APOCALYPSE NOW: CREDIBILITY AND IMPLICATIONS

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Doomsday differs from mere disaster in several ways. In expectation of disaster, one can prepare to mitigate the consequences. If the Apocalypse is at hand, one can only repent. Instead of inspiring a study of history and science, apocalyptic prophecies have a tendency to lead to magical thinking. Some groups, such as Creative Initiative, propose that by collective efforts to change our mode of thinking we could advance beyond warfare. Dr. Edsall [1] is more realistic. He calls for strengthening our conventional armaments, despite the position of Physicians for Social Responsibility that military expenditures should be reduced and the fact that conventional weapons are more costly than nuclear ones [2]. Furthermore, he is willing to acknowledge and to accept the implications of his belief that nuclear weapons are qualitatively different.

Is the "nuclear winter" (TTAPS) report [3] the ultimate refutation of those who claim that nuclear weapons are only quantitatively worse than previous types? Consider the volcanic eruption cited by Dr. Edsall for comparison. Mount Tambora released about 20,200 megatons of energy [4] and ejected about 100 km^3 (2×10^{11} tons) of debris [5]. Worldwide temperatures dropped about 1° for approximately 1 year. The baseline 5,000-megaton case of the TTAPS report was assumed to result in about 1.2×10^9 tons of smoke and dust. Yet the temperature drops calculated for the nuclear winter resemble those thought to have occurred after a 10-km asteroid collided with the earth, possibly causing the massive extinctions at the end of the Cretaceous period [6—compare fig. 2 with fig. 1 of the TTAPS report]. The debris resulting from that impact should have been at least equal to the volume of the asteroid, about 523

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km^3. Assuming a minimum velocity at impact of 11.2 km/sec (escape velocity), at least 2×10^7 megatons of kinetic energy would have been transferred.

Obviously, the total amount of debris and the megatonnage are less important than the distribution of particle size and the consequences of the energy delivery. The results of the TTAPS report are critically dependent on assumptions about targeting strategy, because the most severe effects result from firestorms. The 100-megaton "threshold" involves the detonation of 1,000 warheads of 0.1 megatons each over central urban areas. The report is vague about which cities are chosen but cites a scenario from AMBIO which includes cities throughout the world, even in China, Japan, and India [7]. Whether firestorms would produce a high enough temperature to raise smoke to stratospheric altitudes, and whether modern cities even have a high enough density of combustible materials to permit firestorms [8], are matters for speculation. Additionally, the TTAPS model assumes, without comment, that 50 percent of the urban area in the 2–5-lb psi overpressure zone would burn, in contrast to the 10 percent or less estimated by the Office of Technology Assessment [8].

Many other questionable assumptions underlie the nuclear winter report [9]. The one-dimensional radiative convective model for estimating temperatures neglects horizontal transport of energy, which is most important for predicting climate. Thus, the model cannot adequately account for the thermal inertia of the oceans. Even the general circulation model, which is usually applied, is not very accurate [10, 11] and depends on retrospective manipulation of constants. Since the behavior of the atmosphere is described by nonlinear systems, extrapolating from normal to markedly perturbed behavior is extremely problematic. An acknowledgment of some of these difficulties is relegated to footnote 19 in [3].

The nuclear winter is a hypothesis based on a number of worst-case assumptions. None of its authors is expert in dynamic climatology. The conclusions disagree with those presented by the National Academy of Science in 1975. Though we often hear about an independent Soviet review, Dr. Edsall does not cite any papers. I am aware of only one, based on an American computer model, produced by V. V. Alexandrov, a mathematician who heads a group of computer scientists which includes not a single climatologist [12]. The report was widely publicized in the lay press and by television networks before it even appeared in *Science* (evidently, the American Association for the Advancement of Sciences does not observe the "Ingelfinger Rule.") Nevertheless, the TTAPS report is repeatedly invoked in a manner that is astonishingly uncritical.

Whether or not the nuclear winter is credible, the conclusions drawn

by its major promoter, Carl Sagan, are non sequiturs. Sagan calls for rejecting civil defense [13] and appears on public television to denounce the concept of weapons that might disarm nuclear warheads before they could start a firestorm. In actuality, unlike self-fulfilling prophecies of inevitable breakdowns in transportation and communication, the nuclear winter might be self-belying. Its possibility might be an additional reason for strategists to avoid strikes on population centers [9].

Dr. Edsall's confidence in groups such as International Physicians for the Prevention of Nuclear War seems naive to me, since his evaluation of Soviet attitudes does not take into account the existence of the KGB "active measures" and disinformation bureaus [14]. The most widely heralded Soviet statements about civil defense are contradicted by materials intended for internal distribution [15, 16]. Certainly it is puzzling that the Soviet Union should employ 150,000 people and spend over $3 billion per year, despite a weak economy, in an enterprise they really believed to be a sham [17].

Dr. Edsall forthrightly states that he would prefer surrender to any risk of nuclear war. Whether Lech Walesa would agree is conjectural; inmates of the Omsk transit prison actually hoped for a nuclear attack on their own country [18]. In his statement that Soviet hegemony would not be the "end of the world," Dr. Edsall lucidly identifies the key implication of his belief that nuclear war would be doomsday rather than a devastating but finite catastrophe.

To cause omnicide or *Götterdämmerung* is not yet within the power of humankind. Such predictions induce paralysis and cause us, like millenarians, to neglect actions which *are* possible. We could prevent millions of deaths if nuclear war should occur despite our efforts to keep the peace. Were we to reject the self-destructive path chosen for us by leaders such as Robert McNamara and to use not only our imagination but testable technology, we might be able to banish most of our intercontinental ballistic missiles to the museum [19].

Appendix

A. Amount of Debris from Mount Tambora Eruption:

Density of material erupted by the volcano is assumed to be 2.5 g/cm^3 (the mean surface density of earth's continents is 2.67 g/cm^3).
A volume of pumice and ash of 100 km^3 should produce about

$$\frac{(100\ \text{km}^3)\,(2.5\ \text{g/cm}^3)\,(10^{15}\ \text{cm}^3/\text{km}^3)\,(2.2\ \text{lb/kg})}{(1000\ \text{g/kg})\,(2{,}000\ \text{lb/ton})} = 2.75 \times 10^{11}\ \text{tons of debris.}$$

B. Estimate for Kinetic Energy of 10-km Asteroid Colliding with Earth:

Escape velocity: 11.2 km/sec. A higher velocity is likely; a lower could occur because of the braking effect of the atmosphere in the event of a grazing collision.

1 kiloton is the equivalent of 4.2×10^{19} ergs.

Assuming the asteroid to be a sphere, its volume is $4/3\ \pi\ r^3 = 523\ km^3$.

Its density is assumed to be like the earth's continents, though it is probably higher; the density of common chondrites is 3.7 g/cm^3.

Kinetic energy = $\frac{1}{2}\ mV^2 = (0.5)\ (2.67\ g/cm^3)\ (523\ km^3)\ (10^{15}\ cm^3/km^3)\ (125\ km^2/sec^2) = 8.76 \times 10^{19}\ g\text{-}km^2/sec^2 = 8.76 \times 10^{29}\ g\text{-}cm^2/sec^2 = 8.76 \times 10^{29}$ ergs.

$$\frac{8.76 \times 10^{29}\ \text{ergs}}{4.2 \times 10^{19}\ \text{ergs/KT}} = 2 \times 10^{10}\ \text{KT} = 2 \times 10^{7}\ \text{MT}.$$

REFERENCES

1. Edsall, J. T. Nuclear war and human responsibility. *Perspect. Biol. Med.*, this issue.
2. Harvard Nuclear Study Group. *Living with Nuclear Weapons*. Cambridge, Mass.: Harvard Univ. Press, 1983.
3. Turco, R. P.; Toon, O. B.; Ackerman, T. P.; et al. Nuclear winter: global consequences of multiple nuclear explosions. *Science* 222:1283–1292, 1983.
4. Macdonald, G. A. *Volcanoes*. Englewood Cliffs, N.J.: Prentice-Hall, 1972.
5. Stommel, H., and Stommel, E. The year without a summer. *Sci. Am.* 240:176–186, June 1979.
6. Pollack, J. B.; Toon, O. B.; Ackerman, T. P.; and McKay, C. P. Environmental effects of an impact-generated dust cloud: implications for the Cretaceous-Tertiary extinctions. *Science* 219:287–289, 1983.
7. AMBIO Advisers. Reference scenario; how a nuclear war might be fought. *AMBIO* 11:94–101, 1982.
8. Office of Technology Assessment. *The Effects of Nuclear War* (OTA-NS-89). Washington: U.S. Government Printing Office, 1979.
9. Maccabee, H. Nuclear winter—a snow job? *Reason* (in press).
10. Kerr, R. A. A chance to predict next month's weather? *Science* 220:590–591, 1983.
11. Kerr, R. A. The race to predict next week's weather. *Science* 220:39–41, 1983.
12. Goure, L. Soviet scientists as shills for a freeze. *Washington Times*, December 19, 1983.
13. Sagan, C. The chilling aftermath of a nuclear war. *Wall Street J.*, February 16, 1984.
14. Suvorov, V. *Inside the Soviet Army*. New York: Macmillan, 1982.
15. Yegorov, P. T.; Shlyakhov, I. A.; and Alabin, N. I. *Civil defense A Soviet View*, translated under the auspices of the United States Air Force. Washington: U.S. Government Printing Office, 1970.

16. Advanced International Studies Institute. Civil defense doublespeak continues in U.S.S.R. *Press Reports on Soviet Affairs*, March 5, 1984.
17. U.S. Department of Defense. *Soviet Military Power*. Washington: U.S. Government Printing Office, 1983.
18. Solzhenitsyn, A. I. *The Gulag Archipelago Three*, translated by H. Willetts. New York: Harper & Row, 1976.
19. Jastrow, R. Reagan vs. the scientists: why the president is right about missile defense. *Commentary* 77(1):23–32, 1984.

GENESIS: WHAT MAKES US WHAT WE ARE?

What makes us what we are,
You and Me?
Shall we believe in
Fate or Destiny?
Or, is it the house wherein
We are raised
That leads us to be
Condemned or praised?
And let us not forget
The proteins and the genes,
Which may enter into
Good as well as vicious schemes.
What a complicated quiz this is—
What makes us what we are,
You and Me?

Donald J. Reinhardt