TARGETING FOR NUCLEAR WINTER: A SPECULATIVE ESSAY

by

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Since its first public appearance in the December 1983 issue of *Science*, the "nuclear winter" hypothesis has received a great deal of attention from both the academic community and the public.[1] To the scientific community, the research findings of Turco et al. have been a subject for professional scrutiny and debate.[2] For many members of the general public, they have produced one more reason why nuclear war, in the words of one President, "can never be won and must never be fought."

We suggest that, if the findings about nuclear winter are assumed to be true, they might contribute to the plausibility of nuclear warfighting, rather than to its apparent implausibility. This apparently counter-intuitive argument rests on two basic premises, one technological and the other strategic. The technological premise is that near-future US and Soviet strategic weapon systems may make possible counterforce exchanges with collateral damage well below the nuclear winter threshold. The strategic premise is that the possibility of nuclear winter may improve the case for active and passive defenses instead of rendering them futile.

There is no assumption in the arguments below that nuclear war once begun could be easily controlled. Nevertheless, nuclear winter might suggest to both the United States and the Soviet Union that intra-war deterrence could operate with more effectiveness than previously supposed. If true, such a supposition would be a significant change in Soviet doctrine, which has previously expressed skepticism about controlled nuclear warfighting. More congruity between US declaratory policy and operational or employment policy also would result if nuclear winter were assumed to direct more attention to controlling escalation and terminating war after it began. Thus, technology "push" and doctrinal "pull" on both sides might include nuclear winter assumptions in an architecture more sympathetic to strategic defense and to less-than-apocalyptic warfighting scenarios.

The main result of the Turco study was that the most severe forms of nuclear winter are caused by attacks on cities. For example, in their 5000-megaton "baseline" case, the study's authors assigned between 750 and 1500 megatons to cities.[3] This theoretically would produce a "winter," lowering land temperatures in their model to below the freezing point of water for roughly 100 days and reducing solar energy flux to below the compensation point for photosynthesis for about 15 days.[4] The major reason for this drop in temperature and sunlight is the large amount of smoke assumed to be produced by large-scale fires accompanying nuclear detonations in cities and over forests. In one scenario, 1000 100-kiloton weapons are used to completely burn 100 major cities. In the model, this produces a "winter" almost as severe as that produced by the 5000-megaton baseline exchange.

On the other hand, the Turco study's 3000-megaton counterforce scenario produces a drop in ambient temperature of only about 5° centigrade and a reduction in solar energy flux at ground level "comparable to . . . a major volcanic eruption."[5] The reason for this is that these attacks are assumed to spare major cities, so that little smoke is produced. The effects of this postulated war are produced almost solely by dust, which scatters sunlight but does not absorb it the way smoke does. It should be noted, however, that even this effect could produce quite severe results. As Edward Teller notes, "A decrease of 5° or 6° C between northern latitudes 30° to 70° during summer . . . could still lead to widespread failure of harvests and famine."[6]

Nonetheless, there are several aspects of this finding which are quite remarkable. First, the Turco study's counterforce scenario assumed individual warhead yields of between one and ten megatons. Even now, most weapons that would be detonated in a counterforce war would be substantially lower in yield than one megaton, and yields should become even smaller as warhead accuracy increases.[7] In addition, the Turco study assumed that nuclear weapons were much more efficient producers of fine dust than are volcanoes, an assumption which the study's authors admit is questionable.[8] Third, a later study produced by Covey et al., which took into account the effects of heat transport from ocean to land, generally halved the predicted temperature drop. This means that even given their generous assumptions regarding warhead yields and dust production, the real effect of the counterforce scenario may be a temperature drop of only about 2.5° centigrade. All in all, as Teller puts it, "The most probable conclusion is that the atmospheric effects from war-generated dust would be noticeable but by no means severe."[9]

The major lesson of the Turco and Covey studies thus seems to be that counterforce wars with city avoidance will result in non-suicidal climatic effects, but that large-scale, counter-city attacks will probably produce fairly severe effects. The question is, what are the strategic implications of these results, and is there a way to cope with those effects through manipulating the yields and accuracies of nuclear warheads and the timing of attacks?

ACCURACY, YIELD, AND TARGET DESTRUCTION

Although, as noted above, counterforce attacks do not appear to produce climatic results as severe as larger attacks, it is still important to discuss the extent to which the results that would be produced can be minimized. The way to do this is, of course, to reduce the amount of dust produced in such attacks, especially since they are likely to

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be accompanied or followed by attacks on targets within cities, assuming this is possible. The way to do this, in turn, would appear to be to reduce further the yields of the weapons employed and, concomitantly, the total megatonnage expended in the attack.

Currently, US ICBMs useful for counterforce missions are loaded with Mk-12A reentry vehicles that yield .335 megatons and can be delivered with a CEP of roughly .10 nautical miles.[10] Using the appropriate formulae, this produces a single-shot kill probability (SSKP) of roughly .50 on Soviet missile silos hardened to withstand 5000 psi of overpressure.[11] Of course, as CEP declines with increases in technology, identical or larger SSKPs will be obtainable with smaller yields. But what is a reasonable prospect for accuracy over the near future? William Perry stated in 1982, "In the course of the next decade, improvements will be made . . . that will reduce delivery error to about one half of what it is now."[12] That would mean a reduction in CEP to about .05 nm. Indeed, utilizing a precision-guided warhead, the Pershing II has already achieved a CEP of 90 feet or .015 nm.[13] Further, Robert Aldridge has asserted that by mating high-quality inertial guidance to NAVSTAR and precision-guided warheads, a CEP of 30 feet or .005 nm is not unthinkable.[14]

Assuming that a CEP of .015 nm is reasonable to expect for ICBMs in the moderate term, and assuming that an SSKP of .50 is required against a 5000 psi target, we may solve the formulae for yield. This produces a required yield of only .0012 megatons (1.2 kilotons). If two warheads were assigned to each Soviet silo, this would imply the grand expenditure of 3.36 megatons. If, in addition, 100 airbases and five naval facilities were also targeted with two warheads of this yield, the total expenditure would be 3.612 megatons. If, in addition, the Soviets launched the same type of attack against us, the total would approximately double, to 7.224 megatons. Even if each side threw in several ten-megaton warheads, the total yield would still be less than three percent of the 3000 megatons assumed in the Turco study's counterforce scenario. Given the minimal effects of that scenario, it would be hard to imagine the type of war outlined above having even a noticeable effect on a hemispheric or global scale.

As noted above, the main danger of nuclear winter stems from attacks on cities which are assumed to produce large-scale fires. It is the smoke from these fires that would create the blockage of sunlight which, in turn, would produce freezing temperatures and sufficient darkness to endanger plantlife. These findings, of course, have not gone unchallenged. Many scientists believe that the ability of the atmosphere to cleanse itself of smoke particles is far greater than that assumed in the Turco and Covey studies.[15] However, while this matter may remain one of speculation for the scientists, it poses an all-too-real possibility of disaster for nuclear targeters should they desire to destroy many targets which are in cities, even if they would rather not destroy the cities themselves.

Fortunately, direct attacks on cities seem to hold a low priority for both US and Soviet planners. Despite the recent claim by Thomas Powers that "if you take the cities out of the war-plan, there's no plan left,"[16] an analysis of the most recent US war plan, SIOP-5, by Desmond Ball indicates that first priority is given to the destruction of Soviet nuclear forces, while economic and industrial targets, the kind most often found in or near cities, are last on the list.[17] In addition, Ball notes that population centers are among the publicly identified categories of targets which can be withheld from initial attack. Thus, while there may be important targets to be destroyed within cities, there appears to be no intention to actually destroy them, at least not in the initial stages of a war. With regard to the Soviets, Benjamin Lambeth and Kevin Lewis have noted that so-called "counter-economic" targeting appears to hold an even lower priority for them than it does for us.[18]

Thus, it would appear to be possible to wage a nuclear war for some time, and perhaps even end it, before a decision had to be made with regard to whether to begin attacking targets located in cities. Nevertheless, such a decision might have to be made, or might be forced by enemy action.

The question of whether targets within cities could be struck without creating global catastrophe would then become a very important one.

One solution to this problem is, again, to use weapons of very low yield delivered with precision accuracy. For example, a one-kiloton weapon burst at optimal height would produce 5 psi at a range of .4 miles.[19] This should be enough to destroy virtually any economic or soft military target of interest without doing much, if any, collateral damage. (Hardened targets within cities also could be destroyed with weapons of only a few kilotons if their locations could be identified accurately enough.) Furthermore, it would be quite possible, using such weapons, to destroy a large number of individual targets within a city while subjecting the city as a whole to an equivalent bomb tonnage no greater than many cities suffered during World War II. For example, the most heavily bombed German cities received 50 kilotons.[20] It is hard to imagine a city of almost any size (except, perhaps, Moscow and Washington) which contains more than 50 militarily relevant targets, and easy to imagine cities which contain far fewer.

Of course, there would be some significant differences between delivering 50 one-kiloton bombs and an equivalent tonnage of World War II style weapons. First of all, the tonnage dropped during World War II was delivered, in some cases, over the course of a year and a half. Fifty one-kiloton bombs could be delivered in a single day. From a climatic standpoint, this may or may not make a difference, depending on the characteristics of the weapons and the ability of the city's services to deal with the damage. Additionally, there are thermal effects associated with nuclear weapons which do not occur when employing conventional explosives (unless incendiaries are used; remember Hamburg). However, these effects are not nearly as severe for small weapons as they are for the much larger ones currently in inventory. For example, a one-kiloton weapon will produce second degree burns at a range of .4 miles, the same range over which it produces 5 psi overpressures. A 50-kiloton weapon, however, produces such burns at a range of roughly 2.5 miles, even though it produces 5 psi blast damage over a range of only about 1.4 miles. Thus, it would seem that the danger of large-scale fires starting inadvertently due to the use of very low-yield weapons would appear to be rather small. This would be even more the case if attacks on cities containing a large number of military targets were drawn out over several days or a week. Spreading attacks out in time would also help to ameliorate the effects of larger-yield weapons. For example, burning one city per week for 100 weeks probably would not produce the same effects as burning 100 cities in an afternoon. Another difference between conventional and nuclear weapons involves the nuclear effects of the latter. With regard to climatic damage, however, these effects have already been shown to be less than catastrophic.[21]

There is also one other difference between the nuclear tonnage delivered against targets in cities and their conventional counterparts of World War II which must be noted. This is the fact that the tonnage of World War II was delivered in a highly inaccurate manner and, even when directed against some specific military or economic target, often did a great deal of collateral damage. Nuclear tonnage could be delivered with great accuracy, thus insuring total destruction of the target with, possibly, even less collateral blast damage than was suffered in World War II. This would especially be the case for attacks on target complexes of a size as large as the diameter over which the weapon produced 5 psi. For small but critical targets whose locations were well known, there is no reason why even smaller weapons (of perhaps .5 kilotons) could not be used.

IMPLICATIONS

Given the above discussion, a number of important conclusions can be drawn about the relationship between nuclear strategy and the possibility of climatic disaster. First, it would appear that all sides in the debate agree that the climatic damage due to a counterforce war of attrition would be well below the threshold of self-destruction. Furthermore, movement by both the Soviet Union and the United States to significantly lower-yield warheads than those assumed in the Turco study would appear to make this even more the case. The implication of these developments is that, if deterrence fails, this type of war might be the only kind which could be fought without global risk. Interestingly enough, this is precisely the kind of war which the Soviets appear to prefer to wage.[22]

These developments would also seem to place another, perhaps insuperable, "firebreak" in the path of any nuclear escalation process. The reason for this is that, as things stood, the only thing preventing direct attacks on cities was fear of retaliation. Yet, because of the location in or near cities of important military targets, this "city threshold" could well be breached, and if it is, neither side might feel any qualm about employing weapons yielding hundreds of kilotons to attack as many such military targets as possible as rapidly as possible, thus producing massive collateral damage. However, if both sides were to accept nuclear winter as a reality (or, perhaps, even as a high probability), each side would also accept the suicidal nature of such massive attacks. This acceptance would result either in the avoidance of cities altogether; stretching attacks on cities out in time (thus producing a protracted nuclear war); or the use of very low-yield weapons against targets within cities, accompanied by the maintenance of "intra-city" thresholds—a distinction, within cities, between military and civilian targets. Such a distinction might well hold up better now than it did in World War II due to the use of precision-guided reentry vehicles coupled with advanced inertial guidance.

Should such a change in strategy take place, it would make even less plausible the notion, expressed by some, that Mutual Assured Destruction is itself not a strategy but rather a fact of life. Those strategists who remained MAD adherents would then have to choose self-consciously between a lower probability of war and reduced damage if deterrence failed. That choice has not been posed so clearly in the past, because the line between counterforce attacks and counter-city catastrophe was more indistinct. Thus, the possibility of climatic damage from some types of attacks directed against targets located in cities does not mean that all such attacks would necessarily produce these effects. In particular, it may well be possible to attack targets located in cities if small enough yields are employed or the attacks are sufficiently separated in time. In this regard, nuclear winter may turn out to be similar to the possibility of ozone depletion in that technology gave it to us through large-yield weapons but then took it away by allowing yields to come down dramatically in response to increases in accuracy.[23] As accuracy continues to increase, yields should become small enough to be manageable even within cities. Indeed, Robert Jastrow has gone so far as to argue that accuracies will become so great in the future that nuclear munitions might be dispensed with entirely.[24] Although this may not be possible due to the cost of the ICBM necessary to carry such large payloads, nuclear yields ranging from less than one to a few kilotons, as opposed to the hundreds of kilotons of the weapons now in use, are not unthinkable.

Of course, the changeover from the weapons now in use to the kind advocated here as a solution to the climatic damage problem would require a major modernization and improvement program for both sides' nuclear forces, which would be prohibited by a nuclear freeze agreement. This constitutes one more reason why the freeze may not be a good idea.[25] However, Carl Sagan, in his article on the policy implications of nuclear winter, indicates that this transition to low-yield arsenals could be fraught with dangers. This would be especially true, he argues, while the transition was underway, during the period in which "enough newer weapons are deployed to be destabilizing [in the sense that each side could take out a large portion of the other side's forces without producing severe climatic effects] and enough older weapons are still in place to trigger the nuclear winter."[26] Unfortunately, Sagan overlooks two important points here. First, if both sides accept the reality of nuclear winter, they will each have tremendous incentives to change their inventories. They will also, however, each understand the dangers inherent in the possibility that their opponent will modernize more quickly. It appears to us that these are precisely the kinds of circumstances that make negotiations possible. An arms control agreement covering this transitional phase could be very useful to each side. It could govern the rate of transition of the two forces and could include measures which would allow each side to retain confidence in the survivability of its forces while the transition was underway. These measures could include point defenses of missile silos, ABM-capable SAMs, or other mutually agreeable measures.

Second, if the foregoing analysis of this article is even close to correct, it appears as though nuclear winter does not really rule out the use of large weapons, even against cities. It just rules out the destruction of a large number of cities within a short space of time. Furthermore, as has already been noted, even the use of weapons yielding hundreds of kilotons against counterforce targets does not appear to produce very severe effects. Thus, it is not at all clear just how dangerous the transition period would really be even if it were ungoverned by an agreement.

Yet a third interesting implication of the above discussion is that, if both sides limit themselves to counterforce wars or counterforce plus attacks on targets located in cities with very low-yield weapons, both ballistic missile defense and civil defense begin to make much more sense than they did in previous technology and strategy environments. In the first case, BMD would serve to increase the price paid by an attacker to take out one's missile forces[27] as well as deal with the few weapons which, for technical reasons, accidentally stray off-target. Furthermore, civil defense would need to protect city dwellers primarily from fallout from attacks on missile fields, which is not nearly as difficult a proposition as protecting them from attacks designed to kill them and make life for the survivors as miserable as possible. In the second case, BMD would also be assigned the task of increasing the price paid by an attacker for each city-located target he wished to destroy. With very low-yield warheads, it would no longer be the case that, "if only one gets through, the city is destroyed." Instead, it would be the case that if one got through, one target within the city would be destroyed. Furthermore, given reciprocal targeting restraint by both opponents, urban blast shelters would make real sense as well as being far cheaper to construct than those designed to protect against high-yield weapons.[28]

Of course, the enhanced plausibility of active and passive defense assumes that the superpowers will not respond to one another's deployed defenses by making their offensive attacks less surgical. If, for example, a limited US BMD deployment were followed by Soviet offensive force modernization emphasizing larger warheads along with greater accuracies, then defense might not contribute to reduced collateral damage. The USSR appears set on modernizing its forces regardless of US deployments, and it is not clear that its choices will be heavily influenced by scientific findings about nuclear winter. However, to the extent that the USSR takes such findings into account in its planning, it might inhibit their willingness to deploy defenses so effective that the United States, to defeat them, must employ a more robust arsenal. If these speculations have any validity in the near-term strategic and technological environment, then modest active and passive defenses would contribute to stable deterrence under the assumed plausibility of nuclear winter. Robust defenses, however, would be self-defeating.

In sum, it is not unreasonable to believe that if nuclear winter effects are assumed real and significant in their political implications, they will simply push the United States and Soviet Union in the direction of increased accuracy and lower-yield weapons even faster than they are already moving that way. The end result of this may well be to make nuclear war appear much more wageable and controllable than it now appears to be, and deceptively similar to past wars. Policymakers might then come to believe that the declaratory policies embodied in NSDM-242, PD-59, and NSDD-13 (enunciated during the Nixon-Ford, Carter, and Reagan Administrations, respectively), were now less inconsistent with employment policies for the actual use of nuclear weapons under wartime conditions. This perceived congruity could be correct, but excessive optimism would be unwarranted given uncertainties about the Soviet interest in flexible targeting and escalation control during strategic war. Scientifically objective facts as perceived in the West differ from the scientific laws which move history according to Marx, and the Marxist denouement to history is foreordained with or without nuclear winter. Thus, Soviet understandings of science and strategy may assimilate nuclear winter into a different conceptual framework, with unpredictable results.

Of special interest here is the attitude of Soviet leaders toward risk and uncertainty. The reason for this is that the reality of nuclear winter will no doubt never be fully proven.[29] As a result, national leaders and their advisors will have to weigh the evidence and determine for themselves (and their nations) just what the risks really are. This is where differences between US and Soviet philosophies and forms of government become very important. One consequence of this difference may be seen in the Soviet insistence on maintaining at least some warheads of quite high yield (20 megatons) despite the findings on ozone depletion. Soviet leaders have obviously calculated that in the event of war, the risks inherent in being unable to insure the destruction of the kinds of targets such weapons would probably be aimed at (places like Cheyenne Mountain, etc.) are greater than the climatic risks inherent in detonating a small number of such large weapons. Thus, caution rather than exuberance is called for in US operational policy, and the possibility of nuclear winter only reinforces that conclusion.[30]

NOTES

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1. R. P. Turco et al., "Nuclear Winter: Global Consequences of Multiple Nuclear Explosions," *Science*, 23 December 1983, pp. 1283-92.
2. See, for example, the subsequent work of Covey et al., "Global Atmospheric Effects of Massive Smoke Injections from a Nuclear War: Results from General Circulation Model Simulations," *Nature*, 1 March 1984; and the commentaries on nuclear winter research by Edward Teller and S. Fred Singer as well as the reply by Thompson, Schneider, and Covey in *Nature*, 23 August 1984.
3. Turco et al., p. 1284, assume that between 15 and 30 percent of total yield in a general attack is assigned to urban targets.
4. These results, and the others referred to in this passage, may be seen in the graphs presented by Turco et al. on pp. 1286-87.
5. Turco et al., p. 1285.
6. Teller, p. 624.
7. The only US missile currently capable of attacking Soviet silos with any real degree of success is the Minuteman III loaded with Mk-12A reentry vehicles. The explosive yield of these warheads is .335 megatons. The main Soviet force for attacking hardened targets in the US consists of SS-18 and SS-19 missiles. The latest model of the SS-18 is loaded with warheads yielding .50 megatons, while the latest model of the SS-19 is loaded with warheads yielding .55 megatons. For more on this see International Institute of Strategic Studies (IISS), *The Military Balance, 1983-84* (London: IISS, 1983).
8. Turco et al., p. 1284.
9. Teller, p. 622.
10. The CEP for the Minuteman III/Mk-12A is drawn from *Aviation Week*, 12 March 1984.
11. Comparative US and Soviet silo hardness is discussed in Edgar Ulsamer, "The Prospect for Superhard Silos," *Air Force Magazine*, 67 (January 1984), 74-77, as well as in Colin S. Gray, *Strategic Studies and Public Policy* (Lexington: Univ. Press of Kentucky, 1983), p. 218. Formulae for computing SSKPs were taken from Lynn E. Davis and Warner Schilling, "All You Ever Wanted to Know About MIRV and ICBM Calculations but Were Not Cleared to Ask," *Journal of Conflict Resolution*, 17 (June 1973).
12. William J. Perry, "Technological Prospects," ch. 6 in Barry M. Blechman, ed., *Rethinking the U.S. Strategic Posture* (Cambridge, Mass.: Ballinger Publishing Co., 1982), p. 130.
13. See IISS, *The Military Balance*, p. 118.
14. See Robert C. Aldridge, *First Strike! The Pentagon's Strategy for Nuclear War* (Boston: South End Press, 1983), p. 93.
15. Teller, in his critique of nuclear winter cited above, notes, "During the two-week period required to establish the full effects of a nuclear winter, the water in the atmosphere, ten thousand times greater in weight than the postulated emitted smoke, most probably will rain out. This alone could reduce the smoke content at low altitudes manyfold. Other weather phenomena . . . will serve to bring smoke from the upper levels of the troposphere to the lower, whence it can be removed" (p. 624).
16. Thomas Powers, "Nuclear Winter and Nuclear Strategy," *The Atlantic Monthly*, 254 (November 1984), 55.
17. Desmond Ball, "U.S. Strategic Forces: How Would They Be Used?" *International Security*, (Winter 1982-83).
18. Benjamin S. Lambeth and Kevin N. Lewis, "Economic Targeting in Nuclear War: U.S. and Soviet Approaches," *Orbis*, 27 (Spring 1983).

19. All nuclear weapon effects cited in this section have been obtained from the "Nuclear Bomb Effects Computer" (rev. ed., 1977), developed by The Lovelace Biomedical and Environmental Research Institute and based on data from Samuel Glasstone and Philip J. Dolan, *The Effects of Nuclear Weapons*, 3d ed. (Washington, D.C.: Department of the Army, 1977).

20. Cited in Bernard Brodie, *Strategy in the Missile Age* (Princeton: Princeton Univ. Press, 1965), p. 136.

21. See, for example, J. B. Knox, *Global Scale Deposition of Radioactivity from a Large Scale Exchange*, Lawrence Livermore Nuclear Laboratory Report # UCRL-89907, 1983.

22. The notion that the Soviets prefer to initiate strategic nuclear war with counterforce strikes may be found in Lambeth, as well as, for example, Paul Nitze, "Deterring our Deterrent," *Foreign Policy*, No. 25 (Winter 1976-77).

23. For more on this, see US Congress, Office of Technology Assessment, *The Effects of Nuclear War* (Washington, D.C.: GPO, 1979), pp. 112-14; and Edward Teller, pp. 621-22.

24. Robert Jastrow, "How to Make Nuclear War Obsolete," *Science Digest*, 92 (June 1984).

25. For other reasons, see Colin S. Gray, "Nuclear Freeze?" *Parameters*, 13 (June 1983).

26. Carl Sagan, "Nuclear War and Climatic Catastrophe: Some Policy Implications," *Foreign Affairs* (Winter 1983-84), p. 280.

27. As it can even now. See, for example, Michael F. Altfeld and Stephen J. Cimbala, "Closing the Window of Vulnerability: Peacekeeper and Point Defense," *Comparative Strategy*, forthcoming.

28. This is not to imply that they don't make sense now. See, for example, T. K. Jones and W. Scott Thompson, "Central War and Civil Defense," *Orbis*, 22 (Fall 1978).

29. Indeed, *The New York Times* reported on 12 December 1984, p. 10, that when releasing the recent study of nuclear winter done by the National Academy of Sciences, Dr. Frank Press, the President of that body and Chairman of the National Research Council, stated that there was "great uncertainty" about the possibility of a severe nuclear winter but that it was "not implausible." Obviously, governments will have to figure out for themselves what this means for their policies vis-à-vis targeting and yields.

30. For more on the relationship between risk, uncertainty, and nuclear war, see Michael F. Altfeld, "Uncertainty as a Deterrence Strategy: A Critical Assessment," *Comparative Strategy*, 5 (No. 1, 1985).