Nuclear war: the spectators will starve

If nuclear war ever does break out, the non-combatant nations will suffer more than the superpowers. Even the slightest nuclear chill will destroy the world's agriculture

Marcus Chown

Smog as well as smoke will circle the Earth after nuclear war

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NUCLEAR WINTER is no fantasy. A major climatic change, plunging much of the globe into freezing darkness, could result from a major exchange of nuclear weapons between the superpowers. Confirmation comes from an exhaustive new study by the Scientific Committee on Problems of the Environment (SCOPE)*. The authors stress, however, that a nuclear winter is the most extreme climatic change they can envisage. They say that a much smaller change in climate, involving a drop in temperature of only a few degrees, could have a serious impact on the world's food supplies if it occurred at a critical period during the growing season.

The SCOPE study, coordinated by Sir Frederick Warner at Essex University, summarises two years of research by several hundred scientists from 30 nations. One volume of the study, covering the indirect human, biological and ecological consequences of nuclear war, was published last November. Its companion volume, on the direct atmospheric effects, is due on 6 January.

The direct effects of nuclear weapons—blast, the thermal pulse and prompt radiation—are well known, both from tests and from the two detonations on the Japanese mainland. Only in the past five years have the indirect effects received close attention. Several studies have identified the sequence of events that would follow a nuclear exchange of around 5000 megatons and precipitate a nuclear winter.

Put simply, the thermal pulse from a nuclear explosion ignites materials over a wide area, starting both city fires and forest fires. The fires inject copious amounts of smoke into the atmosphere. Some is removed quickly as black rain, but much of it stays suspended in the atmosphere, where it absorbs sunlight and prevents it reaching the Earth's surface. The temperature profile of the atmosphere is turned on its head, upsetting the entire pattern of global circulation. Typically, the surface temperature of the Earth drops by 20-30° C at mid-continental sites, in summer.

The SCOPE study confirms this. It finds that an exchange of 5000 megatons, half the world's arsenals, would result in a drastic reduction of light levels in the mid-latitudes of the northern hemisphere. The temperature would drop over continental areas within days. Rain patterns would change for months, or longer.

The study also finds that, even if only a few megatons of explosive were to rain down on a hundred major cities, 25 per cent of the combustibles of the developed world would go up in smoke. The result would be 80 million tonnes of smoke, of which 45 million tonnes would be pure carbon, the best absorber of sunlight of all.

Of greatest importance, the study finds, is the production of smoke from fires in oil and coal storage facilities, and from burning asphalt in cities. Fossil fuels and materials derived from fossil fuels, such as asphalt and plastics, produce relatively large quantities of black sooty smoke. Wood is less of a problem.

Countries in the southern hemisphere will not be insulated entirely from the effects of a nuclear war in the north. If smoke is injected into the atmosphere between April and September, the smoke-laden air will be warmed by the Sun, causing it to billow into the stratosphere. Once there, it is above the weather, and the normal patterns of circulation in the atmosphere will be incapable of bringing it back down to Earth. Instead, the smoke will spill across the equator. Within a few weeks a thin veil of smoke could extend to mid-latitudes in the southern hemisphere. But, it would be winter at these latitudes, so

temperature reductions will not be large, a few degrees at most.

Once in the stratosphere, smoke will not be rained out. It could remain there for a year or more, the SCOPE study finds, causing long-term cooling of the Earth by several degrees. The oceans which, because of their very large heat capacity are not easily cooled, would then cool significantly. The result would be a disruption of the world's rain systems. Most seriously, the summer monsoon over Asia and Africa could be greatly reduced.

The newest and most significant conclusions of the SCOPE study concern the biological and agricultural effects of nuclear war. "Human populations are highly vulnerable to disruptions in agricultural systems", the study observes. In turn, the world's major agricultural systems are highly sensitive to changes in climate. This means that the exact details of a nuclear exchange may not be as important as people have previously thought, because even a "minor" nuclear war could change the climate sufficiently to harm agriculture.

Crops can fail in a number of situations: if they receive insufficient light and heat during the growing season; if frost persists and so shortens the growing season; if low temperatures mean that crops take longer to mature; if there is insufficient rain; and if sudden spells of chill or freezing temperatures occur at crucial times during the growing season.

The SCOPE study finds that a drop of 3-5° C at the beginning of the growing season would destroy the North American and Soviet grain harvests. A more serious worry, though, according to Warner, is the vulnerability of rice. "The Japanese rice crop will fail," he says, "if, at any time during the growing season, the temperature dips below 15° C. A large number of people, in Southeast Asia, China, India and Africa are dependent on rice."

"The majority of the world's population is at risk from starvation in the aftermath of a nuclear war", the SCOPE study says. Those countries most at risk are the ones dependent on others for food and energy, and those whose food and energy stores are small relative to their population. Indirect effects on non-combatant nations, such as India, could be *greater* than the direct effects on the countries of NATO and the Warsaw Pact. The SCOPE message, therefore, for non-combatant countries is that they stand to lose most from superpower folly.

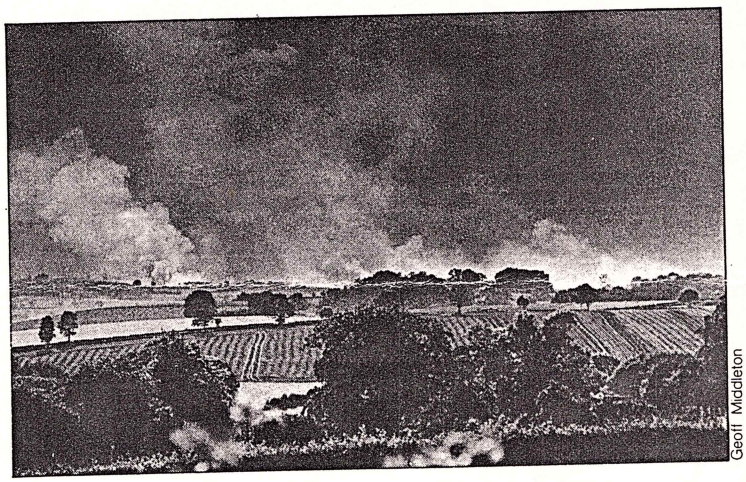
The SCOPE study has also considered the effect of pollutants in the atmosphere after a nuclear war. Nitrogen oxides are created by the high temperature of a nuclear fireball. If the yield of a weapon is greater than a few hundred kilotons, those oxides can be lofted high into the stratosphere. Once there they can catalyse chemical reactions which, bit by bit, dismantle the ozone layer. The SCOPE study finds that the ozone concentration could fall by 10 to 30 per cent within months and take several years to replenish itself.

Large quantities of toxic chemicals would pour into the lower atmosphere from the burning of wood and fossil fuel products. Of particular importance are chemical and petrochemical plants. Pollutants from them would include carbon monoxide, hydrocarbons, sulphur oxides, hydrochloric acid and asbestos.

The land below dense smoke clouds will cool rapidly. This will create a shallow and stable "inversion" layer that will trap the toxic emissions. The resulting smog and acid fog will be far thicker and far more lethal than the pall which shrouds Mexico City, for example.

The SCOPE study makes new estimates of both local fallout, downwind of an explosion, and longer-term global fallout. The new look was neccessary, Warner says, because the mix of weapons in the superpower arsenals has changed in the past decade.

Despite the change in weapons, the SCOPE forecast is that as much as 7 per cent of the land area of the United States, Soviet Union and Europe will be exposed to lethal doses of gamma rays from local fallout within 48 hours. Fallout is spread far and wide when large blasts spout radioactive material high into the stratosphere. The contaminated material takes many years to settle out. The study finds that global fallout after a major exchange would expose people in the northern hemisphere to a gamma ray dose, over a lifetime, of around 10 rads on average. According to Warner this is about 100 times the normal background level. Such exposure, he says, would slightly increase the number of cancers cases. "But what's ten million extra cancers?" he says, with irony.



Geoff Middleton

Fry, freeze or starve. There's no other choice

In tropical latitudes and in the southern hemisphere doses would be, at worst, one-twentieth of those in the mid-latitudes of the northern hemisphere.

But the SCOPE study points out a source of global fallout, previously overlooked by everyone, and which could make life significantly worse in the post-holocaust world. It arises from nuclear installations, but not from reactor cores themselves. "If you target a nuclear power installation", says Warner, "you're not likely to affect the reactor because it's heavily shielded." Even storage tanks for highly active waste are shrouded in thick concrete and should withstand a 100 kiloton airburst, he says. "But cooling ponds and reprocessing facilities—now, they're the real worry." According to Warner, if one-third of the world's nuclear power stations, accounting for a total of 100 gigawatts, were taken out, this would treble the long-term fallout expected after a major nuclear exchange. Warner fears the anti-nuclear lobby will jump on this finding. "It will look to them as if we've blurred the distinction between nuclear power and nuclear weapons", he says.

The computer models of the atmosphere used by SCOPE are much more sophisticated than models used in earlier studies. One of the previous studies, known by its acronym TTAPS, made do with a one-dimensional model. SCOPE modelled the rise of smoke plumes in three dimensions on Cray computers and obtained results which were qualitatively the same, although the models incorporated much more realistic physical processes.

In one respect three-dimensional models do not improve on their one-dimensional cousins. They start with a continent-wide smoke layer, as an initial condition. This hardly differs from the one-dimensional set-up in which one grid point represents the entire atmosphere at a fixed altitude.

The consensus now among meteorologists is that more sophisticated global climate models are not necessary. What is needed is a better idea of some of the inputs to the models. The remaining uncertainties are of two kinds. First, uncertainties resulting from human actions. No one can reliably predict the exact number of weapons that will be used, or their yields, the targets, the height of each detonation or the season of conflict. One consequence is that the exact quantity of smoke to be expected is in doubt. Uncertainties like these can be resolved by nothing short of a nuclear war.

The second kind of uncertainty results from an incomplete knowledge of the physical processes. In this category go optical properties of smoke particles, the height to which smoke will rise, characteristics of large fires, and mechanisms by which smoke particles are rained out.

The fact that uncertainties remain does not mean that SCOPE has foundered. On the contrary, if SCOPE has a central message it is that the uncertainties do not matter. In the words of Paul Crutzen of the Max-Planck Institut für Chemie, Mainz: "The high sensitivity of agricultural productivity to relatively small alterations in climate conditions indicates that the unresolved issues in the physical sciences may not be of great consequence." The fact is that the world's major agricultural systems are so fragile that they can withstand only a tiny drop in temperature before collapsing. □

* *The Environmental Consequences of Nuclear War*—the SCOPE ENUWAR study. Published by John Wiley, Chichester, England.