “Adaptation to and Recovery from Global Catastrophe,” *Sustainability*, Vol. 5, No. 4 (28 March 2013), pp. 1461–79.

¹⁰ Paul Rubinson, “The Global Effects of Nuclear Winter: Science and Antinuclear Protest in the United States and the Soviet Union During the 1980s,” *Cold War History*, Vol. 14, No. 1 (February 2013), pp. 47–69.

country great incentive to reduce tensions and de-escalate conflicts between nuclear weapon states. Thankfully, this point has not gone unnoticed at recent international conferences on the humanitarian impacts of nuclear weapons, such as the December 2014 conference in Vienna, which I spoke at.¹¹ These conferences are led by, and largely aimed at, non-nuclear weapon states.

Nuclear weapon states should also take notice. Indeed, the biggest policy implication of nuclear winter could be that it puts the interests of nuclear weapon states in greater alignment. Because of nuclear winter, a nuclear war between any two major nuclear weapon states could severely harm each of the other six. (There are nine total nuclear-armed states, and North Korea's arsenal is too small to cause any significant nuclear winter.) This multiplies the risk of being harmed by nuclear weapons, while only marginally increasing the benefits of nuclear deterrence. By shifting the balance of harms vs. benefits, nuclear winter can promote nuclear disarmament.

Additional policy implications come from the risk of permanent harm to human civilization. If society takes this risk seriously, then it should go to great lengths to reduce the risk. It could stockpile food to avoid nuclear famine, or develop new agricultural paradigms that can function during nuclear winter.¹² It could abandon nuclear deterrence, or shift deterrence regimes to different mixes of weapons.¹³ And it could certainly ratchet up its efforts to improve relations between nuclear weapon states. These are things that we can do right now, even while we await more detailed research on nuclear winter risk.

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¹¹ Vienna Conference on the Humanitarian Impact of Nuclear Weapons. <http://www.bmeia.gv.at/en/european-foreign-policy/disarmament/weapons-of-mass-destruction/nuclear-weapons-and-nuclear-terrorism/vienna-conference-on-the-humanitarian-impact-of-nuclear-weapons/>

¹² David Denkenberger and Joshua M. Pearce, *Feeding Everyone No Matter What: Managing Food Security After Global Catastrophe* (Waltham, MA: Academic Press, 2014).

¹³ Seth D. Baum, "Winter-Safe Deterrence: The Risk of Nuclear Winter and Its Challenge to Deterrence," *Contemporary Security Policy*, Vol. 36, No. 1 (April 2015), pp. 123–48. See also "The Winter-Safe Deterrence Debate," *Bulletin of the Atomic Scientists*, <http://thebulletin.org/winter-safe-deterrence-debate8094>.

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