



**Zero is the only option**

Four Medical and Environmental Cases  
for Eradicating Nuclear Weapons

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This paper was written and edited by John Loretz, Program Director of International Physicians for the Prevention of Nuclear War. It draws extensively from the work of climate scientists at Rutgers University and the University of Colorado at Boulder, including Alan Robock, O. B. Toon, Michael Mills, and their colleagues, who have been documenting the climate effects of regional nuclear war since 2007. An archive of scientific articles and supporting materials is available at <http://climate.envsci.rutgers.edu/nuclear>. Recent studies published by physician experts on the medical consequences of nuclear war, including Lachlan Forrow, Ira Helfand, and Victor W. Sidel, were also primary sources for this paper, and are cited in the notes. Aki Morizono designed and produced the paper. IPPNW is solely responsible for the policy conclusions expressed in this paper and for any errors that may have been introduced in the editing process.



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**“Nuclear weapons are unique in their destructive power**, in the unspeakable human suffering they cause, in the impossibility of controlling their effects in space and time, in the risks of escalation and in the threat they pose to the environment, to future generations, indeed, to the survival of humanity....

“Preventing the use of nuclear weapons means preventing their proliferation and combating the transfer of materials and technology needed to produce them. **It requires the fulfillment of existing obligations to pursue negotiations to prohibit and completely eliminate such weapons.**”

—Statement of International Committee of the Red Cross (ICRC)  
to the 2009 UNGA First Committee, 9 October 2009

## Introduction

“There is no doubt that, if the peoples of the world were more fully aware of the inherent danger of nuclear weapons and the consequences of their use, they would reject them, and not permit their continued possession or acquisition on their behalf by their governments, even for an alleged need for self-defence.”

—Canberra Commission

“So long as any state has nuclear weapons, others will want them. So long as any such weapons remain, there is a risk that they will one day be used, by design or accident. And any such use would be catastrophic.”

—Weapons of Mass Destruction Commission

The goal of a nuclear-weapons-free world, embedded in Article VI of the Non-Proliferation Treaty, has been embraced by a large majority of UN member states; by prominent diplomats, policy experts, and military leaders worldwide; and by overwhelming majorities of citizens in all countries where the question has been asked in public opinion surveys. UN Secretary-General Ban Ki-Moon and his predecessor, Kofi Annan, have both said that ridding the world of nuclear weapons is one of the most urgent priorities of the international community.<sup>1</sup> US President Barack Obama committed himself to working for “the peace and security of a world without nuclear weapons” in Prague on April 5, 2009.

The importance—in fact the necessity—of getting to zero has been explained by senior ministers, diplomats, and retired military leaders in several countries, including the US.<sup>2</sup> Their views echo the conclusions of international physicians, lawyers, scientists, and civil society organizations, who have been pressing the case for nuclear abolition almost since the beginning of the nuclear age, and certainly since the entry into force of

the Non-Proliferation Treaty some 40 years ago.

The priority and urgency of nuclear disarmament have also been articulated by high-level international bodies convened for the purpose of assessing the nuclear threat and for recommending solutions. Among these have been the Canberra Commission on the Elimination of Nuclear Weapons (1995); the International Court of Justice (1996); the Weapons of Mass Destruction (Blix) Commission (2006); and the International Commission on Nuclear Non-Proliferation and Disarmament (2009).

The latter issued its final report in December 2009, the first paragraph of which should be committed to memory by anyone concerned with the survival of humankind:

*“Nuclear weapons are the most inhumane weapons ever conceived, inherently indiscriminate in those they kill and maim, and with an impact deadly for decades. Their use by anyone at any time, whether by accident, miscalculation or design, would be catastrophic. They are the only weapons ever invented that*

<sup>1</sup> Secretary-General Ban Ki-moon. “The United Nations and security in a nuclear-weapon-free world.” Address to the East-West Institute. New York. October 24, 2008. Secretary-General Kofi Annan. Lecture. Princeton University. November 28, 2006.

<sup>2</sup> George P. Shultz, William J. Perry, Henry A. Kissinger, Sam Nunn. A world free of nuclear weapons. Wall Street Journal. January 4, 2007; Douglas Hurd, Malcolm Rifkind, David Owen, George Robertson. Start worrying and learn to ditch the bomb: It won’t be easy, but a world free of nuclear weapons is possible. The Times of London. June 30, 2008; Helmut Schmidt, Richard von Weizsäcker, Egon Bahr, Hans-Dietrich Genscher. Toward a nuclear-free world: a German view. The New York Times. January 9, 2009; Aleksander Kwasniewski, Tadeusz Mazowiecki, Lech Walesa. The unthinkable becomes thinkable: Towards the elimination of nuclear weapons. Gazeta Wyborcza. April 3, 2009. Odvar Nordli, Gro Harlem Brundtland, Kåre Willoch, Kjell Magne Bondevik, Thorvald Stoltenberg. A Nuclear Weapons-Free World. Aftenposten. June 4, 2009; Alain Juppé, Bernard Norlain, Alain Richard, Michel Rocard. Pour un désarmement nucléaire mondial, seule réponse a la prolifération anarchique. Le Monde. October 15, 2009.

*have the capacity to wholly destroy life on this planet, and the arsenals we now possess – combining their blast, radiation and potential ‘nuclear winter’ effects – are able to do so many times over. Climate change may be the global policy issue that has captured most attention in the last decade, but the problem of nuclear weapons is at least its equal in terms of gravity – and much more immediate in its potential impact.”<sup>3</sup>*

Despite this upsurge in global support for a world without nuclear weapons, the road toward zero remains obstructed and the pace at which the nuclear-weapon states and the policy elites seem content to move is unacceptably slow. Behind the encouraging rhetoric about a nuclear-weapons-free world we see only modest, incremental proposals that will likely postpone the negotiation of a comprehensive nuclear disarmament agreement—a Nuclear Weapons Convention—for another two or three decades or more. Even President Obama has said that a nuclear-weapons-free world may not be achieved in his lifetime.

To put it plainly, the world does not have the luxury of time when it comes to elim-

inating the dangers posed by nuclear weapons. Every day that they remain in fallible human hands is a day in which we might experience a humanitarian and environmental catastrophe. Every day in which that catastrophe is averted must be counted as borrowed time.

International Physicians for the Prevention of Nuclear War has produced this briefing paper summarizing current medical and scientific knowledge about nuclear war and its consequences in the belief that a thorough and unvarnished understanding of the destructive power of nuclear weapons will compel decision makers to fulfill the promise of Article VI of the NPT and to eliminate the prospects of nuclear famine, nuclear winter, and nuclear mass murder without further delay.

“[T]he adoption each year by the General Assembly, by a large majority, of resolutions recalling the content of resolution 1653 (XVI), and requesting the member States to conclude a convention prohibiting the use of nuclear weapons in any circumstance, reveals the desire of a very large section of the international community to take, by a specific and express prohibition of the use of nuclear weapons, a significant step forward along the road to complete nuclear disarmament.”

—International Court of Justice, 1996



#### ONLINE: BLOG

Learn more about the medical and environmental consequences of nuclear war and contribute to the discussion at [nuclear-zero.org](http://nuclear-zero.org).

3 International Commission on Nuclear Non-proliferation and Disarmament. *Eliminating nuclear threats: A practical agenda for global policymakers*. Canberra/Tokyo. 2009.

# Nuclear Famine: How a Regional Nuclear War Will Cause Global Mass Starvation

## CASE STUDY #1



### KEY POINTS

- Tens of millions die immediately in regional nuclear war with 100 Hiroshima-size weapons
- Smoke and soot injected into upper atmosphere spreads globally, blocks sunlight
- Sudden global cooling shortens growing season, disrupts agriculture worldwide
- Ecological damage persists for several years
- Infectious disease epidemics and environmental conflict follow
- One billion nuclear famine deaths possible

Climate scientists who worked with the late Carl Sagan in the 1980s to document the threat of nuclear winter have produced disturbing new research about the climate effects of low-yield, regional nuclear war.<sup>4</sup>

Using South Asia as an example,<sup>5</sup> these experts have found that even a limited regional nuclear war on the order of 100 Hiroshima-sized nuclear weapons would result in tens of millions of immediate deaths and unprecedented global climate disruption. Smoke from urban firestorms caused by multiple nuclear explosions would rise into the upper troposphere and, due to atmospheric heating, would subsequently be boosted deep into the stratosphere.

The resulting soot cloud would block 7–10% of warming sunlight from reaching the Earth's surface, leading to significant cooling and reductions in precipitation lasting for more than a decade. Within 10 days following the explosions, there would be a drop in average surface temperature of 1.25° C. Over the following year, a 10% decline in average global rainfall and a large reduction in the Asian summer monsoon would have a significant impact on agricultural production. These effects would persist over

many years. The growing season would be shortened by 10 to 20 days in many of the most important grain producing areas in the world, which might completely eliminate crops that had insufficient time to reach maturity.

There are currently more than one billion people in the world who are chronically malnourished. Several hundred million more live in countries that depend on imported grain. Even a modest, sudden decline in agricultural production could trigger significant increases in the prices for basic foods, as well as hoarding on a global scale, making food inaccessible to poor people in much of the world. While it is not possible to estimate the precise extent of the global famine that would follow a regional nuclear war, it seems reasonable to anticipate a total global death toll in the range of one billion from starvation alone. Famine on this scale would also lead to major epidemics of infectious diseases, and would create immense potential for mass population movement, civil conflict, and war.

These findings have significant implications for nuclear weapons policy. They are powerful evidence in the case against the proliferation of nuclear weapons and against the modernization

<sup>4</sup> Alan Robock, et al. Climatic consequences of regional nuclear conflicts, *Atmospheric Chemistry and Physics Discussion* 2006;6:11817-11843.

<sup>5</sup> A conflict of this magnitude would not necessarily involve the extremely large nuclear arsenals of the US and Russia. It could arise between emerging nuclear powers such as India and Pakistan, or it could result from escalation in the Middle East. Even the remaining US tactical nuclear weapons based in Europe would be sufficient to cause the devastation described here. The question is often raised about the likelihood of a nuclear war between India and Pakistan. While this scenario is presented primarily as an example of the global destruction of which these relatively small arsenals are capable, Indian leaders, including General Deepak Kapoor and Defence Minister A. K. Antony, have recently warned that the possibility of limited nuclear war in a region marked by territorial disputes, ethnic and religious tensions, and socio-economic disparities is a reality. "Limited war under nuclear overhang possible" General Deepak Kapoor. *Defence Forum Of India*. November 24, 2009.]



FIG. 1 IMPACT ON GLOBAL AGRICULTURE OF REGIONAL NUCLEAR WAR (100 15-KT EXPLOSIONS)

REGION	GROWING DAYS LOST	STAPLE CROPS AFFECTED			GROWING SEASON LENGTH
		WHEAT	MAIZE	RICE	
AUSTRALIA	10-30	●			<b>WHEAT:</b> 110-130 growing days <b>RICE:</b> ~120 days <b>MAIZE:</b> 126-200 days  The debris injected into the atmosphere from 100 15-Kt explosions and resulting fires would produce an average surface cooling of -1.25°C that would last for several years. In addition, there would be major declines in precipitation – up to 40% – in many of the world’s most important grain growing regions. The end result is significant curtailment of the growing seasons for the world’s most essential grain crops.
CANADA	10-20	●	●		
CENTRAL EUROPE	10-20	●	●		
CHINA	10-20	●	●	●	
INDIA	10	●		●	
RUSSIA/UKRAINE	10-30	●			
SOUTH AFRICA	10		●		
USA	20-30	●	●		

of arsenals in the existing nuclear weapon states. Even more important, they argue for a fundamental reassessment of the role of nuclear weapons in the world. If even a relatively small nuclear war, by Cold War standards—within the capacity of eight nuclear-armed states—could trigger a global catastrophe, the only viable response is the complete abolition of nuclear weapons.

Two other issues need to be considered as well. First, there is a very high likelihood that famine on this scale would lead to major epidemics of infectious diseases. Previous famines have been accompanied by major outbreaks of plague, typhus, malaria, dysentery, and cholera. Despite the advances in medical technology of the last half century, a global famine on the anticipated scale would provide the ideal breeding ground for epidemics involving any or all of these illness, especially in the vast megacities of the developing world.

Famine on this scale would also provoke war and civil conflict, including food riots. Competition for limited food resources might well exacerbate ethnic and regional animosities. Armed conflict among nations would escalate as states dependent on imports adopted whatever means were at their disposal to maintain access to food supplies.

"The first nuclear war so shocked the world that in spite of the massive buildup of these weapons since then, they have never been used again. But the only way to eliminate the possibility of climatic catastrophe is to eliminate the weapons."

— Alan Robock, O. B. Toon.  
Local nuclear war; global suffering.  
Scientific American. January 2010.



### CLIMATE DISRUPTION LEADS TO FAMINE

The **Tambora volcano eruption in 1815** — the largest in recorded history — caused a year-long global cooling of about 0.4°C-0.7°C and a dramatic shortening of the growing season around the world. Four major frosts during the summer of 1816 caused extensive damage to crops, particularly to maize, much of which was destroyed. Famine in densely populated countries was the inevitable result. Climate disruption from a regional nuclear war would be far more severe and would last up to ten times as long.

# A Nuclear Ozone Hole: The Global Cancer Burden of a Regional Nuclear War

## CASE STUDY #2



### KEY POINTS

- Soot from burning cities displaces and destroys stratospheric ozone
- Average global ozone depletion up to 25% for five years after nuclear exchange
- 25-45% depletion at mid-latitudes; 50-70% at northern high latitudes
- Substantial increases in ultraviolet radiation
- Increased rates of skin cancer, eye damage, destruction of aquatic ecosystems
- Effects persist for years

A nuclear war using only a small fraction of current global arsenals would quickly cause prolonged and catastrophic stratospheric ozone depletion. The impact on human and animal health and on fundamental ecosystems would be disastrous.

Scientists have known for more than two decades that a global nuclear war—an event that came perilously close during the Cold War between the US and the former Soviet Union, and which cannot be ruled out as long as those massive arsenals exist—would severely damage the Earth’s protective ozone layer. Studies in the 1980s by the US National Research Council and others showed that solar heating of the smoke produced by massive fires would displace and destroy significant amounts of stratospheric ozone.<sup>6</sup>

Early in 2008, physicists and atmospheric scientists from the University of Colorado, UCLA, and the National Center for Atmospheric Research published important new findings that a

regional nuclear war involving 100 Hiroshima-sized bombs would result in severe losses in stratospheric ozone.<sup>7</sup>

The scientists concluded that a regional nuclear conflict between India and Pakistan in which each used 50 Hiroshima-sized weapons (~15 kt) would produce an estimated 6.6 teragrams (Tg) of black carbon. In addition to the global surface cooling described above, large losses in stratospheric ozone would persist for years. The global mean ozone column would be depleted by as much as 25% for five years after the nuclear exchange. At mid-latitudes (25-45%) and at northern high latitudes (50-70%), ozone depletion would be even more severe and would last just as long.

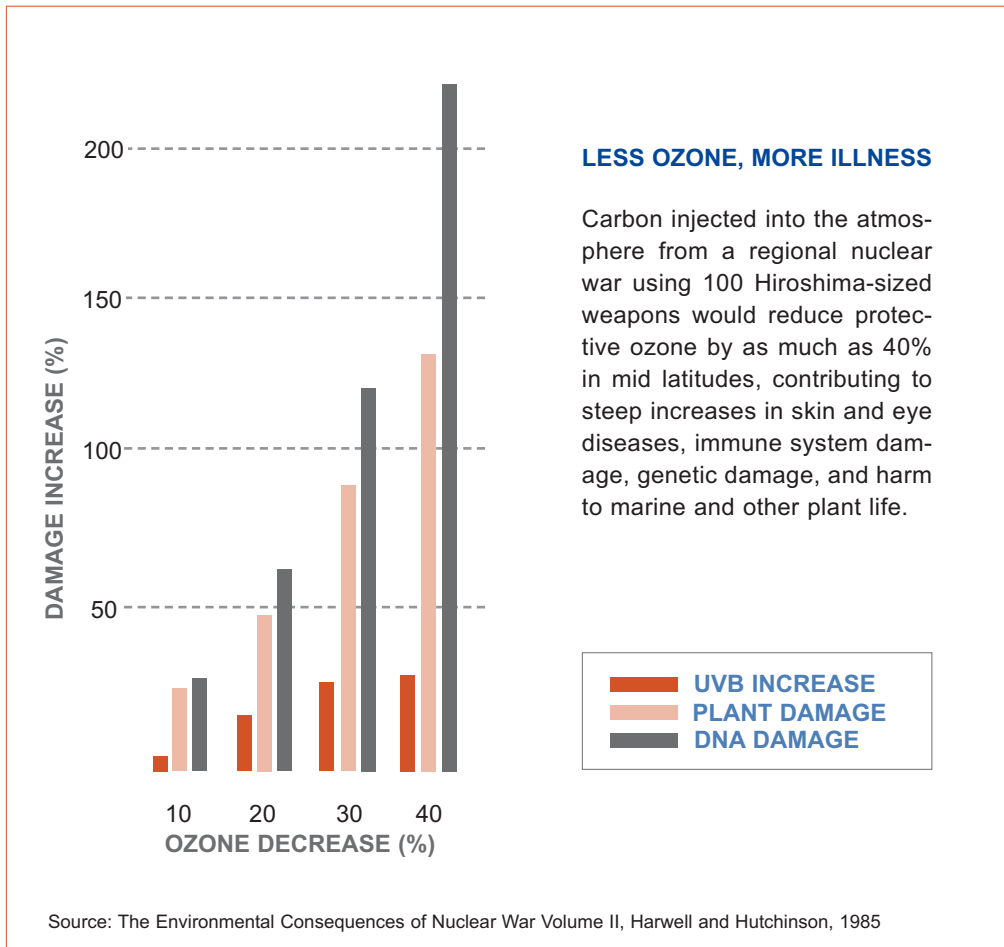
Substantial increases in ultraviolet radiation would have serious consequences for human health. Those consequences, as we know from earlier studies of stratospheric ozone loss—the “ozone hole” that prompted the Montreal Protocol and the phasing out of ozone-depleting chlorofluorocarbons (CFCs)—

6 Fred Solomon and Robert Q. Marston (ed.). *The Medical Implications of Nuclear War*. Institute of Medicine, National Academies Press. Washington, DC. 1986; S. L. Stephens, J. W. Birks. *Bioscience* 35, 557 (1985); R.C. Malone, L.H. Auer, G.A. Glatzmaier, M.C. Wood, O.B. Toon, J. *Geophys. Res. Atm.* 91, 1039 (1986); C.Y.J. Kao, G.A. Glatzmaier, R.C. Malone, R.P. Turco, J. *Geophys. Res.-Atm.* 95, 22495 (1990).

7 Michael J. Mills, Owen B. Toon, Richard P. Turco, Douglas E. Kinnison, Rolando R. Garcia. Massive global ozone loss predicted following regional nuclear conflict. *Proceedings of the National Academy of Sciences*. 105, 5307–5312. April 8, 2008.



FIG. 2 BIOLOGICAL CONSEQUENCES OF OZONE DEPLETION AT 45°N



include steep increases in skin cancer, crop damage, and destruction of marine phytoplankton.

A 1-Tg infusion of soot would also dangerously deplete stratospheric ozone, although the effects would be smaller and shorter-lived than in the 5-Tg case. The study concluded that global mean ozone column losses would peak at 8%

and that the perturbation would last up to four years. One of the most surprising findings is that the magnitude and duration of the predicted ozone reductions from the regional nuclear war considered by the scientists are greater than those calculated in the 1980s for global thermonuclear war with yields a thousand times greater.

“Increased UV radiation is largely detrimental, damaging terrestrial and oceanic plants and producing skin cancer, ocular damage, and other health effects in humans and animals.

Conclusive evidence shows that increased UV-B radiation damages aquatic ecosystems, including amphibians, shrimp, fish, and phytoplankton.”

— Michael J. Mills, Owen B. Toon, et al<sup>7</sup>

# Nuclear Winter: The Earth's Life-Sustaining Ecosystems Remain at Risk

## CASE STUDY #3



### KEY POINTS

- Catastrophic war with current arsenal devastates global climate
- 45% global average reduction in precipitation in worst case
- Global average surface cooling of  $-7^{\circ}\text{C}$  to  $-8^{\circ}\text{C}$ , more extreme than last ice age
- $-20^{\circ}\text{C}$  in North America;  $-30^{\circ}\text{C}$  in Eurasia
- Food production stops; most people on Earth die within one year
- Even a portion of existing arsenal causes severe and unprecedented climate disruption

More than 20 years ago, climate scientists led by the renowned Carl Sagan coined the term “nuclear winter” to describe the global ecological destruction that would result from a massive nuclear exchange between the US and the former Soviet Union. Applying climate model simulations available to them at the time, the scientists concluded that smoke and dust produced by a catastrophic nuclear war would cause rapid drops in temperature and precipitation, block sunlight, and threaten agriculture worldwide for at least a year.

Using modern climate models that have been developed to study global warming, some of these same scientists and their colleagues have recently returned to the question of nuclear winter and have reexamined the climate consequences of a range of nuclear wars. These new studies have reconfirmed that a nuclear war involving the large arsenals of the US and Russia would result in a nuclear winter even more long lasting than previously thought.<sup>8</sup>

The scientists looked at the effects over a 10-year period of two different scenarios that are possible today—a nuclear war injecting 150 teragrams [Tg] of

smoke into the upper troposphere over a one-week period, and one producing 50 Tg of smoke. One important difference between now and 20 years ago, which they looked at closely, has been the growth of cities and, consequently, larger smoke emissions from the same targets.

They calculated that roughly 150 Tg of smoke would be emitted by the use of the entire current global nuclear arsenal with a yield of 5,000 megatons.<sup>9</sup> If one-third of the current arsenal were used, 50 Tg of smoke would be emitted.

In the 150 Tg scenario, black carbon particles spread quickly across the upper stratosphere and produce “a long-lasting climate forcing” that would last for more than a decade and affect both the Northern and Southern hemispheres. Among the effects would be a 45% global average reduction in precipitation and a global average surface cooling of  $-7^{\circ}\text{C}$  to  $-8^{\circ}\text{C}$ , which would persist for years. **By comparison, the scientists remind us, “the global average cooling at the depth of the last ice age 18,000 years ago was about  $5^{\circ}\text{C}$ ,”** which would be “a climate change unprecedented in speed and amplitude in the history of the human race.” At the extremes, people in

8 A. Robock, L. Oman, G. L. Stenchikov. Nuclear winter revisited with a modern climate model and current nuclear arsenals: Still catastrophic consequences. *Journal Of Geophysical Research* 2008;112 [www.pnas.org/content/105/14/5307].

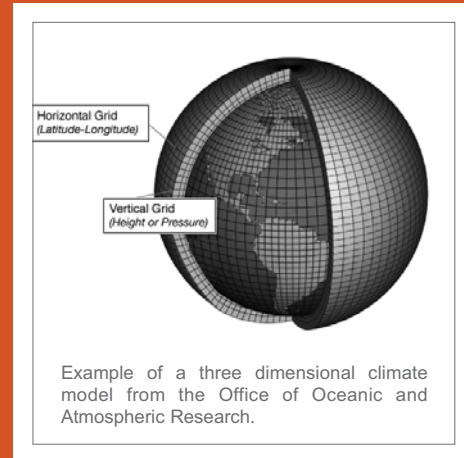
9 The US and Russia possess about 95% of these weapons, a proportion that has remained virtually unchanged since the Cold War.

## NUCLEAR WINTER: THE SKEPTICS WERE WRONG

Critics of the early scientific evidence for nuclear winter pointed to limitations in computer technology and climate models available in the 1980s to support their claim that the environmental consequences of a massive nuclear war would be less catastrophic than Carl Sagan and his colleagues were telling the public and policy makers. The nuclear winter findings have now been verified, with the help of state-of-the-art atmospheric general circulation models (GCMs) developed to study global warming.

*“It turns out that not only do we still get a nuclear winter using the previous baseline case, but that the climate response is much longer than that of earlier results, and current nuclear arsenals can still produce a nuclear winter,”* according to the authors of a 2007 paper in the *Journal of Geophysical Research*.

Source: Alan Robock, Luke Oman, and George L. Stenchikov (2007)<sup>8</sup>



North America and Eurasia would experience cooling of more than  $-20^{\circ}\text{C}$  and  $-30^{\circ}\text{C}$  respectively.

The reductions in temperature and precipitation in the 50 Tg scenario were about half those for 150 Tg, over the same timescale. While not cold enough to be classified as “nuclear winter,” according to the scientists, such climate forcing would still be “severe and unprecedented.”

Perhaps the most extreme and lethal impact would be the collapse of agriculture. The earlier nuclear winter studies

concluded that food production would cease entirely around the world for at least a year, leading to death by starvation for most of the human population. The results of the new studies paint an even grimmer picture: “this period of no food production needs to be extended by many years, making the impacts of nuclear winter even worse than previously thought.”

“The effects of the smoke cloud on surface temperature are extremely large....A global average surface cooling of  $-7^{\circ}\text{C}$  to  $-8^{\circ}\text{C}$  persists for years, and after a decade the cooling is still  $-4^{\circ}\text{C}$ . Considering that the global average cooling at the depth of the last ice age 18,000 years ago was about  $-5^{\circ}\text{C}$ , this would be a climate change unprecedented in speed and amplitude in the history of the human race.”

—Alan Robock, Luke Oman, George L. Stenchikov. Nuclear winter revisited. 2008<sup>8</sup>

# Casualties of Nuclear War: Why Prevention is Still the Only Cure<sup>10</sup>

## CASE STUDY #4



### KEY POINTS

- The blast, heat, and radiation from a single nuclear weapon can kill hundreds of thousands of people, placing nuclear weapons in a class of their own as weapons of mass destruction.
- A large-scale nuclear war would destroy the economic, communications, and transportation infrastructures on which the entire population depends for survival.
- Casualties among physicians and health workers, combined with the destruction of hospital and clinics, would make caring for survivors extremely difficult or even impossible.
- Even if they are not exploded, nuclear weapons present hazards at every step in their production, testing, storage, and transportation.

Physicians first confronted the medical consequences of the use of nuclear weapons on August 6, 1945, when surviving medical personnel struggled to care for the massive casualties in the aftermath of the Hiroshima nuclear explosion:

*In a city of two hundred and forty five thousand, nearly a hundred thousand people had been killed or doomed at one blow; a hundred thousand more were hurt. The people ... wept and cried, for Dr. Sasaki to hear, "Sensei! Doctor!"... Bewildered by the numbers, staggered by so much raw flesh, Dr. Sasaki lost all sense of profession and stopped working as a skillful surgeon and a sympathetic man; he became an automaton, mechanically wiping, daubing, winding, wiping, daubing, winding.<sup>11</sup>*

Many of Dr. Sasaki's patients who survived the injuries caused by heat, fire, and blast soon developed the devastating features of acute radiation sickness: severe gastrointestinal problems, uncontrolled bleeding, hair loss, and extreme susceptibility to infection. With the city's medical facilities almost entirely destroyed, effective care was virtually impossible.

The 12.5-kiloton bomb detonated in the air over Hiroshima created ground temperatures that reached about 7,000 degrees Celsius. Of the 76,000 buildings

in the city, 92% were destroyed or damaged. There were more than 100,000 deaths and about 75,000 injuries among a population of about 250,000. Of the 298 physicians in the city, 270 were dead or injured and 1,564 of 1,780 nurses died or were injured.

The 21-kiloton bomb detonated in the air over Nagasaki three days later leveled 6.7 million square meters (2.6 square miles). There were 75,000 immediate deaths and 75,000 injuries, with similar destruction of medical facilities and personnel and similar health consequences for the population of the city.

In the decades following the atomic bombings of Hiroshima and Nagasaki, the medical effects of nuclear weapons have been documented in painstaking detail and published in medical and scientific journals, books, and monographs (see "Medical Consequences of Nuclear War," facing page).

<sup>10</sup> Excerpted and adapted from L. Forrow, V. W. Sidel, J. E. Slutzman. *Medicine and nuclear war: preventing proliferation and achieving abolition*. IPPNW monograph. 2007.

<sup>11</sup> John Hersey. *Hiroshima*. New York: Vintage Books. 1989 (reprinted edition).

### MEDICAL CONSEQUENCES OF NUCLEAR WAR

The physical effects of nuclear weapons include a heat (thermal) wave, a blast wave, an electromagnetic pulse, the release of ionizing radiation, and the production of isotopes, many of them radioactive. Specifically, the effects of a 10-20-kiloton nuclear weapon include:

- At the center of the blast (ground zero) the overpressures are greater than 20 pounds per square inch (psi), sufficient to destroy all but the skeletons of reinforced concrete structures.
- At approximately 0.6 mile (1.0 km) from the center of the blast, the overpressures are about 10 psi, sufficient to destroy all wood and brick-built structures.
- The blast not only destroys buildings but turns bricks, lumber, furniture, cars, and people into missiles. Overpressures on the order of 0.5 to 2 psi, which would prevail within 1.3–2.2 km of the hypocenter of a 1-kiloton blast, will turn a window into a thousand particles of glass traveling in excess of 100 miles per hour.
- The winds rushing out from the center of the blast cause air to rush back in fanning the fires produced by the thermal radiation and the initial blast damage creating a firestorm.
- In a densely populated area, injuries include tens of thousands of burns, with many of them third degree. These occur on top of thousands of crush injuries due to collapsed buildings. Hospital beds, trained personnel, and medical supplies in the immediate area are unavailable.
- Many victims would suffer from ruptured organs (particularly lungs), penetrating trauma (due to the objects that were turned into missiles), fractured skulls, and compound fractures from people having been turned into missiles until they struck any hard object.
- A significant number of people would be deafened due to ruptured eardrums.
- Many people would be blinded. The initial flash of light at the start of a detonation bleaches retinal pigments causing flash blindness for up to 40 minutes. Viewing the fireball can cause more permanent damage, including retinal burns and scars in the visual field.
- Radiation exposure would result from the initial radiation flux of neutrons and gamma rays and from the fallout of the radioisotopes produced by the detonation. Radiation poses a particular problem for rescuers attempting to assess the severity of injuries since there is no way, especially in the initial period, to know whether a person has received a moderate exposure and might survive with adequate care or has received a large exposure and will die regardless of what treatment is offered.
- The combinations of the diverse injuries (burns, crush injuries, ruptured organs, fractures, extensive blood loss, and radiation exposure) would multiply the likelihood that injuries would be fatal.

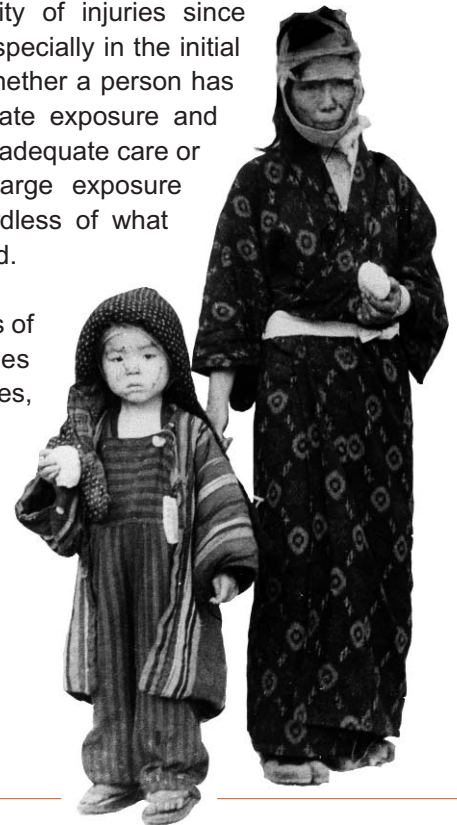
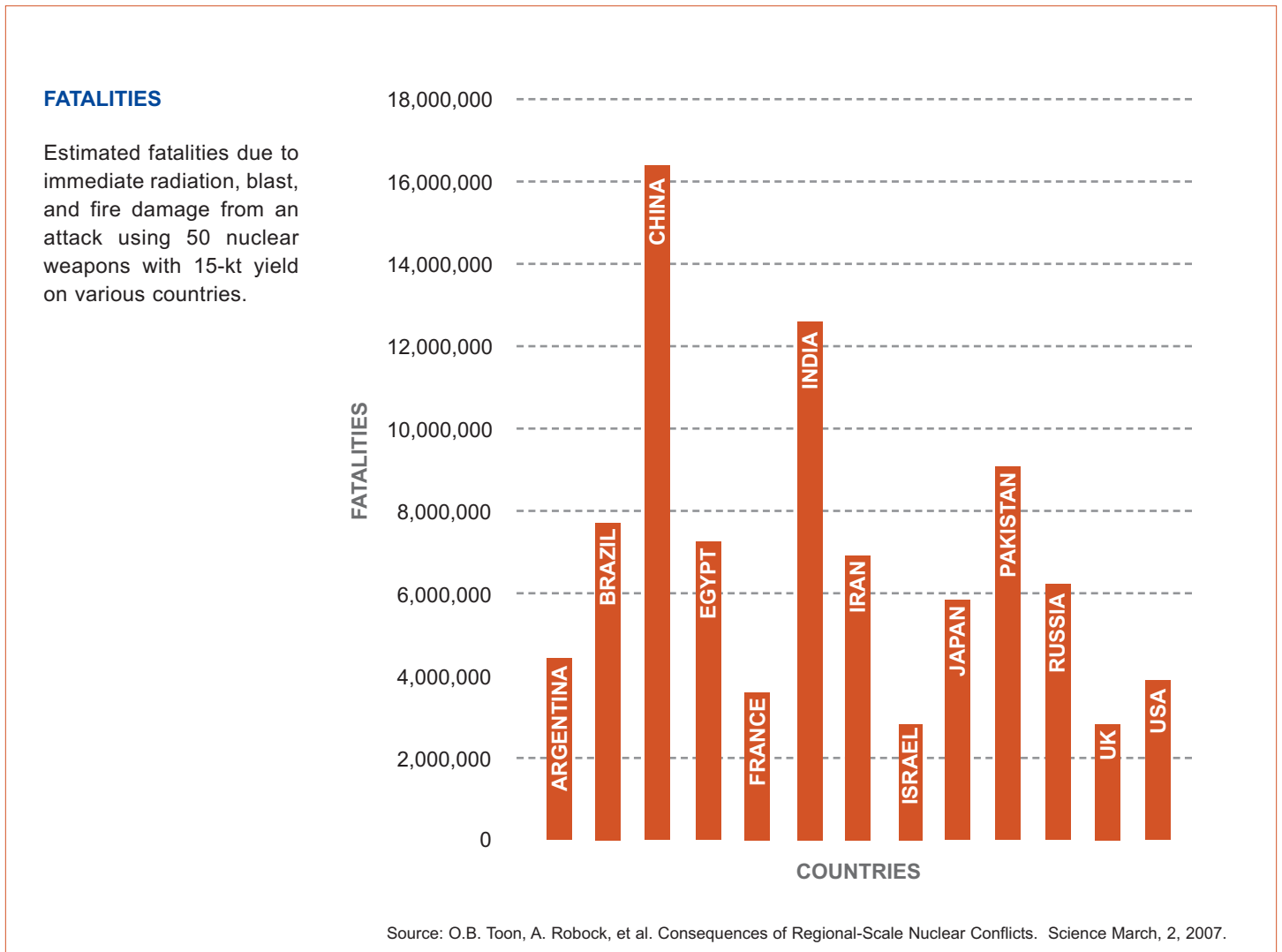




FIG. 3 PREDICTED FATALITIES



As global arsenals have changed in size and composition following the Cold War and in the early years of a new century, scientific and medical studies have kept pace. A 2002 study published in the British Medical Journal estimated the casualties from a 12.5- kiloton nuclear explosion at ground level near the port area of New York City. The model projected 262,000 people would be killed,

including 52,000 immediately and the remainder succumbing to radiation sickness. Caring for survivors would also be difficult, if not impossible, with the loss of 1,000 hospital beds in the blast and another 8,700 in areas of high radiation exposure.<sup>12</sup>

A related study published in 2002 showed that if only 300 of the weapons in

12 I. Helfand, L. Forrow, J. Tiwari. Nuclear terrorism. BMJ, 2002;324(7333):356-9.

the Russian arsenal attacked targets in American cities, 90 million people would die in the first half hour. A comparable US attack on Russia would produce similar devastation. Furthermore, these attacks would destroy the entire economic, communications, and transportation infrastructure on which the rest of the population depends for survival. In the ensuing months the vast majority of people who survived the initial attacks in both countries would die of disease, exposure, and starvation.<sup>13</sup> Such force levels are less than one third of the nuclear weapons each country will retain after the current round of START negotiations.

Nuclear weapons present hazards in virtually all areas of their life cycle. Production and testing have their own impacts. The US National Cancer Institute estimated that the release of iodine-131 in fallout from US nuclear test explosions was by itself responsible for 49,000 excess cases of thyroid cancer among American citizens.<sup>14</sup>

A 1991 IPPNW study estimated that the strontium-90, cesium-137, carbon-14, and plutonium-239 released worldwide

in all nuclear test explosions would be responsible for 430,000 cancer deaths by the year 2000.<sup>15</sup> Moreover, there are additional widespread health and environmental effects of nuclear weapons production as the result of massive contamination of land by radioactive materials and toxic chemicals.<sup>16</sup>

Epidemiological studies in the last decade have indicated serious health effects on individuals exposed as a result of nuclear weapons testing and manufacture. A reevaluation of the relationship between Nevada Test Site fallout and thyroid disease showed a greater than previously thought excess risk for thyroiditis at a rate of 4.9 per Gy of exposure.<sup>17</sup> In addition, mortality and morbidity of United Kingdom and New Zealand military personnel involved in nuclear tests in the 1950s and 1960s was found to be worse than those who were not involved. Radioactive material releases from the Mayak nuclear weapons facility in Russia contaminated the region surrounding the Techa River and led to an additional risk of leukemias (excluding chronic lymphoid) of 4.6 times the background risk per Gy of exposure.<sup>18</sup>

“Today, the world has a third and possibly final opportunity to end the threat of nuclear weapons definitively, before nuclear explosions again devastate cities, nations, or even the planet. The only real way this can be achieved is through a universal, verifiable, and enforceable treaty banning nuclear weapons from our world – a Nuclear Weapons Convention.”

— Lachlan Forrow, Victor Sidel, and Jonathan Slutzman. *Medicine and Nuclear War*. IPPNW. 2007.

13 I. Helfand, L. Forrow, M. McCally, RK. Musil. Projected US Casualties and Destruction of US Medical Services From Attacks by Russian Nuclear Forces. *Medicine & Global Survival*, 2002;7:68-76.

14 National Cancer Institute. Calculation of the estimated lifetime risk of radiation related thyroid cancer in the United States from the Nevada Test Site fallout. 1997.

15 International Physicians for the Prevention of Nuclear War. *Radioactive heaven and earth: the health and environmental effects of nuclear weapons testing in, on, and above the earth*. New York:Apex Press. 1991.

16 A. Makhijani, H. Hu, K. Yih, editors. *Nuclear wastelands: a global guide to nuclear weapons production and its health and environmental effects*. Cambridge, Mass: MIT Press. 1995.

17 J. L. Lyon, S. C. Alder, M. B. Stone, A. Scholl, J. C. Reading, R. Holubkov, et al. Thyroid disease associated with exposure to the Nevada nuclear weapons test site radiation: a reevaluation based on corrected dosimetry and examination data. *Epidemiology*, 2006;17(6):604–14. The Gray (Gy) is the SI unit of absorbed radiation dose. It is equal to one Joule per kilogram of target mass. For x- and g-rays, one Gy equals one Sievert (Sv).

18 E. Ostroumova, B. Gagniere, D. Laurier, N. Gudkova, L. Krestinina, P. Verger, et al. Risk analysis of leukaemia incidence among people living along the Techa River: a nested case control study. *J Radiol Prot*, 2006;26(1):17–32.

## Conclusion

For more than 45 years, physicians have documented and described the horrifying medical and humanitarian consequences of nuclear weapons explosions. We have informed political and military leaders that doctors, hospitals, and other medical infrastructure would be so completely overwhelmed in the event of a nuclear war that we would be unable to respond in any meaningful way to relieve the suffering of survivors or to restore health to a devastated world. We have warned that the unique nature of nuclear weapons — their unprecedented destructive power and the radiation they release, causing cancers, birth defects, and genetic disorders across generations

— removes any moral justification for their use as weapons of war and requires their abolition.

The findings described in this briefing paper have significant implications for nuclear weapons policy. They are powerful evidence in the case against the proliferation of nuclear weapons and against the modernization of arsenals in the existing nuclear weapon states. Even more important, they argue for a fundamental reassessment of the role of nuclear weapons in the world. If even a relatively small nuclear war, by Cold War standards, could trigger a global catastrophe, the only viable response is the complete abolition of nuclear weapons.



“The [World Medical Association] considers that it has a duty to work for the elimination of nuclear weapons.

Therefore the WMA:

\* condemns the development, testing, production, stockpiling, transfer, deployment, threat and use of nuclear weapons;

\* requests all governments to refrain from the development, testing, production, stockpiling, transfer, deployment, threat and use of nuclear weapons and to work in good faith towards the elimination of nuclear weapons; and

\* requests all National Medical Associations to join the WMA in supporting this Declaration and to urge their respective governments to work towards the elimination of nuclear weapons.

—The World Medical Assembly, Seoul, Korea, October 2008

“The existence of thousands of nuclear weapons is the most dangerous legacy of the Cold War....I state clearly and with conviction America's commitment to seek the peace and security of a world without nuclear weapons.”

—President Barack Obama, April 5, 2009





**International Physicians  
for the Prevention of Nuclear War**

(IPPNW) is a federation of national medical organizations in 62 countries, representing doctors, medical students, other health workers, and concerned citizens who share the common goal of creating a more peaceful and secure world freed from the threat of nuclear annihilation.



**The International Campaign to Abolish Nuclear Weapons (ICAN)** is a global grassroots movement for disarmament through a legally binding, verifiable and timebound Nuclear Weapons Convention.

More than 200 organizations in 60 countries are part of the campaign, and thousands of individuals have signed our petition for a nuclear-weapon-free world. We provide a voice to the overwhelming majority of people globally who support abolition.

# Zero is the Only Option: Four Medical and Environmental Cases for Eradicating Nuclear Weapons



**CASE STUDY #1**  
Nuclear Famine: How a Regional Nuclear War Will Cause Global Mass Starvation



**CASE STUDY #2**  
A Nuclear Ozone Hole: The Global Cancer Burden of a Regional Nuclear War



**CASE STUDY #3**  
Nuclear Winter: The Earth's Life-Sustaining Ecosystems Remain at Risk



**CASE STUDY #4**  
The Casualties of Nuclear War: Why Prevention is Still the Only Cure