Assessing the Risks

2

All weapons kill and maim, but those commonly referred to as "weapons of mass destruction ''-nuclear, chemical, and biological-an do so on an especially large scale. What is more, many of these weapons can cause not just instant death or mutilation, but lingering disease and suffering. This chapter begins with a review of the basic characteristics of the devices of mass destruction. It also identities various ways these weapons might be delivered. The next section of the chapter then compares the destructive effects and possible military uses of these weapons. This overview of the weapons, their effects, and their uses serves two purposes. First, it illustrates why the weapons have been singled out for particular opprobrium and special efforts at control. Second, it indicates why states (and sometimes nonstate organizations) might come to believe that the weapons would be useful additions to their arsenals.

U.S. DOE

The proliferation of weapons of mass destruction is both a general and a particular problem. In the long term, dealing with the problem will require strengthening international norms against the weapons and fostering a political order that makes them unattractive. In the nearer term, however, proliferation problems are particular: the weapons are spreading to specific nations that have decided, for one reason or another, that the existing international norms against further proliferation should not apply to them. The third part of this chapter identifies states suspected of trying to acquire one or more types of weapon of mass destruction. This discussion leads to the conclusion that the immediate proliferation threats, as now understood, are serious but still limited in scope. Many more nations are economically and technically capable of building weapons of mass destruction than are actually trying to do so. All this is not to suggest

complacency about the dangers of proliferation: rather, it suggests that national and international nonproliferation policies actually have some prospect of containing the problem.

The fourth part of ch. 2 discusses what differences it may make to the international community in general, and to the United States in particular, when weapons of mass destruction spread. This analysis underscores the strong interest in containing the threat of proliferation that the United States shares with all civilized nations.

With ch. 1 having reviewed trends in the international arena that nonproliferation policies must take into account, the final section of this chapter calls special attention to the multifarious problems posed by the breakup of Soviet Union.

WEAPONS OF MASS DESTRUCTION

"Mass destruction" is a relative term. Allied fire bomb attacks on Dresden during World War II killed between 130,000 and 200,000 people with 1,400 aircraft sorties over 2 days.[1] A single atomic bomb killed about 68,000 people and injured another 76,000 in Hiroshima.[2] A 1-megaton hydrogen bomb exploding over Detroit might kill 470,000 and injure 630,000 more.[3] Thus, a single weapon of mass destruction can do damage equivalent to that of hundreds or thousands of 'conventional' high explosive or incendiary weapons. This report addresses the spread of three broad types of weapon meeting that criterion of killing more with less: nuclear, biological, and chemical. How do these weapons injure and kill?

Table 2-1 surveys the destructive agents discussed in this report. Table 2-2 identifies factors that can affect just how lethal these agents may be when used. To do their deadly work, these agents of mass destruction have to be incorporated into weapons (e.g., an aerial bomb, a ballistic missile warhead, an artillery shell, or a even a suitcase) and then delivered. Table 2-3 lists the kinds of weapons that have been, or in principle could be, designed for nuclear explosives or chemical or biological agents. During the Cold War, the United States and the Soviet Union developed every type of nuclear weapon listed in the chart.[4]

The easiest course for nuclear proliferant nations would be to try to build aerial bombs first, because these need not be as light or compact as other weapon types. The bomb dropped on Hiroshima weighed about 4,400 kg (9,700 lb), but proliferants should be able to do much better than that on their first try.[5] The countries currently suspected of nuclear weapon ambitions also have ballistic missile programs; even if they succeed in developing heavier aerial bombs sooner, they seem likely to pursue missile-capable nuclear explosives in the longer run. Iraq appears to have been trying to make its first nuclear weapon light enough for a missile warhead.

Chemical weapons were frost used extensively in World War I. Initially, gaseous agents, such as chlorine and phosgene, were released from ground-based tanks as airborne clouds; later, liquids such as sulfur mustard were delivered in artillery shells. Aerial bombing and spraying methods appeared between the two World Wars. During the Cold War, the United States and the Soviet

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[1] Science Applications Inc., *Evaluations of Collateral Damage* (La Jolla, CA: SAIC, Nov. 15, 1976), p. 131,

[2] Samuel Glasstone and Philip J. DoIan, (eds.), *The Effects of Nuclear Weapons, Third Edition (Washington DC:* U.S. Department of Defense and U.S. Department of Energy, 1977), p. 544.

[3] U.S. Congress, Office of Technology Assessment *The Effects of Nuclear War* (Washington, DC: U.S. Government Printing office, 1979), p. 37.

[4] In the aftermath of the Cold War (and even before), both superpowers began to withdraw from service most of their so-called tactical nuclear weapons.

[5] The United States and the Soviet Union had already deployed much lighter weapons by the 1950s.

Table 2-I—Weapon Agents of Mass Destruction

Type of weapon agent	Examples	Mechanism	Effects on human beings
Nuclear:			
fission and fusion	Hiroshima fission bomb= 12.5 kt (1 kt = 1,000 tons TNT); fusion bomb, e.g., largest U.S. test = 17 Mt (1 Mt = 1,000,000 tons TNT)	Blast (overpressure)	Bleeding and rupture; violent displacement; blows or crushing by debris
		Thermal radiation	flash burns, blinding, burning or suffocation from building fires
		Nuclear radiation (immediate)	Vomiting, diarrhea fever, bleeding, infection, circulatory failure, respiratory failure, brain swelling
		Nuclear radiation (delayed effects and fallout effects)	Above effects at high doses; contact burns, cataracts, leukemia, other cancers, birth defects at lower doses
Biological:			
viruses	Venezuelan equine encephalitis	Inhaled or ingested infectious diseases	A variety of debilitating or potentially fatal illnesses
bacteria	Anthrax, brucellosis, plague	(same)	(same)
rickettsiae	Q fever, typhus	(same)	(same)
Toxins:[2]	Botulin, ricin, animal venoms	Inhaled or ingested poisons	A variety of toxic effects, often fatal
Chemical:			
Blistering (Vesicants)	Mustard, lewisite	Skin and tissue destruction on contact or inhalation	Skin blistering, blindness, potentially fatal lung damage
Choking	Chlorine, Phosgene, PFIB	Lung damage on inhalation	Fluid build-up leading to fatal choking
Blood	Cyanogen chloride, hydrogen cyanide	Blocking of blood oxygen on inhalation	Anoxia (severe oxygen starvation of body tissues)
Nerve	Tabun (GA), Sarin (GB), Soman (GD), GF, VX	Nervous system disruption on contact or inhalation	Convulsions, paralysis leading to death

[1] Some chemical and biological agents may cause irritation, illness, or behavior changes, but may not normally be fatal; weapons using these agents may incapacitate people for hours, days or weeks, but cannot be accurately said to inflict mass destruction. Other agents can destroy livestock or crops, having great potential for economic warfare but (except for the possibility of causing mass starvation) not leading immediately to widespread human injury.

[2] Toxins are nonliving, posionous chemicals, first produced in biological processes. It was therefore reasonable to consider them to& biological weapons, and they are covered in the international treaty banning biological weapons. However, as toxic chemical (nonliving) substances, they are also categorized as "chemical' 'weapon agents—and they are so considered in the Chemical Weapons Convention banning chemical weapons.

SOURCE: Office of Technology Assessment, 1993.

Table 2-2—Factors Affecting Lethality of Nuclear, Biological, and Chemical Weapons

Factor	Nuclear	Biological	Chemical
Delivery modes	Higher altitude burst increases lethal area, decreases fallout; Lower altitude increases central blast and fallout	Aerial spraying produces wider lethal area than explosive bomb or missile warhead Explosive dispersion may also kill agent organisms	Aerial spraying produces wider lethal area than explosive bomb or missile warhead Persistent agents can injure or kill additional victims as they pass through a contaminated area
Terrain			
Open, flat	Increases exposure to thermal and ionizing radiation Decreases injuries from debris, collapsing structures	Maximizes lethal dispersion of agent	Maximizes lethal dispersion of agent
Hilly	Redirects blast effects May shield from thermal and ionizing radiation	Atmospheric turbulence impedes even distribution and increases vertical dilution of agent, reducing casualties	Atmospheric turbulence impedes even distribution and increases vertical dilution of agent, reducing casualties
City	Supplies material for injurious debris Masonry may shield from blast, debris, and radiation Building collapses increase injuries Wood buildings and petrochemicals burn, may produce lethal firestorm	Atmospheric turbulence impedes even distribution and increases vertical dilution of agent, reducing casualties Buildings partially shelter from agent	Atmospheric turbulence impedes even distribution and increases vertical dilution of agent, reducing casualties Buildings partially shelter from agent
Weather	Wind, rain patterns may either increase or decrease lethal distribution of radioactive fallout	Wind may blow agent away from or toward targets Air temperature and temperature gradient affect dispersal	Wind may blow agent away from or toward targets Air temperature and temperature gradient affect dispersal

Union deployed the gamut of chemical delivery systems from spray tanks[6] to chemical warheads for short-range ballistic missiles, rockets, land mines, bombs, and artillery. The Iraqi chemical arsenal included artillery shells, bombs, and some ballistic missile warheads.

If any live biological weapons have been used in the twentieth century, their characteristics for the most part have been well concealed.[7] But apparently weapon designs have included spray-tanks, bombs, cluster bombs, and bomblet dispensers.[8] Like chemical weapons, biological agents are best dispersed as low-altitude aerosol clouds. (Moreover, explosive methods of dispersion may destroy the organisms.) Ballistic missile warheads that can effectively generate aerosols are

[6] Chemical agent is most efficiently delivered as a spray at low altitudes.

[7] As noted in table 2-1, from the delivery and effects standpoints, toxins are closer to being chemical than biological weapons. Japan seems to have attempted limited biological agent attacks in China during World War II-apparently with inconclusive effects. See below, footnote 23.

[8] World *Health Organization Health Aspects of Chemical and Biological Weapons* (Geneva: World Health Organization, 1970), p. 84. See also Stockholm International Peace Research Institute, *The Problem of Chemical and Biological Warfare: Vol II, CB Weapons Ted@ (New* York, NY: Humanities Press, 1975), pp. 83-89.

Table 2-2--(Continued)

Factor	Nuclear	Biological	Chemical
Weather (continued)		High winds disperse farther, but may dilute lethal concentrations sooner	High winds disseminate farther, but may dilute lethal concentrations sooner
		Rains may clear air, wash away deposited agent	Rains may dear air, wash away some types of deposited agent
		Sunlight or drying rapidly destroys some agents	Cold weather prevents evaporation, reducing concentrations in air but lengthening period of ground contamination
Defensive measures	Shelters offer varying degrees of protection outside central destructive area of bomb	Immunization possible if agents known in advance, but massive exposures can overwhelm immunity	Antidotes for some agents can be effective if administered soon enough after exposure; limited preventive treatment also possible for nerve agents
	With ample preparation and warning, evacuation the best protection	Depending on agent, early medical treatment can reduce mortality rate	Early decontamination and medical treatment can reduce mortality
		With adequate detection and warning, special masks and clothing or buildings or vehicles with filtered, positive internal air pressure can protect effectively	With adequate detection and warning, special masks and clothing or sealed buildings or vehicles with filtered, positive internal air pressure can protect effectively
		Surfaces can be decontaminated	Surfaces can be decontaminated
		With ample preparation and warning, evacuation the best protection	With ample preparation and warning, evacuation the best protection

SOURCE: Office of Technology Assessment, 1993.

technically challenging to design, although the United States had done so by the 1960s. Long-term storage of missile or artillery warheads filled with live or freeze-dried biological or toxin agent is difficult (except for anthrax spores); even if refrigerated, most of the organisms have a limited lifetime. Small, unmanned aerial vehicles carrying spray tanks might become an appealing option for third-world countries seeking inexpensive weapons of mass destruction.[9]

The biological agents usually considered for warfare have been infectious (multiplying within the infected person) but not contagious (spreading from one person to another). A nation contemplating the military use of contagious agents would have to consider the following problems:

- the spread of the disease might be so slow as to dilute the military impact;
- there would be a risk that the disease would spread back to the attacker; thorough vacci-

[9]See W. Seth Carus, " 'The Poor Man's Atomic Bomb?' Biological Weapons in the Middle East" (Washington DC: The Washington Institute for Near East Policy, Policy Papers No. 23, 1991), p. 11.

Table 2-3--Weaponizing Agents of Mass Destruction: Actual and Possible Methods of Delivery

Weapon	Nuclear	Biological	Chemical
Aerial bomb	J	√	√
Bomb subminitions		√	√
Aerial spray tank		√	√
Ballistic missile warhead, nonseparating	√	√	√
Ballistic missile warhead, separating	√	(poss.)	(poss.)
Reentry vehical			
Artillery Shell	√	√	√
Rocket Shell	√	√	√
Mortar shell	√		√
Cruise missile warhead	√	(poss.)	(poss.)
Mine (land)	√		√
Mine (sea)	√		
Antiaircraft missile warhead	√		
Torpedo	√		
Transportable Clandestine Bomb	√	(p0ss)	(poss.)
Actual Cases	√		
Theoretical possibility	(poss.)		

SOURCE: SIPRI, 1975 and Office of Technology Assessment, 1993.

nation of one's own troops and population would be very difficult; and

. many nations not at war with, and perhaps even allied to, the attacker might also suffer from the epidemic, exposing the attacker to unnecessary sanctions or retaliation.

A clandestine terrorist might not care about these problems. A nation with an advanced biotechnology program might try to create a contagious organism that was both difficult to treat and susceptible to a vaccine uniquely available to the nation's own population. These conditions would be difficult to achieve, as well as to implement covertly on a nationwide scale, but cannot be dismissed as impossible (see the OTA background paper on technologies underlying weapons of mass destruction, in press).

Means of delivery

How nuclear, biological, or chemical weapons are incorporated into weapons will depend both on their purposes and on the available means of delivery. This section introduces the primary kinds of vehicles by which these weapons might be delivered. Following sections address possible uses. As table 2-2 illustrates, properly configured weapons of mass destruction can be delivered by many kinds of military delivery systems, and at ranges from a few to thousands of kilometers. Depending on the scenario, such weapons can be highly threatening even without sophisticated military delivery systems. A nuclear device planted by terrorists or commando squads, or delivered by disguised cargo ships, aircraft, or even small pleasure craft, could kill just as many people as one delivered by an ICBM; a given quantity of lethal microorganisms effectively spread by human agents might kill even more than one delivered by missile.

Thus, the absence of advanced delivery systems does not mean that states or sub-national groups could not use weapons of mass destruction. Even though few proliferant states (with the

possible exceptions of India, Israel, and China)[10] have---or are likely soon to acquire-military delivery systems capable of directly reaching the United States, unconventional delivery methods could still put U.S. territory at risk. U.S. allies abroad or deployed U.S. forces are already threatened by shorter range systems. In the cases of rival states bordering one another, nuclear, biological, or chemical weapons mounted on even very short-range means of delivery can pose a major threat.

Nevertheless, states possessing considerable numbers of advanced longer range systems equipped with these weapons can more reliably threaten more nations with higher levels of destruction than those only possessing short-range systems. Every state currently of proliferation concern has combat aircraft in principle capable of delivering weapons of mass destruction; most of those states also own or have programs to acquire ballistic missiles.

Partly for these reasons, the discussions of delivery systems in this OTA report and its associated background paper deal primarily with advanced systems.[11] Another reason is a more practical one: because advanced systems designed to penetrate enemy defenses are in many cases technically more demanding, there is greater hope (than there is for short-range systems) of imposing international controls on their further proliferation.

The three principal types of advanced delivery vehicle are aircraft, ballistic missile, and cruise missile. Aircraft (in the sense used here) are piloted, air-breathing (usually jet) airplanes; the combat aircraft of many of the world's air forces can deliver payloads of several thousand pounds to distances of hundreds of kilometers (or more, if they are equipped for aerial refueling) 12; they may fly at speeds of 1,000 to **2,000 km/hr or** more.

Ballistic missiles carry both fuel and oxidizer and (except for very short-range systems) fly part of their trajectory outside the atmosphere. They usually reenter the atmosphere hypersonically, at speeds of thousands of km/hr, and carry smaller payloads than aircraft. They are likely to delivery weapons less accurately than aircraft, but high accuracy is unnecessary for delivering nuclear weapons on many kinds of missions.

Cruise missiles or other unpiloted aerial vehicles share some characteristics with piloted aircraft and some with ballistic missiles. Like airplanes, these missiles fly nonballistic trajectories within the atmosphere and are powered throughout their flight. (Ballistic missiles, in contrast, are powered only at the beginning of their trajectories, coasting to their targets once their final rocket motor stages burn out.) Unpiloted aerial vehicles range from simple, unmanned drone aircraft used for target practice, to short- and medium-range (10 to 100 km) antiship missiles widely available around the world, to highly sophisticated, longer range, autonomously guided missiles such as the U.S. Tomahawk. Like ballistic missiles, they do not require as extensive a training and support infrastructure as do piloted aircraft.

Since cruise missiles can be launched from air, sea, and underwater as well as from land, their own range is extended by that of their carrier (airplane, ship, or submarine). Like other aircraft, they can be shot down once detected and identified. However, small size (and radar cross-section), low-altitude flight, and circuitous courses can make them hard to find. Like ballistic missiles, they are expendable, eliminating the need to risk a pilot (and avoiding the possibility

10 Declared nuclear-weapon states are not considered nuclear "proliferants." China, although a declared nuclear-weapon state, is suspected of being a chemical and biological weapon proliferant.

11 Background paper on technologies underlying weapons of mass destruction, in press.

12 Converted cargo aircraft or long-range bomber aircraft (if available) can fly thousands of kilometers without refueling.

of pilot error while forfeiting the potential for pilot improvisation if something goes wrong).

With the worldwide availability of high-precision navigation services such as that provided by the U.S. Global Positioning System (GPS), a simple cruise missile can in principle be made more accurate than even a sophisticated ballistic missile. A piloted aircraft, on the other hand, has abetter chance than a cruise or ballistic missile of delivering chemical or biological weapons onto mobile military targets and of adjusting bombing or spraying patterns to the weather.

An analysis comparing the relative advantages of aircraft and ballistic missiles for nuclear weapon delivery concludes:

> Ballistic missiles are of principal concern to the degree they are coupled to the delivery of nuclear and, to a somewhat lesser extent, chemical weapons. But advanced-strike aircraft can be effective in delivering nuclear weapons and can be more effective than ballistic missiles for delivering conventional or chemical ordnance.[13]

On the other hand, to deliver weapons at intercontinental range, developing and building intercontinental ballistic missiles may be easier than acquiring long-range bombers and refueling capabilities.[14]

Since biological warfare agents are, like chemical ordnance, best disseminated in an aerosol over a wide area, aircraft and cruise missiles are better for delivering them than are ballistic missiles. In addition, it is more difficult (but not impossible) to develop ballistic missile warheads in which live biological agents can survive the stresses of space flight and atmospheric reentry.

WEAPON EFFECTS COMPARED

Destructive Effects

Figures 2-1 and 2-2 illustrate some rough estimates for the effects of comparable amounts of chemical, nuclear, and biological weapons. These are based on somewhat arbitrary assumptions, but they do give a basis for relative comparison of the weapon types.

These comparisons suggest the following generalizations:

- nuclear weapons remain the most massively destructive weapons that can be built: unlike chemical and biological weapons, nuclear weapons also threaten massive destruction of property (civilian or military);
- in principle, biological weapons efficiently delivered under the right conditions against unprotected populations would, pound for pound of weapon, exceed the killing power of nuclear weapons; on the other hand, if warning is provided, effective civil defense measures are considerably easier to take against chemical and biological weapons than against nuclear weapons;
- for maximum physical effect, chemical and biological weapons are more efficiently delivered by aircraft or artillery barrages than by high-speed missiles; missile attacks, however, may be useful as instruments of terror;
- chemical weapons must be delivered in great quantities to approach the potential lethality of nuclear and biological weapons; against well-protected troops or civilians, they will be less lethal than even conventional explosives; and

13 Center for International Security and Arms Control, Stanford University, *Assessing Ballistic Missile Proliferation and Its Control* (Stanford, CA: CISAC, November 1991), p. 7.

14 See Edward Luttwak, foreword to Seth Carus, *Ballistic Missiles in Modern Conflict* (New York, NY: Praeger, 1991) p. vii

Figure 2-l-Comparing Lethal Areas of Chemical, Biological, and Nuclear Weapons: Missile Delivery on an Overcast Day or Night, With Moderate Wind (Neither Best nor Worst Case)

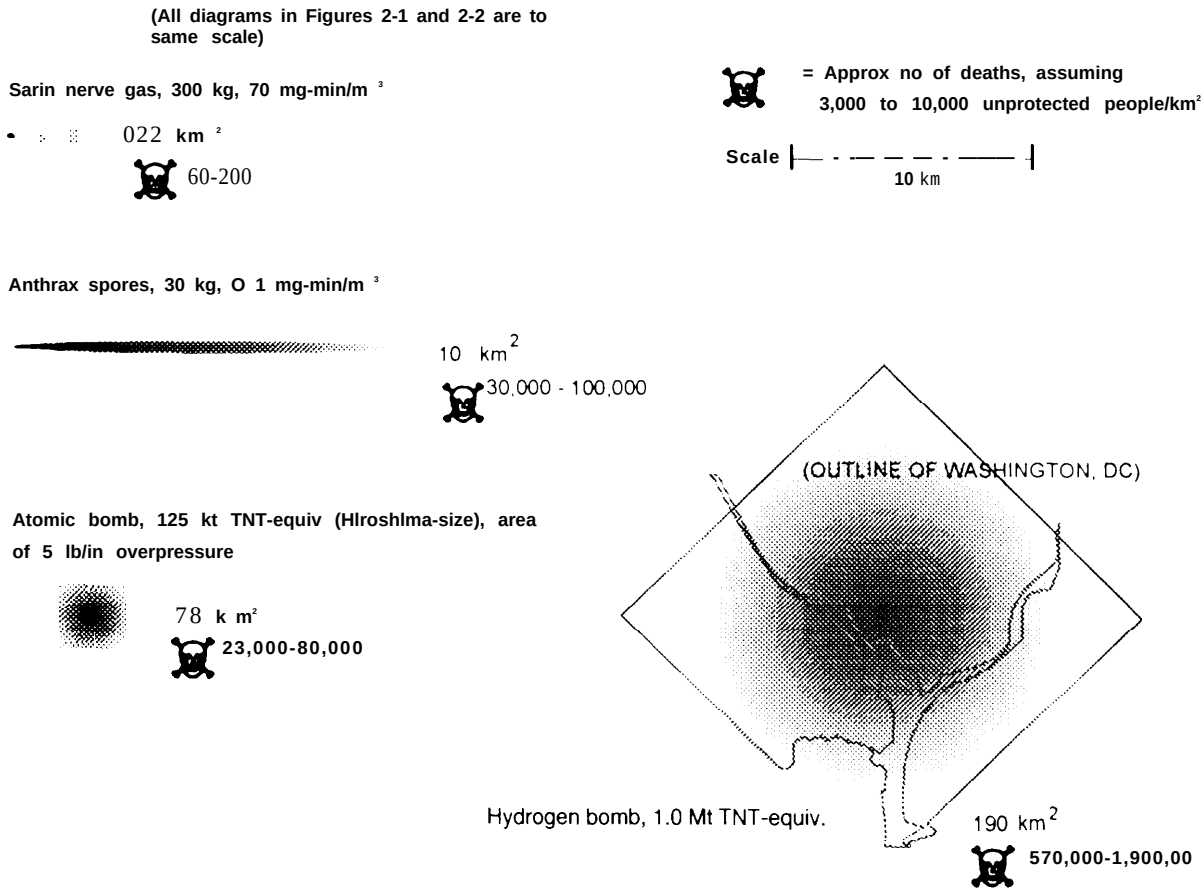

Figure shows the lethal areas of the agents delivered by a Scud-like missile with a maximum payload of 1,000 kg (note that the amount of biological weapon agent assumed would weigh considerably less than this; since the lethality per unit weight is great, the smaller amount considered here would still more than cover a large urban area). The estimates of lethal areas for chemical and biological weapons were prepared using a model that takes account of postulated release height, wind velocity, deposition velocity, height of temperature inversion layer, urban air currents, and residence time in air of the agent. The diagrams show approximate outer contours of areas with sufficient concentrations of agent that 50 percent to 100 percent of the unprotected people would receive fatal doses. Although some people within the defined area would survive, about the same number in the outer, less lethal areas, would die; therefore, the defined areas give approximations of the total number of unprotected people who could be expected to die in each scenario, With ideal (forlethalit y) population densities and weather, the chemical and biological agents could kill more people than shown here; under worse conditions, they might kill many fewer. The atomic weapons (fission and fusion) are assumed to be ah burst for optimum blast and radiation effects, producing little lethal fallout. The lethal area is assumed to be that receiving 5 lb/in² of overpressure--enough to level wood or unreinforced brick houses.

SOURCE Office of Technology Assessment, 1993.

Figure 2-2-Comparing Lethal Areas of Chemical and Biological Weapons: Delivery by Aircraft as Aerosol Line Source

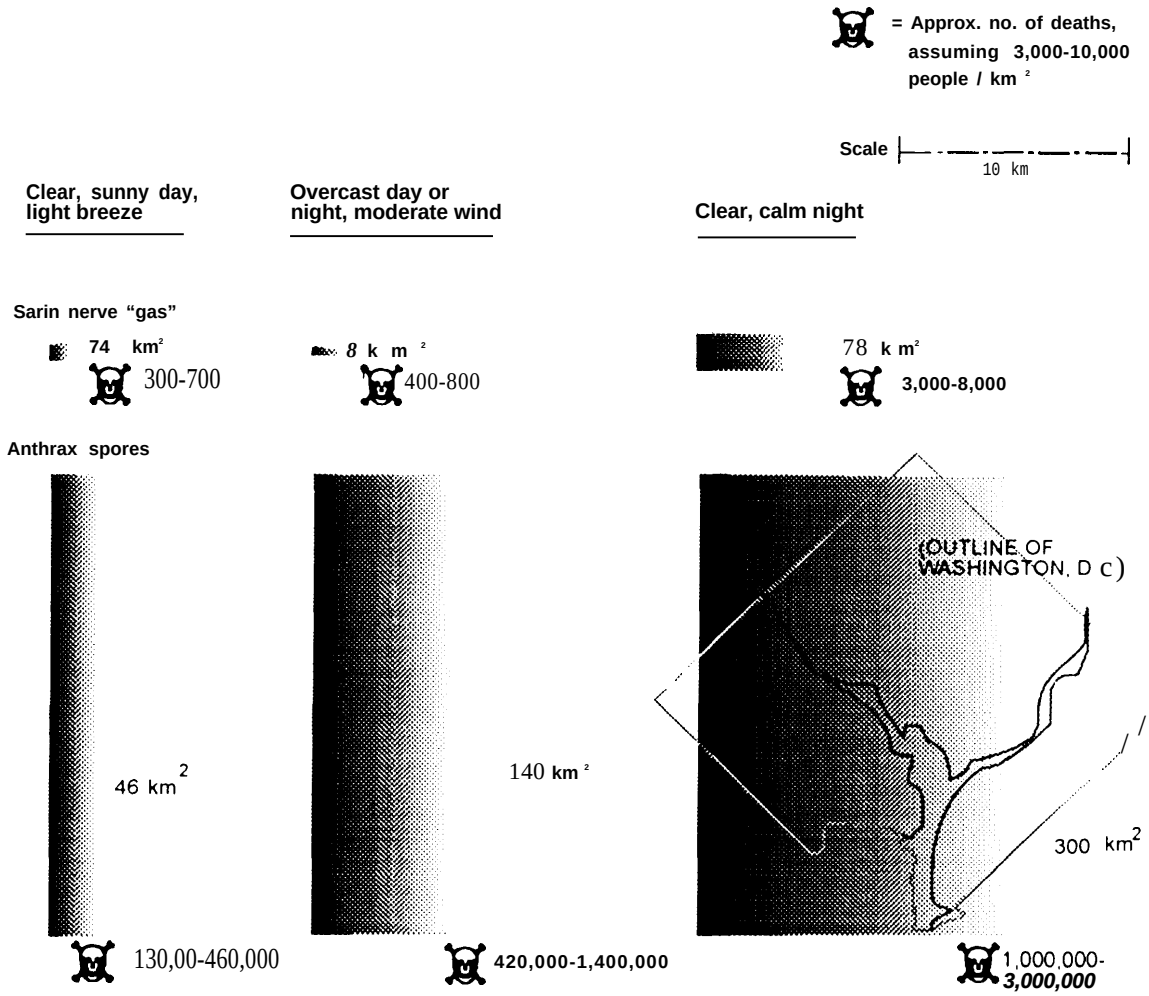

Figure shows the lethal areas of single airplane-loads of chemical and biological weapons, assuming a highly efficient line-source delivery of the killing agents. The figure also assumes that the aircraft has a greater payload than the missile in figure 2-1, delivering 1,000 kg of sarin nerve agent or 100 kg of anthrax spores. (More anthrax would be inefficient in a city attack.) Given these two factors, a single airplane delivering chemical or biological weapons can be considerably more lethal than a single missile. For an anthrax attack, the diagram shows how fatalities could vary greatly under three different weather scenarios. In one case, that of an overcast day or night with moderate wind, maximizing the lethal area would require distributing the agent in a 4.5 km by 34 km area, which would not be appropriate for most cities; therefore, the figure assumes a more rectangular distribution, which would still generate a comparable number of casualties.

SOURCE: Office of Technology Assessment, 1993.

- because they are so dependent on weather and the degree of defensive protection, the consequences of chemical and biological weapons are much less predictable than those of nuclear weapons; nevertheless, even when military utility is questionable, chemical and biological weapons may terrorize civilian populations (and, particularly for terror uses, the attacker may be able to wait for optimal weather).

Military Utility

A principal-but by no means exclusive—motive for developing countries to acquire weapons of mass destruction is for their potential military utility. The symbolic, deterrent, or intimidating uses of these weapons may be disproportionate to their actual effects on opposing military forces.[15] On the other hand, political inhibitions on using the weapons may render moot their purely military effectiveness. These cautions noted, table 2-4 compares general military uses of the weapons (along with conventional explosive weapons, for comparison).

The nuclear age has generated special meanings for the terms *strategic* and *tactical* as applied to weapons of mass destruction. The general meaning of *strategic military* action in this context is the attempted destruction of the military infrastructure, economic base, and even the population that enables the enemy nation to make war. *Tactical* attacks, on the other hand, are those more directly engaging the enemy's frontline military forces, immediate reinforcements, or supply lines. As table 2-4 indicates, nuclear, chemical, and biological weapons can each be applied tactically or strategically. From a strictly military viewpoint, though, their utilities are not equivalent because the consequences of using each are different.

TACTICAL USES

The tactical uses of weapons of mass destruction may have both direct and indirect purposes. The direct purpose would be to destroy or disable specific military targets-bases, equipment, or personnel. The indirect purpose would be to compel the enemy to change his operations to cope with extraordinary threats. For example, the threat of nuclear attack might force the dispersal of large troop or armor concentrations. Chemical weapon threats might require troop dispersals and protective measures that reduce combat effectiveness, while perhaps overburdening medical services with injured personnel. Biological weapon threats would impose similar burdens.

During the Cold War, the United States and the Soviet Union each deployed thousands of 'tactical' ' nuclear weapons (e.g., artillery, rockets, short-range ballistic missiles, aerial bombs). For the most part, these weapons would have been aimed at military forces and installations more or less directly involved in battle. Their explosive yields reportedly ranged from less than 1 kiloton (kt) of TNT to several hundred kt.[16] Limited use of these weapons in Europe would, at the very least, have forced armies on both sides to alter their tactics to avoid presenting large concentrations of troops and armor as targets. Used en masse, these tactical weapons might have produced damage to the population and the civilian infrastructure resembling that to be expected from

15 In some unusual cases, the uses may intend provocation, as opposed to deterrence or intimidation. The apparent intent Of Iraq's use of Scud missiles against Israel during the Gulf War was to lure Israel into military retaliation. Iraq might then have persuaded the Arab members of the Coalition to change sides to avoid fighting on the same side as Israel. Thus, even though the Iraqi attack would probably have had little direct military effect, its political effect might have been enormous. (Iraq might have increased the chances of Israeli military action had it used chemical warheads on its missiles; on the other hand, Iraq also had to consider the possibility that Israel would respond to such an attack with nuclear weapons, an escalation Saddam Hussein probably wanted to avoid,)

16 See william M. Arkin and Richard W. Fieldhouse, *Nuclear Battlefields: Global Links in the Arms Race* (Cambridge, MA: Ballinger, 1985), pp. 57-58. By way of comparison the bomb that destroyed Hiroshima had a yield of 12.5 kt.

Table 2-4-Applications of Weapons of Mass Destruction Compared

Characteristics	Conventional explosives (for comparison with WMD)	Nuclear	Chemical	Biological
Destructive effects (See table 2-1)	Blast, shrapnel, fire	Blast, fire, thermal radiation, prompt ionizing radiation, radioactive fallout[1]	Poisoning: skin, lungs, nervous system, or blood	infectious disease or biochemical poisoning
Typical militarytargets	Military bases and equipment; Command-and-control installations (e.g. command posts, radars); troop concentrations; ships[2]	Similar to targets for conventional munitions (esp. targets hardened against blast) Enemy nuclear or other WMD facilities	infantry concentrations, towed artillery, air bases, ships, ports, staging areas, command centers	infantry concentrations, air bases, ships, ports, staging areas, command centers
Typical missions against military targets	Destruction of targets, personnel casualties	Destruction of targets Personnel casualties intimidation of personnel Disruption of operations by requiring dispersal of units. Disruption of communications by electromagnetic pulse effects	Unprotected personnel casualties; disruption of operations by requiring protective measures or decontamination Demoralization or panic of personnel	Unprotected personnel casualties; disruption of operations by requiring protective measures or decontamination Demoralization or panic of personnel
Drawbacks as military instrument	Small lethal radius requires either many weapons or great accuracy for most military missions	Potential for great "collateral damage" Risk of retaliation and escalation in kind Radioactive contamination of ground that user may wish to cross or occupy	Relatively large quantities required Protective measures may greatly reduce casualties Leave buildings and equipment reusable by enemy (but persistent agents may require decontamination) With persistent agents, chemical contamination of ground that user may wish to cross or occupy	Protective measures may reduce casualties Most agents degrade quickly With persistent spores, contamination of ground that user may wish to cross or occupy Leave buildings and equipment reusable by enemy (but persistent spores may require decontamination) Effects depend on weather and time of day; are delayed, unpredictable, or uncontrollable

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a‘ ‘strategic” nuclear war.[17] Moreover, they were deployed in the context of superpower arsenals containing thousands more strategic nuclear weapons aimed at each other’s homeland.

New nuclear powers are likely to have anywhere from one to a few hundred nuclear weapons, most likely of explosive yields equivalent to a few tens of kilotons of TNT. These new nuclear powers might intend to use their limited numbers of weapons against isolated military targets for tactical purposes, or they might seek to achieve maximum economic damage and psychological effects by directly attacking cities. The decision would probably depend on the military and political context, including whether the adversary or its allies also had nuclear arms, and, if so, how many.

During World War I, both sides used large amounts of chemical weapons. Japan used chemical and biological weapons against China in World War II. Since then, the world has had some further experience with use of chemical weapons: Egypt (reportedly) in Yemen in 1967 and 1968; Iraq against Iran during the 1981-1988 war, Iran against Iraq, and Iraq against some of its own Kurdish population. During its war with Iran, Iraq used aerial bombardment and artillery to deliver mustard and nerve agents against Iranian infantry and ‘‘human wave’ attacks and against support troops and staging areas.[18] Iranian troops were poorly protected throughout, but apparently only by 1986 did the Iraqis learn to use their chemical weapons in coordinated and effective ways, preventing Iranian troops from massing and counterattacking with conventional forces. In 1988, Iraq used chemical weapons in an offensive mode, weakening Iranian forward positions and limiting rear operations. Iraq reportedly also used a combination of mustard and nerve agents on Kurdish civilian villages and rebel encampments.[19]

Pelletiere and Johnson point out that, as was the case in World War I, the ratio of deaths to injuries from chemicals seems to have been low in the Iran-Iraq war, and that therefore chemical weapons should not be thought of as ‘‘a poor man’s nuclear weapon. ’[20] Anthony Cordesman concludes that although the contribution of chemical weapons to Iraqi success in any one battle is hard to estimate, and although they produced less than 5 percent of the more than 1 million Iran-Iraq war casualties,

> Nevertheless, [they] had a critical effect on Iranian military and civilian morale by late 1987, and during the Iraqi counter-offensives and ‘‘war of the cities” in 1988. Sheer killing power is not the key measure of success: it is rather the strategic, tactical, and psycho-political impact of the use of such weapons. Even when troops are equipped with defensive gear, they often feel they

17 Indeed, full application of the conventional firepower deployed in Europe might have had consequences nearly as terrible—which may be one reason why NATO allies were willing to rely so heavily on nuclear deterrence against a Soviet attack.

18 See Steven C. Pelletiere and Douglas V. Johnson II, *Lessons Learned: The Iran-Iraq War* (Carlisle Barracks, PA: Strategic Studies Institute, U.S. Army War College, 1991), “Appendix B: chemical Weapons,” pp. 97-101; and Anthony H. Cordesman, *Weapons of Muss Destruction in the Middle East* (London: Brassey’s (UK), 1991), pp. 85-93. The following discussion is drawn primarily from these sources.

19 Signs of mustard, nerve, and blood agents were reported found in Kurdish areas in statements of Robert Cook-Degan and of Deborah Lief-Dienstag and supporting documents (given in U.S. Congress, Senate Committee on Governmental Affairs, Permanent Subcommittee on Investigations, *Global Spread of Chemical and Biological Weapons, Hearings,* 101st Cong., 1st sess., S. Hrg. 101-744 (Washington, DC: U.S. Government Printing Offfice, 1990), pp. 242-266). There is general agreement that Iraq used the mustard and nerve agents. Some authors argue that Iraqis also delivered cyanide on the village of Halabjah, but Cordesman, ibid., concludes that Iranians were the likelier source.

Gordon Burck argues that the cyanide could have come from ill-manufactured Iraqi nerve agent (“The Geneva Protocol: Selective Enforcement” in Lessons *of the Gulf War: Mediation and Conflict Resolution,* AAAS, *Proceedings from an Annual Meeting Symposium,* Feb. 17, 1990, New Orleans, Louisiana, p. 17). Kenneth Timmerman, on the other hand, charges that Iraqis were using purposely developed hydrogen cyanide bombs; see *The Death Lobby: How the West Armed Iraq (New* York, *NY:* Houghton Mifflin, 1991) p. 293. The UN Special Commission, however, did not report finding hydrogen cyanide weapons in the Iraqi arsenal.

20 See Pelletiere and Johnson, op. cit., footnote 18, p. 100. They report that although 27.3 percent of all American casualties in World War I were gas-generated, and 31,4 percent of wounds were gas-related, the death rate among gas victims was only 2 percent.

U.S. AIR FORCE PHOTOS

Even if chemical weapons did not inflict large-scale casualties, they could seriously interfere with military operations. These pictures were taken during a 1988 exercise at Eglin Air Force base. On the left, an airman dons cumbersome protective gear. Top right, a simulated casualty is carried away from the airfield. On the bottom right, an aircraft is decontaminated by spraying and scrubbing with neutralizing chemicals.

> are defenseless and break and run after limited losses. Populations which fear chemical attacks may well cease to support a conflict.[21]

On the other hand, chemical weapons used against troops in World War I did not appear to damage civilian morale. Nor can it be shown that chemical weapons clearly affected civilian morale in the Iran-Iraq war.

Chemical weapons may be used in tactical warfare either to kill or terrorize instantly, or to impose operational difficulties on the enemy by contaminating key areas or equipment for hours or days. Thus, an attack on an infantry position might use a volatile agent like GB, while a viscous, persistent agent like VX might be applied to an airbase or a strip of territory. Table 2-5 indicates approximate quantities of those two types of agent that might be needed for some representative military missions. Although a few drops of nerve agent can kill, the fact that chemical agents are usually disseminated as a wind-borne aerosol or spray means that many tons may be needed to produce many battlefield casualties. The military utility of attacks on troops

21 Cordesman, op. cit., footnote 18, p. 92.

Table 2-5-Quantities of Chemical Weapons for Various Missions

Mission	Quantity
Attack an Infantry position: Cover 1.3 km² of territory with a "surprise dosage" attack of GB (Sarin) to kill approximately 50% of unprotected troops	216 240-mm rockets (e.g., delivered by 18, 12-tube Soviet BM-24 rocket launchers) each carrying 8 kg agent (totalling 1728 kg)
Prevent launch of enemy mobile missiles: Contaminate a 25 km² missile unit operating area with 0.3 tons of VX per sq. km	8 F-16 bombers each delivering 0.9 ton of VX (totalling 7.2 tons)
Immobilize an air base Contaminate a 2 km² air base with 0.3 tons of VX twice a day for three days	1 F-16 bomber, 6 sorties
Defend a broad front against large-scale attack: Maintain a 300-m deep strip of VX contamination in front of a position defending a 60-km wide area for 3 days	65 metric tons of agent delivered by approximately 13,000 155-mm artillery rounds
Terrorize population: Kill approximately 125,000 unprotected civilians in a densely populated (10,000/km²) city	8 F-16 bombers each delivering 0.9 ton of VX (totalling 7.2 tons) under optimum conditions

SOURCE: Adapted from Victor A. Utgoff, The *Challenge of Chemical Weapons* (New York, NY: St. Martin's Press, 1991), pp. 23S-242.

would depend greatly on how effectively they were protected with gas masks, clothing, and shelters .22

For biological weapons, there is little documented experience with military use.[23] One analyst speculates that, for surprise attacks or for repelling immediate attacks by others, biological weapons would be too slow and unpredictable to be militarily attractive. He argues, however, that they might be useful on the front lines against freed defensive positions in long wars of attrition.[24] Another analyst argues that suitable tactical targets for biological weapons might include reserve combat units, formations massing in preparation for an offensive, air force squadrons, and rear area support units:

> Thus, it would appear that biological weapons could be militarily useful in situations when immediate results are not required and where the danger to friendly forces is minimal. Thus, even

22 Chemical weapon researchers very likely have in the past studied methods of penetrating gas masks with chemical warfare agents.

23 Japan reportedly used biological warfare against China before and during World War II, with inconclusive results. Although the Japanese Army performed field trials in which bombs carrying plague-infested fleas were dropped on at least 11 Chinese cities, the weapons were not reliable and had little military impact-although they claimed an estimated 700 civilian lives. Contamination of Chinese territory with plague also caused thousands of unintended casualties among Japanese troops. See "Japan's Germ Warfare: The U.S. Cover-Up of a War Crime," *Bulletin of Concerned Asian Scholars,* vol. 12, October-December 1980, pp. 2-17; John W. Powell, "A Hidden Chapter in History," *Bulletin of the Atomic Scientists,* vol. 37, No. 8, October 1981, pp. 44-52; and Peter Williams and David Wallace, *Unit 731: Japan's Secret Biological Warfare in World War H* (New York, NY: Free Press, 1989).

24 Raymond A, Zilinskas, "Biological Warfare and the Third World," *Politics and the Life Sciences,* vol. 9, No. 1, August 1990, pp. 59-76.

> if biological warfare has only slight immediate value on the battlefield, it could have considerable utility when directed at rear units.[25]

Note that even if not many troops were killed, a sudden epidemic of incapacitating disease could at least temporarily paralyze both logistic and fighting units.

It is feasible—if the right weather occurs and can be utilized-for a single aircraft to disseminate high dosages of biological agent over hundreds, or even thousands, of square kilometers by spraying a long line upwind from the target region. This was one nightmare scenario for coalition forces facing Iraq in northern Saudi Arabia during the Gulf War. For comparison of the relative lethalities of biological, nuclear, and chemical weapons under somewhat different scenarios, see figures 2-1 and 2-2.

Defending against biological weapons may be difficult. Currently there is no reliable way of quickly detecting their presence or identifying them, so soldiers may not take shelter or don protective clothing in time. Vaccination requires advance knowledge of the infective agents the troops will encounter, the availability of effective vaccines, and sufficient time for the soldiers to develop immunity. High concentrations of agent may overcome the immunity even of vaccinated personnel.

According to the commander of the recently created U.S. Army Chemical and Biological Defense Agency (CBDA),

> . . . the biological threat has been recently singled out as the one major threat that still poses the ability for catastrophic effects on a theater-deployed force. Desert Storm solidified the perception in our country-in the Congress and among our military leadership--that [biological warfare] was something that third-world nations considered a potential equalizer.[26]

DEPARTMENT OF DEFENSE

With adequate warning, troops can be protected from biological weapon attack by means of protective suits. Soldiers in Saudi Arabia during Operation Desert Shield (prior to Desert Storm) sometimes trained wearing chemical/biological protective gear.

STRATEGIC USE

Nuclear—Between World Wars I and II, the military theorist Giulio Douhet and others developed an idea of strategic bombing in which aerial attacks on key military and economic targets in the enemy's homeland would severely diminish his ability to make war. During World War II, strategic bombing evolved in practice into efforts not only to inflict crippling damage on the enemy's infrastructure, but to cripple his war effort by demoralizing the population. Although the strictly military and economic effects of the two atom bombs dropped on Japan did not directly affect Japan's armed forces, the shock of the attacks (combined with the fear that more might follow) led to an unconditional surrender that might otherwise not have come so soon. During the Cold War, the nuclear standoff between the United States and the Soviet Union was sometimes called the ''balance of terror." Although both superpowers integrated nuclear weap-

25 Carus, op. cit., footnote 9, p. 37.

26 Brig. Gen. George Friel, Commanding General, U.S. Army CBDA, quoted in John G. Roos, ''Chem-Bio Defense Agency Will Tackle 'Last Major Threat to a Deployed Force,' '' ***Armed Forces Journal International,*** December 1992, p. 10.

ons into their military forces, the primary role of the weapons was not to win wars but to back threats.

This terroristic component to strategic warfare with weapons of mass destruction makes it difficult to analyze just what would constitute ''rational' or ''irrational' use by proliferant states. When leaders threaten to use the weapons (whether in an initial or a retaliatory attack), they must decide what level of threat will be sufficiently intimidating. In some cases, conveying the impression that one could assemble a nuclear bomb in 2 weeks might seem enough; in other cases, the threat to launch a nuclear missile attack in 1 hour might not.

A leader actually ordering a strategic attack must subjectively predict its psychological impact on the other side's population and government, not just calculate the physical effects of the weapons on the other side's war machine. The attacker must also estimate what kind of retaliation to expect, and whether he would be willing to accept it. Alternatively, the leader may be ordering a retaliatory attack, either in pure revenge or to warn against further escalation of the conflict. In sum, this section's discussion of the physical suitability of the weapons for strategic warfare is only part of the story.

Threatening both population and property, nuclear weapons are the most dangerous strategic weapons. While civil defense measures can mitigate their effects somewhat, within a certain radius (dependent on the explosive yield) they promise certain destruction of all but deeply buried blast shelters. Despite the great uncertainties in calculating the precise consequences of nuclear war, the impact of even a ''small' or "limited" nuclear attack would be enormous.[27]

Chemical—Medium- to large-scale attacks with chemical weapons (e.g., tens of tons) on civilians may kill many more unprotected people (e.g., thousands) than would equivalent amounts of high explosives. On the other hand, the many uncertainties involved in dispersing chemical agents efficiently-as well as the effectiveness of relatively simple civil defense measures (e.g., wearing gas masks and remaining inside living spaces that are sealed off during attack)--could keep casualties relatively low. Contamination of certain areas by persistent chemical agents might slow down industrial activities for days or weeks, but for the most part chemical weapons would leave the economic infrastructure of cities intact. Enclosed military facilities are even more likely to be protected and to continue functioning.

Biological—Like chemical weapons, biological weapons would leave the material (as opposed to human) economic and military infrastructure relatively untouched.[28] Like nuclear weapons, they have the potential in modest amounts (e.g., a few kilograms of agent), properly delivered, to kill and disable many thousands of urban residents and to seriously impair war-supporting activities. On the other hand, biological weapons (except for some toxins) act more slowly than chemical or nuclear weapons, taking days or weeks to achieve full effect. Moreover, their effects are much harder to predict than those of nuclear weapons: weather, time of day, local terrain, and civil defense measures could all act to reduce casualties (as with chemical weapons).

Unlike nuclear and chemical weapons, the use of biological weapons might not be attributed to enemy attack, since outbreaks of disease can occur naturally. The problems of protecting civilian populations against biological attack are similar to those cited above for protecting troops: immediate detection and protection are likely to be difficult, and effective advance vaccination may be infeasible.

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27 See OTA, *The Effects of Nuclear War,* Op. Cit., footnote 3, p. 4.

28 With the exception that biological weapons can and have been developed for application to target food crops, with the aim Of strategic reductions of the enemy's food supply. Moreover, spore-forming organisms such anthrax might require major decontamination efforts, and therefore interfere seriously with normal economic or military activities.

NEAR-TERM PROLIFERATION THREATS: SUSPECTED PROLIFERANT NATIONS

Weapons

At the U.S. State Department's last count published in 1992, *there* were 188 countries in the world. Five of the world's nations (United States, Russia, United Kingdom, France, China) have acknowledged owning nuclear weapons. Three other states—Ukraine, Belarus, and Kazakhstan—have on their territory former Soviet strategic nuclear weapons, nominally under control of the Commonwealth of Independent States,[29] and it is not yet fully certain that all will give them up. Since the end of World War II, three states have admitted having chemical weapons (United States, Russia, and Iraq). None say they have deployed biological weapons, although five (United States, Russia, France, the United Kingdom, and Canada) admit having had offensive weapon munition supplies or development programs in the past. Additional countries are suspected either of possessing some of these weapons of mass destruction or of trying to acquire them, but many more are not. In sum, the scope of the problem of proliferation is worrisome but still limited enough to encourage hope that it can be contained.

This section presents data intended to convey a sense of the general character of the near-term proliferation problem. It names countries cited in the public literature as having either the weapons, or programs to acquire the weapons, of concern to this report. The arbitrary criteria for including countries are explained in the footnotes to each list. These lists should be treated with caution and should in no way be considered authoritative or as representing official U.S. Government assessments. To have included such assessments in this report would have resulted in its classification as a secret document, since the U.S. Government has released few of its estimates about the activities of specific countries.

Intelligence information might tend to confirm or undermine some of the estimates in the public literature, These details, however, are more important for the implementation of U.S. unilateral policies (particularly those involving covert action or certain bilateral international arrangements) than for the formulation of the broader policies to be addressed in this report and its sequel.[30] In any case, the broader policies *must be* formulated in the context of publicly available information. First, although Congress can authorize classified activities that may be subject to some oversight, it cannot pass secret legislation. Second, Congress responds to public pressure, which in turn derives from publicly available information. Third, achieving international consensus and collective action on proliferation will require openness. Fourth, multilateral agreements such as the Nuclear Non-Proliferation Treaty (NIT), the Biological Weapons Convention (BWC),[31] and the Chemical Weapons Convention (CWC) were not negotiated or implemented in secrecy.

The United States will have to choose and carry out its national policies toward specific countries on the basis of the best information available, classified and unclassified. Nevertheless, it should be understood that both classified and unclassified assessments of foreign weapon programs will be subject to uncertainties, incompleteness, lack of integration of available data, or inadequate interpretation-as the case of the Iraqi nuclear program well illustrates.

Table 2-6 summarizes a published estimate of what countries (beyond the five self-acknowledged nuclear powers) are pursuing nuclear weapon programs. Note that some of the countries

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29 The three non-Russian states have at least a political veto over launch of the weapons on their territory, but apparently they do not currently have the technical means to launch them independently.

30 OTA report on nonproliferation policies, in preparation.

31 convention *on the Prohibition of th, Development, Production and Stockpiling of Bacteriological (Biological) and Toxin Weapons and on Their Destruction.*

Table 2-6--Countries Reportedly Trying to Acquire Nuclear Weapons

Region	Country	Comment
Middle East/ North Africa	Algeria	Possibly interested in nuclear weapons, but currently lacks facilities; has agreed to IAEA inspection of formerly secret, Chinese-supplied nuclear reactor; not a party to the NPT.
	Iran	Reportedly pursuing nuclear weapons, but little public evidence of progress; CIA testimony estimated production unlikely before the end of the decade without foreign assistance.
	Iraq	Massive program uncovered after Gulf War; United Nations has required destruction of most infrastructure, but knowledgeable personnel still in country.
	Israel	Widely believed to have a clandestine nuclear arsenal of approximately 100 weapons.
South Asia	India	Exploded a nuclear device in 1974; probably has sufficient materials for several weapons.
	Pakistan	Undoubtedly has nuclear weapon program, probably successful. U.S. President no longer certifies to Congress that Pakistan does not possess a nuclear device, suggesting high likelihood that it does.
East Asia	North Korea	Suspicious reactor and reprocessing laboratory; submitted to some IAEA inspections in 1992 and 1993, but refused others; in March 1993, denied IAEA access to suspected reprocessing waste sites and declared its intention to withdraw from NPT (since rescinded).
Latin America	Argentina	in agreement with Brazil, seems to have ceased weapons program. No disclosure of progress towards weapons, but suspected of having developed clandestine enrichment plant, a key step towards weapons.
	Brazil	In agreement with Argentina, has apparently ceased weapons program. in 1987, revealed it had developed the ability to enrich uranium. (Brazil has also had a nuclear power submarine program requiring highly enriched uranium fuel.)
Africa	South Africa	Widely suspected to be very near nuclear-weapon capability, South Africa declared in March 1993 that it had in fact constructed 6 nuclear weapons, but dismantledthem in 1990. The South African president promised that South Africa would cooperate fully with the IAEA to assure the world that it was complying with the NPT. Joined NPT in 1991, placed declared weapons grade uranium under IAEA inspection, and presumably dropped nuclear weapon ambitions,

SOURCE: Leonard S. Spector and Jacqueline R. Smith, *Nuclear Ambitions: The Spread of Nuclear Weapons 1989-1990* (Boulder, CO: Westview Press, 1990) and Nuclear Non-Proliferation Project, "Nuclear Proliferation Status Report July 1992," (Washington, DC: Carnegie Endowment for International Peace, July 1, 1992). The latter report also: names Libya as "presumed to be seeking N-weapons," but does not cite evidence of indigenous nuclear weapon facilities; and names Syria as identified by a U.S. official as having a "nuclear program with suspicious intentions," but no suspicious facilities have been publicly cited.

on this list now appear to have halted, or even reversed, their programs. In a class by themselves are three republics of the former Soviet Union—Belarus, Kazakhstan, and Ukraine. On the territory of each are former Soviet strategic nuclear weapons. These weapons are nominally under the joint control of the Commonwealth of Independent States. Each of the three governments has pledged to abide by the START I agreement and to join the NPT as a non-nuclear-weapon state (so far, Belarus has ratified both treaties, Kazakhstan the START I Treaty). Should any of them fail to abide by that promise, it would become a de facto nuclear-weapon state, although

Table 2-7-Countries Generally Reported as Having Undeclared Offensive Chemical Warfare Capabilities

Region	CW Capability
Middle East	Egypt
	Iran
	Iraq[a]
	Israel
	Libya
	Syria
East Asia	China
	North Korea
	Taiwan
Southeast Asia	Myanmar (Burma)
	Vietnam

SOURCE: Gordon Burck and Charles C. Flowerree, *International Handbook on Chemical Weapons Proliferation (New York, NY:* Greenwood Press, 1991), pp. 164-171, cite 19 published reports, from 1985 *to* 1989, that identify nations suspected by various sources as having chemical weapon programs. In addition, a later publication, Elisa D. Harris, "Towards a Comprehensive Strategy for Halting Chemical and Biological Weapons Proliferation," *Arms Control: Contemporary Security Policy, vol. 12,* No. 2, September 1991, p. 129, cites statements of U.S. Government officials listing suspect countries; also added is *Russian Federation Foreign Intelligence Service Report: A New Challenge After the Cold War: Proliferation of* Weapons *of Mass* Destruction, JPRS-TND-93-O07. OTA hes listed here the nations mentioned In two-thirds or more of t hese sources published since 1989. See app. 2-A for the table compiled from these sources,

a U.N. inspections of Iraq found a considerable chemical arsenal; that which has been found is being destroyed. Quiescence of Iraqi programs probably depends on continued U.N. monitoring.

it might face technical difficulties in operating and maintaining the weapons.[32] As of this writing, Ukrainian delays in ratifying START and the NPT have caused the most international concern.

Table 2-7 names countries appearing in at least two-thirds of 11 published lists of countries suspected of covertly developing or producing offensive chemical weapon capabilities. OTA has made no effort to assess the scale of each countrys program, the precise meaning of capability,' or the evidence on which the allegations are based.

Table 2-8-Countries Generally Reported as Having Undeclared Offensive Biological Warfare Programs

Region	BW Program
Middle East	Iran
	Iraq[a]
	Israel
	Libya
	Syria
East Asia	China
	North Korea
	Taiwan

SOURCE: Mentioned in at least four of the following six (i.e., two-thirds): David Fairhall, "Eleven countries Defying Ban on Germ Weapons," *The Guardian* (London), Sept. *5, 1991,* p. 1.; Elisa Harris, "Towards a Comprehensive Strategy. . .," op. cit., p. 129; Seth Carus, " 'The Poor Man's Atomic Bomb'?' . . .," op. cit., p. 25; and Harvey J. MeGeorge, "Chemical Addiction," *Defense and Foreign Affairs,* April 1989, p. 17; Russian Federation Foreign Intelligence service, op. cit., and U.S. Arms Control and Disarmament Agency, "Adherence to and Compliance with Arms Control Agreements and The President's Report to Congress on Soviet Noncompliance with Arms Control" (Washington, DC: ACDA, January 14, 1993). See app. 2-A for the table derived from these sources.

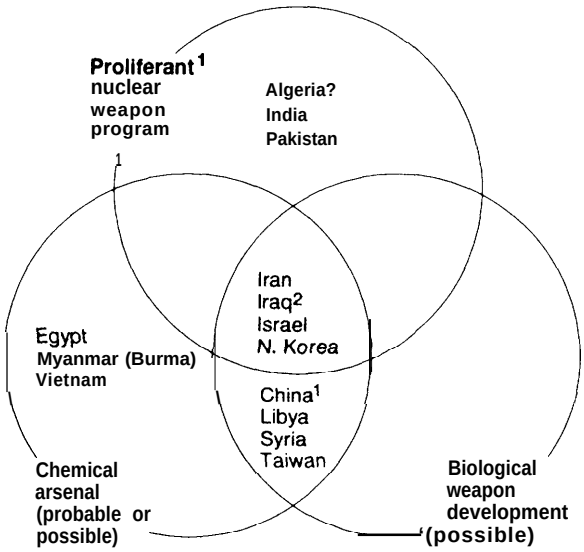
a U.N. inspections of Iraq found some evidence of offensive biological weapon research, but no stocks of agent. Quiescence of Iraqi programs probably depends on continued U.N. monitoring.

Table 2-8 summarizes 6 published lists of nations suspected of having undeclared biological weapon programs (which may include anything from research on offensive biological weapons to actual stockpiles of munitions). Like the list of chemical weapon suspects, this one arbitrarily identifies those appearing in two-thirds of the published reports. (The former Soviet Union had an undeclared offensive biological weapon program that violated its obligations under the 1972 BWC. The Russian Republic has ostensibly ended this program, but, since doubts remain about whether the program has been totally eliminated, it could be argued that Russia should be on the list.)

Figure 2-3 combines the data in the previous three tables to provide a combined perspective on

[32] A longer term option might be to dismantle the existing weapons and incorporate their fissile materials into new weapons.

Figure 2-3-Suspected Weapon of Mass Destruction Programs



This figure shows the considerable overlap among countries of chemical, biological, nuclear, and missile proliferation concern. The countries named In the figure are those in Tables 2-6,2-7, and 2-8; as the notes to those tables indicate, the lists are compiled from unclassified sources and should not be considered either authoritative or complete.

SOURCE: Office of Technology Assessment, 1993.

the states suspected of having or trying to develop **or produce weapons of mass** destruction. Three features of the problem stand out. First, the estimate for the current number of potential nuclear proliferants is relatively small--and smaller than **it might have been a** few years ago. Second, the **set** of countries trying to acquire nuclear weapons overlaps considerably with the set suspected of having chemical and biological weapon programs. Third, the most immediate and serious threats (beyond the potential threat posed by former Soviet republics) are concentrated in three regions of international rivalry: the Koreas, India-Pakistan, and the Middle East. Thus, on the one **hand, proliferation is still limited enough to encourage hope that it can be contained. On the other hand, it is occurring in places where political conflicts pose a major complication to nonproliferation efforts.**

Delivery Systems

The countries in shaded areas in figure **2-3 also** have Scud-range or better ballistic missiles. In addition, all the nations in the figure except Burma have fighter-bomber aircraft, most with ranges of 1,000 km or more and with payloads between **3,000 and 8,800 kg.**

Over a dozen countries outside of the five declared nuclear powers possess or are developing ballistic missiles **with ranges from 300-600 km.**[33] **Soviet** export of Scud-B missiles in the 1970s and 1980s played a major role in the spread of these missiles. The Missile Technology Control Regime has reduced the potential number of suppliers of missiles. However, additional countries have learned to copy, modify, extend the range of, and produce their own versions of previously imported missiles; a few have developed their own long-range systems-often in conjunction with space-launch programs and foreign technical assistance.

Those emerging missile powers that might have the intent to strike at the United States (e.g., Iran, Iraq, North Korea, Libya) will not be able to field long-range missiles or ICBMs over the next 10 years, and those that could develop the capability (e.g., Israel, India, Taiwan) are not likely to have the intent. It is therefore unlikely that any country (other than China and the former Soviet republics that already possess intercontinental ballistic missiles or ICBMs) would pose a direct ballistic missile threat to the U.S. within the next 10 years.

The only developing country that in the next decade is likely to be able to threaten U.S. territory with ballistic missiles is China, which

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[33] See OTA, op. cit., footnote 11.

Table 2-9-Classification of Indigenous Production Capabilities of Ballistic Missiles

Country	None	Incipient[a]	Intermediate[a]	Advanced[a]
Middle East				
Libya	X			
Egypt		X ——————>		
Israel	—	—	—	X
Syria	X			
Iraq		X		
Iran	—	X ——————>		
Saudi Arabia	X			
Yemen	X			
South Asia				
India	—	—	—	X
Pakistan		X ——————>?		
East Asia				
Taiwan	—	—	—	X[b]?
North Korea	—	—	X ——> ?	
South Korea		—	X[b] ——————>	
Southern Africa				
South Africa		—	X ?——————> ?	
Latin America				
Argentina	—	— X ? — >		
Brazil	—	—	X[b] ——————>	

NOTES:

a "Incipient" means some capability to modify existing Scuds, but little else. "Intermediate" means the capability to reverse-engineer Scud-like missiles, to introduce changes, and to make solid-propellant short-range missiles. "Advanced" means capable of making missiles comparable to those produced by the United States in the mid-1960s (including intercontinental ballistic missiles and space launch vehicles).

b South Korea could be characterized as "Advanced" although it has only demonstrated capabilities for reverse-engineering. Largely because of diplomatic efforts by the United States since the 1970s, Taiwan and South Korea do not appear to be aggressively pursuing either ballistic or space-launch missile programs at the present time, although they would have the technological capability to do so if they chose. Brazil's space-launch rocket program is in abeyance for financial reasons, but its technological capability gives it missile-making potential.

—> Indicates estimated potential for progress over next 10 years.

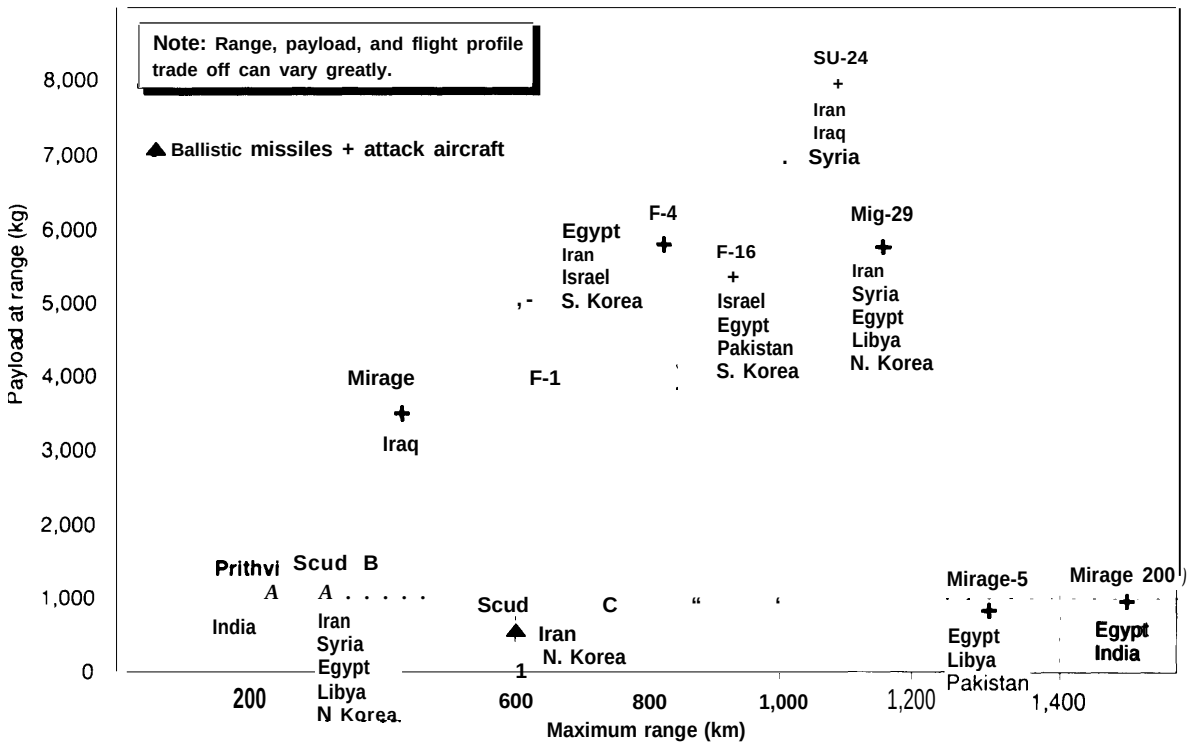
? Indicates greater uncertainty.

SOURCE: Adapted by OTA from Stanford Center for International Security and Arms Control, *Assessing Ballistic Missile Proliferation and Its Control,* November 1991, pp. 153, 15. See OTA background paper on technologies underlying weapons of mass destruction, in press.

has long had that capability. Israel and India, both suspected nuclear powers, have space launch vehicles in principle adaptable as missiles that could deliver weapons to intercontinental ranges. Both have also tested ballistic missiles that could reach the territory of other nuclear powers (e.g., Russia, in the case of Israel, and China, in the case of India), posing an implicit nuclear threat and possibly provoking counter-threats in return.

As shown in table 2-9, countries of proliferation concern vary widely in their ability to produce missiles, extend their capabilities, or design new types. Whereas several developing nations have essentially no indigenous capability, others match that of the United States in the mid-to-late 1960s. Practically all, however, depend on assistance or at least purchases of supplies from abroad; outside the most industri-

Figure 2-4--Proliferants' Delivery Systems: Selected Aircraft and Missiles



This figure shows nominal ranges and payloads of selected aircraft and missile systems of countries (beyond the 5 nuclear-weapon states) suspected of having or trying to acquire weapons of mass destruction, The graph is not Intended to be exhaustive, but only to indicate that each country already possesses aircraft or missile systems of one kind or another that could be adapted to deliver weapons of mass destruction.

SOURCE: Office of Technology Assessment, 1993.

ally advanced countries, only Israel, India, and China might be argued to be independent in missile design and production.[34] For a more detailed breakdown of missile possessions and programs, see the background paper to this report.

Few nations can produce advanced fighter aircraft indigenously; some produce them locally using foreign-licensed technology, but many have been able to import them. Figure 2-4 shows some of the types of combat aircraft owned by proliferate countries listed in figure 2-3. Scud missiles, the Iraqi-modified Scud, and the Indian Prithvi missile are included for comparison.

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34 Janne E. Nolan, *Trappings of Power: Ballistic Missiles in the Third World* (Washington, DC: Brookings Institution, 1991), P. 18. One reviewer of the literature on ballistic missile proliferation has concluded:

> . . . it is possible to show that the missile programs of almost all countries have been exaggerated in the literature. A careful scrutiny of the data shows that as of early 1992, only six or seven countries of the [author's] list of twenty-two had a meaningful ballistic missile program or capability. That includes India and Israel, the countries with the most developed programs; Brazil, Argentina, and possibly South Africa, which have meaningful indigenous launcher development programs but not yet operational ballistic missiles; and North Korea and Iraq which possess (in the case of Iraq did possess) the indigenous capability to produce Scuds. All of the other countries have either purchased missiles (mostly Frogs or Scuds or have indigenous efforts which does [sic] not look promising.)

Matthias Dembinski, "Ballistic Missile Proliferation and the New World Order: A Critical Survey of the Literature, " CSIA Discussion paper 92-07, Kennedy School of Government, Harvard University, July 1992, p. 6.

More than 40 developing countries possess antiship cruise missiles, with ranges typically under 150 km.[35] So far, there have been no publicly identified programs among proliferant nations to develop cruise missiles for delivering weapons of mass destruction. Rather than buy or indigenously develop long-range cruise missiles, proliferant states seeking them will most likely attempt either to attach warheads to nonmilitary systems (such as small aircraft) or to retrofit missiles originally equipped with conventional warheads (see delivery systems chapter of the background paper on technologies underlying weapons of mass destruction).

Since both nuclear and biological weapons carry so much destructive potential in such small packages, they are both suitable for small scale attacks by unconventional methods-e. g., smuggling and secret emplacement, or delivery by small boat or light aircraft. Politically and technically plausible scenarios for the current set of suspected proliferants to threaten U.S. territory with nuclear or other weapons of mass destruction, however, are difficult to devise. None have missiles or combat aircraft with sufficient range to reach the United States. But since strategic warfare with these weapons would be so much a matter of psychology, it is also difficult to rule it out. A state that badly wanted to wreak destruction on a U.S. city could probably do so, whether it had advanced delivery systems or not (and whether the United States had effective antiaircraft or antimissile defenses or not).

IMPLICATIONS OF PROLIFERATION

If more nations do acquire nuclear, chemical, or biological weapons, what will be the effect on international security? Since there are important differences in the effects and the military utilities of each of the three types of weapons, the consequences of their proliferation will not be the same. They may, however, be interrelated.

The following sections explore the consequences of proliferation from two perspectives. First, considering the broader concerns of the global political system and human welfare, what might be the consequences for the world? Second, from the narrower Perspective of U.S. deterrence and potential uses of force, what might be the consequences for U.S. foreign and military policies?

The International Community

NATURE OF WARFARE

Destruction of human beings on a large scale is not new to warfare, or even to this century. Nevertheless, weapons of mass destruction compress the amount of time and effort needed to kill. Wars lasting a few hours could now devastate populations, cities, or entire countries in ways that previously took months or years. Nuclear or biological wars among proliferant nations may not match the scope of a U.S.-Soviet exchange of thousands of thermonuclear weapons, but the damage to their people could still be catastrophic.

Even in a conventional war, high-explosive or incendiary bombing attacks on nuclear, chemical, or biological facilities could release harmful substances into the environment. In this way, a countrys own weapons of mass destruction could be turned against it. In a war in which only one side had and used weapons of mass destruction, the other might retaliate by attacking nuclear reactors, possibly causing mass casualties (from radioactive fallout) and economic disruption comparable to those it had suffered.

CHANCES OF WAR

Some scholars have argued that, at least under the right circumstances, further nuclear prolifera-

35 W. Seth Carus, *Cruise Missile Proliferation in the 1990s* (Washington, DC: Center for Strategic and International Studies, 1992), p. 2; and *Eric* Arnett, *Sea-bunched Cruise Missiles and U.S. Security (New York, NY:* Praeger, 1991), p. *28.*

tion could be a good thing.[36] One of these authors argues that well-managed proliferation could produce a stable order in Europe, but that "Unfortunately, however, any proliferation is likely to be mismanaged. ' He cites four principal dangers:

- existing nuclear powers might use force to prevent others from getting nuclear weapons (as Israel tried against Iraq);
- new nuclear powers might only be able to afford nuclear forces vulnerable to destruction by preemptive first strikes, leading to instabilities;
- those controlling nuclear weapons might believe they could fight and win nuclear wars; and
- increasing the number of fingers on the nuclear trigger would increase the probability that some would use them accidentally or irrationally, or that terrorists would steal them.[37]

The same principles would probably apply, in varying degrees, to chemical and biological weapons. The predominant view amongst most scholars-and national governments-is that these dangers are not controllable and that proliferation should be avoided, not accepted.

INTERSTATE RELATIONS

Massively destructive weapons can alter international balances of power in both positive and negative ways. A relatively small nation may gain useful leverage against larger or more numerous adversaries. France's primary argument for acquiring its nuclear force *de frappe* was that although a French nuclear blow would be limited in comparison to the damage that the Soviet Union could inflict, it might still impose a higher price on aggression than the Soviets would find worthwhile. Israel seems to believe that its undeclared nuclear weapons give it an ultimate deterrent against invasion from its more numerous Arab neighbors. But, while some nations might use nuclear weapons to deter aggression, aggressor nations might use them to deter resistance.

COLLECTIVE SECURITY OPERATIONS

The spread of weapons of mass destruction may make it more difficult to organize groups of nations (whether under U.N. aegis or within regional security groupings) to respond to acts of aggression. For example, we do not know, if the Iraqi Scuds had been known to carry nuclear warheads,

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36 See Kenneth N, Waltz-, 'The Spread of Nuclear Weapons: More May Be Better,' *Adelphi Paper 171* (London: International Institute for Strategic Studies, 1981) and John J. Weltman, "Nuclear Devolution and World Order," *World Politics,* vol. *32,* January 1980, pp. 169-193, arguing although that considerable nuclear proliferation is inevitable, regional balances of nuclear power could emerge and be no less stable than the superpower balance; the latter author was only slightly less optimistic in "Managing Nuclear Multipolarity,' *International Security,* winter 1981/82, vol. 6, No. 3, pp. 182-194. See also John Mearsheimer, "Back to the Future: Instability in Europe After the Cold War, " *International Security,* summer 1990 (vol. 15, No. 1), pp. 5-56. Mearsheimer advocates that

> . . . the United States should encourage the limited and carefully managed proliferation of nuclear weapons in Europe. The best hope for avoiding war in post-Cold-War Europe is nuclear deterrence; hence some nuclear proliferation is necessary to compensate for the withdrawal of the Soviet and American nuclear arsenals from Central Europe. Ideally, as I have argued, nuclear weapons would spread to Germany, but to no other state. (p. 54)

He does not explain how proliferation can be "carefully managed" and confined only to Germany, or, indeed, only to Europe.

Another author argues not so much that nuclear proliferation will be stabilizing, but that it is inevitable, He therefore concludes that the U.S. must learn to adjust to the situation. While it may be possible tofocus some policy efforts on temporarily delaying proliferation to some "unstable or brutal anti-American dictatorships,' for the most part the U.S. should give up 'a non-proliferation system that is becoming less and less viable." Ted Galen Carpenter, "A New proliferation Policy," *The National Interest,* summer 1992, pp. 63-72,

37 Paraphrased from Mearsheimer, Op cit., footnote 36, pp. 37-38.

- whether Saudi Arabia would have agreed to participate in a coalition to drive Iraq from Kuwait,
- whether other Arab states within range of Iraqi missiles or aircraft would have joined,
- whether the United States and European nations would have been willing to send their troops into the region, or
- what role U.S. nuclear capabilities might have played in building coalition consensus.

Nor do we know what coalition reactions would have been if Iraq had threatened to respond with nuclear or biological attacks on European cities. A more dangerous Iraqi threat might have caused coalition participants to think twice. On the other hand, they may have come to feel all the more strongly that it was better to stop Iraqi aggression sooner, rather than later when its ambitions and power had grown even larger. The United States, for its part, might have considered additional long-range bomber or cruise missile attacks as alternatives to large ground-troop concentrations.

FALLING DOMINOES

Arms races

One likely result of proliferation is more proliferation. India justifies its nuclear weapon program by pointing to China's. Pakistan has tried to keep up with India. Iran may have decided it must match Iraq's chemical weapons, as well as try to develop nuclear weapons. Some Arab nations have sought nuclear weapons to counter those of Israel; or, they may have pursued biological weapons as the "poor man's atomic bomb. " If proliferation proceeds, more nations that until now have forgone the nuclear option may reconsider. For example, if North Korea got nuclear weapons, South Korea would be strongly tempted to follow suit, particularly if it perceived U.S. security guarantees and involvement in Pacific affairs to weakening. Japan also might question its own renunciation of the weapons.

Erosion of norms

Iraq's use of chemical weapons has already weakened the international taboo attached to them. The frost large-scale use of biological weapons would be shocking, the next less so, and so on. Moreover, a single successful application of a biological weapon might inspire non-state terrorists to try the same thing. Although a small nuclear war *might* mobilize the international community into action to prevent a recurrence, it might instead show that outside powers will try to keep their distance.

Increase of supply

More states in the business of making nuclear, chemical, or biological weapons could also mean more potential suppliers of means of production or actual weapons to still other parties-perhaps states, perhaps terrorist groups. Even if proliferant states did not intentionally transfer these goods, they might become targets for illicit foreign purchasers and smugglers.

SHORT OF WAR...

Nuclear, chemical, and biological weapons exact a toll, whether possessing states ever use them or not. Experiences in both the United States and the former Soviet Union show some of the costs and risks.

Increased chances of terrorist theft

This report does not address the non-state terrorist uses of weapons of mass destruction.[38] But any state building these weapons must erect and maintain a formidable security apparatus, both to protect the secrets of the weapons and to prevent their falling into unauthorized hands. Ineffective or inexperienced governments, especially those with relatively unstable regimes, may

38 See U.S. Congress, Office of Technology Assessment, *Technology Against Terrorism: Structuring Security*, OTA-ISC-511 (Washington, DC: U.S. Government Printing Office, January 1992).

not be as successful as the owners of nuclear, chemical, or biological weapon facilities have been so far. Indeed, it is still too early to be certain that Russia will successfully gain and keep stable, central control over all the weapons of the former Soviet Union.

Increased risk from political fragmentation

Disintegration of national political authority, regional secession, or civil war could deliver weapons of mass destruction into the hands of groups **that, at** best, would be poorly equipped to manage the weapons safely, or at worst, would use them irresponsibly. Again, the republics of the former Soviet Union, perhaps including Russia, seem vulnerable to this risk.

Diversion of economic resources

The start-up costs of a nuclear weapon program are great. Iraq probably spent about $10 billion before its efforts were interrupted. A narrower program than Iraq's might cost less, but could still cost billions. Acquisition programs for chemical and biological weapons cost much less. Despite the expense, some countries may see weapons of mass destruction as substitutes for larger, even more expensive, conventional forces (the United States decided in the 1960s that nuclear weapons were a way of getting ''more bang for the buck' '). At the same time, those in charge of conventional forces may feel that spending on weapons of mass destruction diverts resources from more usable military instruments. Nevertheless, in most cases the quest for weapons of mass destruction is usually embedded in an across-the-board arms competition. Each country's possession of such a weapon will inevitably increase the stakes of the competition for its adversaries, feeding regional arms races. Nations pay for these arms races at the cost of their peoples' welfare.

Safety and environmental effects on proliferants' and their neighbors' populations

The United States and the former Soviet Union face monstrous clean-up operations: radioactive elements and hazardous chemicals contaminate the soil, sediments, surface water, and groundwater at most or all of the sites where nuclear weapons were manufactured.[39] To complete the U.S. cleanup could cost hundreds of billions of dollars. Little is known about the public health consequences if this mess is not cleaned up-as, in the former Soviet Union, it seems unlikely to be. Production-and destruction--of chemical weapons also poses environmental risks. Neither the United States nor Russia has developed politically acceptable plans (let alone built the facilities) to destroy their chemical weapon stockpiles according to the 10-year schedule specified in the CWC.[40]

There is little reason to think that developing nations manufacturing weapons of mass destruction will allocate much of their scarce resources to environmental health and safety. One might take as an indicator the recklessness with which the Iraqi chemical weapon program handled toxic chemicals (as reported by U.N. Special Commission inspectors).

Infectious biological agents eventually die, and toxins are biodegradable. But some spore-forming microorganisms, in particular anthrax bacteria, can persist in the environment for many years. Moreover, biological weapon programs themselves can pose a threat to public health, as apparently happened when anthrax spores were accidentally released in 1979 from a biological

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39 See U.S. Congress, Office of Technology Assessment, *Complex Cleanup: The Environmental Legacy of Nuclear Weapons Production, OTA-O-484 (Washington* DC: U.S. Government Printing Office, February 1991) for an assessment of the scope of the U.S. problem; the situation in the former Soviet Union is unquestionably **far** worse.

40 See U.S. Congress, Office of Technology Assessment, *Disposal of Chemical Weapons: Alternative Technologies*, background paper, OTA-BP-O-95 (Washington, DC: Office of Technology Assessment June 1992).

weapon research facility in the Soviet city of Sverdlovsk, triggering a deadly epidemic.[41]

U.S. Political-Military Policies

U.S. military forces are likely to continue to be called to deter or combat military actions abroad, whether unilaterally or as a member of an international coalition. Future aggressor states having weapons of mass destruction will change the context for U.S. decisions about when and how to threaten or use force.

DETERRENCE

Deterrence oft he United States

The United States acted to protect its national interests against challenges from a Soviet Union heavily armed with nuclear, chemical, and possibly biological weapons aimed at U.S. territory, U.S. forces abroad, and U.S. allies. Nevertheless, the risk of direct conflict with the Soviet Union clearly constrained U.S. definitions of its national interests, its policies for defending those interests, and its strategies and tactics for managing clashes with Soviet international policies.

Would other, though vastly smaller, nuclear (or biological or chemical) powers be able to deter the United States from regional interventions to protect its interests? Possibly, depending on whether U.S. leaders perceived the stakes to be worth the risks. In the case of Iraq, for example, the United States was concerned about, but not deterred by, the known Iraqi chemical arsenal and the possibility of a biological weapon threat. The United States would have had a different problem if Iraq had had nuclear weapons. If Iraq could have credibly threatened to use a few nuclear weapons against U.S. cities or those of U.S. allies, the calculus of U.S. intervention would have been even more different.

The nature of U.S. decisions might have depended in part on whether U.S. leaders believed that the Iraqi rulers would have themselves been deterred from escalating to the use of nuclear weapons by U.S. nuclear retaliatory capabilities. (To the extent that U.S. military forces will be used in conjunction of those of other states, the dynamics of building and sustaining coalitions in the face of threats from weapons of mass destruction will also be important; this topic is discussed below.)

We now know of one historical case in which the proliferant country hoped to use its nuclear weapon not to *deter* U.S. military intervention, but to ***cause*** it. Although South Africa kept its nuclear weapon program secret,

> The strategy was that if the situation in southern Africa were to deteriorate seriously, a confidential indication of the [nuclear] deterrent capability would be given to one or more of the major powers, for example the United States, in an attempt to persuade them to intervene.[42]

Thus, South Africa hoped to engage in a kind of reverse nuclear blackmail.

Deterrence by the United States

To some extent, the U.S. and Soviet nuclear arsenals neutralized each other; the two nuclear superpowers never engaged in direct military conflict with one another at least in part because of the risk of escalation to mutual annihilation. Even in much more one-sided confrontations, the availability of nuclear weapons to the greater power did not deter, for example, the North Vietnamese from engaging the United States or the Mujaheddin in Afghanistan from taking on the

41 U.S. suspicions about this *event* were finally *Officiall, confirmed* by the Russians in *1992*. See R. Jeffrey Smith, "Yeltsin Blames '79 Anthrax On Germ Warfare Efforts, ' *Washington Post,* June 16, 1992, pp. Al, A2. For a Russian *Komsomolskaya Pravda report with* details on the incident, see Foreign Broadcast Information Service, *JPRS Report: Proliferation,* JPRS-TND-92-022, July 10, 1992, pp. 19-24. See also Milton Leitenberg, "Anthrax in Sverdlovsk: New Pieces to the Puzzle," *Arms Control Today,* April 1992, pp. l&13.

42 President F.W. de Klerk, speech to joint session of South African Parliament, transcribed from Johannesburg Radio South Africa Network, Mar. 24, 1993 (JPRS-TND-93-009, Mar. 29, 1993, p. 2).

Soviet Union. Nor did the nuclear stand-off deter the superpowers from arming each other's enemies in those two conflicts. In these cases, the lesser powers had good reason to believe that the nuclear superpowers were very unlikely to use their nuclear weapons-both because of the opprobrium that would come from such a disproportionate use of violence and because of the risk of escalation of conflict with the victim's nuclear-armed ally.

Emerging nuclear powers that avoid direct attacks on the United States may justifiably doubt whether the United States would unleash nuclear weapons on them for conventionally armed acts of aggression elsewhere. Thus, U.S. *nuclear* deterrence, already a small factor in such situations, might not be much affected by nuclear proliferation.

U.S. *conventional* military threats may have deterred less industrialized countries from attacking U.S. interests abroad. Would further proliferation of weapons of mass destruction weaken such deterrence in the future? The issue in this case is not just whether U.S. leaders decide that U.S. interests at stake justify deploying conventional forces in the face of the risks to them posed by weapons of mass destruction: it is also whether the nation to be deterred would believe that its own threats would counter-deter the United States, leaving itself free to act without fear of U.S. intervention. For the next several years, such a counter-deterrent threat might take the form of either limited unconventional attacks on U.S. cities, or somewhat larger, but still limited, attacks on U.S. forces intervening abroad.

MILITARY OPERATIONS

In preparing for war in Central Europe, U.S. forces had to take account of the possibility that they would confront Warsaw Pact nuclear or chemical weapons. They could probably learn to prepare to operate under such threats elsewhere in the world. Even so, having to cope with weapons of mass destruction would make U.S. foreign interventions costlier and more difficult. Nuclear or biological[43] weapons (to a greater extent than chemical) would increase the risk of casualties. For Operation Desert Shield (preceding Desert Storm), the U.S. had to move in large quantities of troops and supplies through a few ports and airfields. An effective nuclear, chemical, or biological threat against vital transportation nodes or staging areas would have caused great difficulty for the Coalition. (An alternative strategy might have been to rely on still more intensive long-range cruise-missile and bombing attacks than were used in Desert Storm; this strategy, however, would still leave the problem of occupying territory on the ground.)

During the Cold War, part of U.S. preparedness in the European theater was based on the assumption that the United States would retaliate in kind against Soviet nuclear (and possibly against chemical) attacks; tither, the United States did not foreclose the possibility that it would initiate the use of nuclear weapons if it were losing a conventional battle. On the other hand, much of the world would probably see U.S. first use of nuclear weapons in the developing world as grossly disproportionate to any conceivable U.S. interests there.[44]

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[43] In the absence of effective means of detection that would allow soldiers to don protective gear soon enough.

[44] U.S. decisionmakers may have already internalized such concerns. Lewis Dunn notes that

> . . . war games on this subject have frequently revealed a reluctance of players from the Washington national security elite to use nuclear weapons against third-world countries, even in retaliation for nuclear use.

Containing Nuclear Proliferation, Adelphi Papers 263 (London: Brassey's for the International Institute for Strategic Studies, 1991), p. 73, note 1-4S.

ALLIANCES OR COALITIONS

A continuing theme of the Cold War was the West European fear that the superpowers would fight a ''tactical' nuclear war in Europe-with consequences for them similar to those of a ''strategic' nuclear exchange for the United States. In the case of the U.S.-Soviet contest, however, the United States shared at least some risk of nuclear devastation with its allies. In confrontations with proliferant nuclear powers lacking the means to attack the United States, U.S. allies abroad would bear heavier relative risks and may be reluctant to participate.

On the other hand, some states facing a nuclear adversary might welcome an alliance with a nuclear power—if they believed that the adversary would be deterred by the possibility of U.S. nuclear retaliation. As noted above, though, such a deterrent threat might not be fully credible.

A NEW DIMENSION TO PROLIFERATION: RISKS FROM THE BREAKUP OF THE SOVIET UNION

The breakup of the Soviet Union—and the shakiness of governmental authority in the splintered republics--could contribute to all categories of the proliferation problem.[45] The threat is potentially great, but just how great it will be is hard to predict at this writing. The major dangers include the following.

Seizure of Soviet Weapons by Non-Russian Authorities

Ukraine and Kazakhstan have agreed in principle to ultimate elimination of the strategic nuclear weapons on their territories. Even so, the missiles and warheads are still in place. In the case of Ukraine, as of this writing the government continues to place various conditions (such as monetary compensation and regional security guarantees) on its progress toward non-nuclear status. Even if the various republics comply fully with their commitment-in the Lisbon Protocol to the START agreement-to forswear nuclear weapons, actual removal would take several years. Should they choose in the meantime to become nuclear powers themselves, they could seize these weapons and adapt them to that purpose. Alternatively, they might dismantle the weapons for their fissile materials and then fail to control those materials properly.

Emergence of Ukraine or Kazakhstan (Belarus has ratified the NPT) as new nuclear powers would seriously undermine the nonproliferation regime in several ways. First, depending on world reaction, other potential nuclear powers may conclude that the political and diplomatic costs of joining the nuclear club are tolerable. Second, the retention of former Soviet nuclear weapons outside Russia would likely torpedo the ongoing nuclear arms reductions between the United States and Russia. Russian ratification of the START I Treaty was contingent on the other republics ratifying the Treaty, agreeing to implementation measures, and joining the NPT Since the NPT links renunciation of nuclear weapons on the part of the nonnuclear powers with ''effective measures relating to cessation of the nuclear arms race,'' interrupting the U.S./Russian arms reductions process could have serious repercussions when a conference to renew the NPT convenes in 1995. Finally, the de facto creation of new nuclear states in Europe would affect regional security issues and balances of power, possibly triggering other European states to reevaluate their nonnuclear status.

It appears that all Soviet tactical nuclear weapons have been pulled into the Russian

[45] For further discussion of resources from the former Soviet Union that could aid nuclear proliferation, see Zachary Davis and Jonathan Medalia, *Nuclear Proliferation From Russia: Options for Control, Report 92-310 INR* (Washington, DC: Congressional Research Service, Mar. 30, 1992). See also Kurt M. Campbell, Ashton B. Carter, Steven E. Miller, and Charles A. Zraket, *Soviet Nuclear Fission: Control of the Nuclear Arsenal in a Disintegrating Soviet Union* (Cambridge, MA: Harvard University Center for Science & International Affairs, Studies in International Security, No. 1, November 1991); and Graham Allison et al., *Cooperative Denuclearization: From Pledges to Deeds* (Cambridge, MA: Harvard University Center for Science & International Affairs, Studies in International Security, No. 2, January 1993).

Federation. The question of whether the Russian Federation itself will fragment, or whether the custodial system for the thousands of former Soviet nuclear weapons and hundreds of tons of nuclear weapon materials (enriched uranium and plutonium) will break down, still seems unsettled. One can imagine either successor states attempting to become nuclear powers, or non-state groups seizing and exploiting weapons or materials.

Export of Weapons or of Weapon Components

Press reports indicate the smuggling of all kinds from the former Soviet Union is a growing problem. Despite some rumors, there is as yet no serious evidence that Soviet nuclear weapons have been sold to other countries. There have been no reports of the export of chemical or biological weapons, but the possibility that it might happen cannot yet be entirely excluded. Much will depend on the continued integrity of the Russian nuclear weapon custodial system under conditions of economic hardship and political confusion.

Emigration of Technical Personnel

There is also no clear evidence yet that former Soviet technical personnel with knowledge of how to build weapons of mass destruction have emigrated to other countries. There have been reports of some attempts at recruitment. Although such scientists or technicians might not be essential to a third-world country's weapon program, they might be able to provide useful guidance about what works and what doesn't work, thus speeding the development of weapons.

Export of Critical Information, Equipment or Materials

The most immediate risk may lie here. The major areas of concern are dual-use technologies, critical dual-use materials, and fissile materials. Russia and the other former Soviet republics face severe shortages of hard currency. They are trying to establish market systems of production and trade, but the legal infrastructure to regulate those activities is not yet fully developed. It is possible that some exporting enterprises may be unaware of the proliferation risks of particular goods; others may intentionally take advantage of poorly enforced or corruptly administered export control laws. A Ukrainian firm reportedly has already exported tens of tons of hafnium and zirconium, metals on the Nuclear Suppliers Group list of restricted dual-use items.[46]

In its need for foreign trade, a government itself may disagree with other nations' judgments about which exports constitute a proliferation risk. For example, Russia has declared its intent to proceed, over U.S. objections, with sale to India of cryogenic rocket motor technology for space launch vehicles. The United States, declaring the sale to be in violation of the Missile Technology Control Regime constraints that the Russians had voluntarily adopted, has suspended U.S. trade with both the Russian and Indian organizations involved.

Fissile materials might in one way or another be diverted from former Soviet weapon stockpiles or from production facilities. The possibility of a breakdown in the Russian custodial system for weapons is mentioned above. A similar breakdown in the control of material production facilities, leading to theft and export of fissile

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46 See William C. Potter, "Nuclear Exports From the Former Soviet Union: What's New, What's True," *Arms Control Today*, January/February 1993, p. 3.

materials, is also conceivable. Outside Russia, some important former Soviet production facilities remain; of particular concern is a fast breeder reactor, capable of producing over 100 kg of weapon-grade plutonium per year, at Aktau, Kazakhstan.[47]

Indigenous Weapon Development

A longer term possibility is that some former Soviet republics might utilize their own expertise, equipment, or materials to develop indigenous weapon programs.[48] Unlike other new proliferants, such countries might inherit, rather than have to import, some critical weapon technologies. Given the current economic conditions throughout the former Soviet Union, new nuclear weapon programs do not seem to be an immediate threat. Chemical or biological weapons would be easier to develop. Kazakhstan has inherited chemical and biological weapon facilities from the former Soviet military complex; Uzbekistan has inherited test ranges for both types of weapons.

47 Ibid., *p.* 5. See also William C. Potter, *Nuclear Profiles of the Soviet Successor States* (Monterey, CA: CIS Nonproliferation Project, Monterey Institute of International Studies, April 1993) for more detailed listings of former Soviet nuclear-related facilities.

48 See Central Intelligence *Agency,* Directorate of Intelligence, ***The Defense Industries of the Newly Independent States of Eurasia,*** CIA publication number OSE-93-10001, January 1993.