THE WORLD AFTER NUCLEAR WAR
CONFERENCE ON THE LONG-TERM
WORLDWIDE BIOLOGICAL CONSEQUENCES
OF NUCLEAR WAR
OCTOBER 31-NOVEMBER 1, 1983

Summary of Conference Findings

CONFERENCE FINDINGS INDICATE STARTLING CHANGES IN EARTH'S CLIMATE AFTER NUCLEAR WAR COULD HAVE DEVASTATING IMPACT ON SURVIVORS

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INTRODUCTION

The world's nuclear arsenal today stands at over 12,000 megatons (MT), enough to destroy one million Hiroshimas. Recent studies estimate that anywhere from 300 million to 1 billion people would be killed outright in a large-scale nuclear war (5,000-10,000 MT yield) and an equal number would suffer serious injuries requiring immediate medical attention--which would be largely unavailable. But what of the longer-term effects of nuclear war? What kind of world would survivors face? New evidence suggests that the lingering atmospheric and biological consequences may be even more serious than the immediate ones.

These findings will be presented at the Conference on the Long-Term Worldwide Biological Consequences of Nuclear War being held in Washington, D.C. October 31 - November 1, 1983.

The findings are largely the result of studies done over the last two years by Richard P. Turco; Owen B. Toon, Thomas P. Ackerman and James B. Pollack, of NASA Ames Research Center; and Carl Sagan, of Cornell University, on the optical and climatic impacts of the dust and smoke particles which would be generated in nuclear war. Their work has been critically reviewed by some 100 eminent physicists, atmospheric scientists and biologists from the U.S. and other countries who participated in a series of meetings held earlier this year in Cambridge, Massachusetts.

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The atmospheric findings, which augment earlier studies and introduce previously unforeseen consequences of nuclear war, have been reported in a paper entitled "Global Atmospheric Consequences of Nuclear War" (referred to as the "TTAPS" paper, after the names of its authors). The authors conclude that a nuclear war, even at the level of 100-1,000 MT could cause profound climatic and meteorological disturbances, including darkness and extreme cold, and that exposure to radioactivity would be much greater than previously projected.

Some 40 biologists reviewed the atmospheric findings, determined the biological consequences and also considered other potential ecological effects not caused by atmospheric changes. Their conclusions are outlined in a separate paper entitled "The Long-Term Biological Consequences of Nuclear War."* Their unanimous view is that the atmospheric stresses resulting from nuclear war could so disrupt the earth's biological support systems that the extinction of a significant proportion of the earth's animals and plants would occur. They conclude that the possibility of human extinction cannot be excluded.

At the Conference, Dr. Sagan will present the atmospheric and climatic consequences and Dr. Paul R. Ehrlich of Stanford University will present the biological consequences. The Conference begins at 2 p.m., Monday, October 31, in the Cotillion Ballroom of the Sheraton Washington Hotel.

METHODOLOGY

To study the optical and climatic effects of dust and smoke clouds generated in a nuclear war, the physicists ran computer models of dozens of different nuclear war scenarios. They adopted as a baseline case a 5,000 MT exchange with 20% of the explosive power (yield) expended on urban or industrial targets in the Northern Hemisphere. Given current arsenals, this is a realistic possibility for a full-scale war. Other cases studied ranged in total yield from 100 to over 10,000 MT.

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* See Appendix 1 for names of the principal authors.

In each case, the scientists calculated:

1. How much dust and smoke was generated;
2. How much sunlight was absorbed by the dust and smoke;
3. How much the temperature changed;
4. How the dust and smoke spread, and how long before it all fell back to the surface;
5. The extent of radioactive fallout over time;
6. How much ultraviolet light reached the surface after the soot and dust fell out.

The following conclusions reflect aggregate data from the baseline scenario in the original TTAPS paper and from the paper on "The Long-Term Biological Consequences of Nuclear War." They have been substantially edited. Complete scientific and technical support data will be provided at the Conference.

CONCLUSIONS

1. Unbroken Pall of Darkness Would Cover Northern Hemisphere

Within a week after the war, the amount of sunlight at ground level could be reduced to just a few percent of normal; an unbroken gloom could persist for weeks over the Northern Hemisphere. The light would be absorbed primarily by sooty smoke from nuclear fires ignited by surface bursts and airbursts. The total amount of smoke released in the baseline model is 225 million tons (released over several days). Smoke particles are extremely small, which lengthens the time they remain in the atmosphere. The soil dust raised by surface bursts, while important, would have less climatic impact since it is typically poorly absorbing.

(0) Low light level would disrupt photosynthesis, food chains.

In the early months following a substantial nuclear exchange, the amount of light filtering through the cloud cover might not be adequate to sustain photosynthesis. Even assuming that plants would be otherwise undamaged, which is unrealistic, the lack of light would severely limit growth, and the consequences would cascade through all food chains.

2. Effects on Southern Hemisphere Greater Than Previously Assumed

Large disturbances in global circulation patterns could greatly accelerate the interhemispheric transport of smoke, dust and radioactivity. Rapid interhemispheric mixing means that the Southern Hemisphere could be subjected to massive injections of nuclear debris soon after an exchange in the Northern Hemisphere. Possible rapid transport of dust and smoke from the Northern to the Southern Hemisphere may involve the entire planet in after-effects. Previous studies have assumed that Southern Hemisphere effects would be minor.

3. Harsh "Nuclear Winter" Would Prevail

Contrary to the conclusions reached in most earlier studies, nuclear war probably would have a major impact on climate lasting for several years. It would be manifested by a dramatic drop in land temperatures to subfreezing levels for several months, large disturbances in global circulation patterns, and dramatic changes in local weather and precipitation. Even if the war were to occur in the summer, many areas might be subject to continuous snowfall for months.

- o Subfreezing temperatures would substantially reduce chances for human survival.

Except for areas near coastlines, land temperatures would plunge from -15° C (+5° F) to -25° C (-13° F), with dire consequences for survivors. The impact of dramatically reduced temperatures on plants would depend on the time of year at which they occurred, their duration, and the tolerance limits of the plants. The abrupt onset of cold is of particular importance, though, since plants that normally can withstand subfreezing temperatures would have no time to develop tolerance. A spring or summer war would kill or damage virtually all crops in the Northern Hemisphere.

Most uncultivated food sources also would be destroyed, as would most farm animals. Many animals that survived would die of thirst, as surface fresh water would be frozen over the interior of continents. Available food supplies would be rapidly depleted. Most of the human survivors would starve.

o Non-target areas that import food directly affected.

Nations that now require large imports of foods, including those untouched by nuclear detonations, would suffer the immediate cessation of incoming food supplies. These countries would be forced to rely on their local agricultural and natural ecosystems. This would be especially serious for many less-developed countries, particularly those in the tropics.

4. Exposure to Radioactive Fallout Worse than Expected

Exposure to radioactive fallout would be more widespread than is predicted by standard empirical exposure models because of the intermediate fallout which would extend over many days and weeks. With unprecedented quantities of fission debris released into the atmosphere, even areas remote from the explosion sites would be subject to large doses of fallout radiation.

o Radiation doses approach lethel dose for humans.

In the baseline case, roughly 30 percent of the land at Northern mid-latitudes (30° N to 60° N) would receive a radioactive dose greater than 250 rads over several months. About 50 percent of the Northern mid-latitudes would receive a long-term dose greater than 100 rads. (This dose includes radionuclides ingested from contaminated food.) These doses are roughly ten times larger than previous estimates. A 100 rad dose is the equivalent of approximately 1,000 medical x-rays. A 400 rad whole-body acute dose is usually considered lethal. Doses this large can affect the immune system and increase the probability of infectious disease, cancer and genetic and embryonic defects.

5. No Ice Age, but the Ocean Would Not Provide Relief

Because the climatic effects would not last longer than a few years, an Ice Age would probably not be generated. Subfreezing temperatures will freeze most freshwater systems to considerable depth, leaving survivors without surface water. The oceans will not freeze due to their enormous reservoir of heat. It has often been thought that the coastal areas would be a major source of food for survivors of a nuclear war. However, the combined effects of darkness, ultraviolet light, severe coastal storms due to enormous land-sea temperature differentials, run-off of silt and toxic chemicals from the land, destruction of

ships and concentrations of radionuclides in fish and other marine life cast strong doubt on this contention.

6. Fire Would be a Major Problem With Serious and Unanticipated Consequences

About one-sixth of the world's urbanized land area, or ≅240,000 km^2 would be partially burned by ≅1,000 MT of explosions in the baseline scenario. The remaining 4,000 MT of yield could ignite wildfires and firestorms. Uncontrolled fires could sweep over large areas. For example, multiple airbursts over California in the late summer or early fall could burn off much of the state, leading to catastrophic flooding and erosion during the next rainy season.

- o Urban fires would generate large amounts of deadly toxins.

  Cities hold large stores of combustible, synthetic materials that would release large quantities of toxic gases (pyrotoxins) as they burn, including carbon monoxide, cyanides, dioxins and furans. These pollutants might have only limited immediate effect on vegetation, but they would certainly hinder the recovery of vegetation devastated by nuclear blast and fire. Transport by winds to distant, initially unaffected ecosystems could be an important additional adverse side effect. This problem had not been addressed in previous studies.

7. Ozone Depletion Would Increase Exposure to Ultraviolet Light (UV-B)

High-yield explosions would inject nitrogen oxides (NO_X) into the stratosphere, which would result in large reductions in the ozone layer. The ozone layer, only 3 millimeters thick if it were brought down to sea level, shields the earth from UV-B, a damaging type of radiation. In the baseline case, dust and soot would absorb the increased UV-B at first. But when the dust and soot cleared a few months later, UV-B doses roughly 1.6 times normal would be transmitted to the surface.

Increased levels of UV-B can harm biological systems in several ways. The immune systems of humans and other mammals are known to be suppressed by relatively low doses of UV-B. Given the conditions of increased radioactive fallout and other stresses, such suppression of the immune systems leads to an

increase in the incidence of disease. Protracted exposure to increased UV-B also may lead to widespread blindness among humans and other mammals.

8. Tropical Forests Could Disappear

Tropical plants are less able to cope with even short periods of cold and dark than those in temperate zones. If darkness or cold, or both, were to become widespread in the tropics, the tropical forests, which are the major reservoir of organic diversity, could largely disappear. This would, in turn, lead to the extinction of a majority of the species of plants and animals on earth.

- o Dependence on imports threatens survivability in tropical and developing countries.

  The dependence of urban populations in many tropical and developing countries on imported food would lead to severe effects, even if those areas were not affected directly by the war. Large numbers of people would be forced to leave the cities and attempt to cultivate the remaining areas of forest, accelerating their destruction and the consequent rate of extinction. Regardless of the exact distribution of the immediate effects of the war, everyone on Earth would ultimately be profoundly affected.

9. Even Small Nuclear Exchanges Could Trigger Severe After-effects

Relatively large climatic effects can result from small nuclear exchanges (100 to 1,000 MT). A scenario involving 100 MT exploded in the air over cities could produce a two-month interval of subfreezing land temperatures, with a minimum near -23° C. In this scenario thousands of fires would be ignited and the smoke from these fires alone would generate a period of cold and dark almost as severe as in the baseline (5,000 MT) case.

IN SHORT:

In the aftermath of a 5,000 MT nuclear exchange, survivors would face extreme cold, water shortages, lack of food and fuel, heavy burdens of radiation and pollutants, diseases, and severe psychological stress -- all in twilight or darkness.

It is clear that the ecosystem effects alone resulting from a large-scale thermonuclear war would be enough to destroy civilization as we know it in at

least the Northern Hemisphere. These long-term effects, when combined with the direct casualties from the blast, suggest that eventually there might be no human survivors in the Northern Hemisphere. Human beings, other animals and plants in the Southern Hemisphere would also suffer profound consequences.

The scenario described here is by no means the most severe that could be imagined with present world nuclear arsenals and those contemplated for the near future.

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