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Aadhi Raat Ke Baad
"After Midnight"

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*Aadhi Raat Ke Baad**

(“After Midnight”)

S. Rashid Naim

The Bulletin of Atomic Scientists has a clock on which midnight would signal the outbreak of nuclear war between the superpowers. Tension between the superpowers is reflected by the minutes left to midnight. This study evaluates the likelihood of such a dreaded midnight occurring in South Asia, discusses the likely scenarios in a nuclear exchange between India and Pakistan, and estimates the likely subsequent damage.

It is imperative that those making decisions on the acquisition and use of nuclear weapons in South Asia should understand both what is known *and unknown* about the consequences of the use of nuclear weapons. Indeed, it may be more important to be aware of the extent to which the impact of the use of nuclear weapons cannot be predicted. This study discusses both the predictable and unpredictable effects of the use of nuclear weapons.

The Immediate Effects of Nuclear Weapon Use

An atomic explosion releases three forms of energy: blast, nuclear radiation, and thermal radiation (heat). Blast is a high-powered wind that is forced away from the point of explosion and is caused by a sudden increase in pressure around the area of blast leading to overpressure. Although it lasts for only a short time after an explosion, overpressure causes, directly or indirectly, most of the material damage on the surface, or at low or moderate altitudes in the air. The magnitude of the blast effect depends on the yield of the weapon and the height of burst.

A second type of destructive energy released by a nuclear explosion is thermal radiation. Actually all the energy released by a nuclear explosion, including residual radiation from weapon debris, is thermal energy (heat), but what we define as thermal radiation is the part that can cause fire damage and personal injury.[1] Approximately 35 percent of the energy of a typical nuclear explosion at up to a height of 100,000 feet is in the form of thermal energy of this kind.[2]

Thermal radiation causes damage in two ways. First, it results in dangerous burns on human flesh. Second, depending upon the amount of combustible material in the area of the explosion, it can lead to massive fires. A single megaton weapon can cause third degree burns up to five miles away, second degree burns up to distances of six miles, first degree burns similar to sunburn up to seven miles away.[3] The distances up to which burns are caused depend upon weather conditions; the behavior pattern of thermal energy is similar to that of sunlight. Thermal radiation also results in massive fires. According to some estimates, up to 10 percent of the buildings within the 5 psi (pounds per square inch) ring may catch fire, whereas within the 2 psi ring, about 2 percent of the buildings may sustain fire damage.[4] The vertical updraft of heated air may cause a firestorm which can be made worse by existing winds.[5] Temperatures can exceed 1,000°C.

A nuclear explosion also releases two forms of radiation: direct nuclear radiation and fallout. Direct nuclear radiation is a stream of atomic particles which may be injurious or fatal to a human being, depending upon the extent of exposure. Fallout is nuclear radiation caused by contaminated debris lifted by the explosion and carried by the wind to other areas. A dose of 600 rem (Roentgen Equivalent Man).within a short period of time (six to seven days) could result in fatal illness among 90 percent of the population exposed. A dose of 450 rem within a short period of time could cause up to 50 percent fatalities. A dose of 300 rem would kill about 10 percent of those exposed.[6]

Long-Term Effects of Nuclear Weapon Use

Besides the long-term impact that would be caused by the destruction of structures and resources in the target area there are other long-term effects, both calculable and those which cannot be estimated. Among the long-term effects which can be calculated with reasonable precision are the effects of low-level ionizing radiation and damage to the ozone layer. Incalculable or unpredictable long-term effects which are possible include irreversible damage to the ecological system, impact on food production, and other unknown physical and biological effects.

Calculable Effects

Among the long-term effects of the use of nuclear weapons that can be calculated with some degree of precision is the effect of low-level ionizing radiation. We have already discussed the effects of intensive radiation above. Doses of ionizing radiation that are too small to cause immediate death or incapacitate those exposed can, nevertheless, have harmful effects in the long-term. Such exposure to low-level radiation can be caused by sublethal doses from the nuclear blast itself, by being on the fringes of the fallout zone of a nuclear blast, or by delayed fallout from debris deposited in the troposphere and stratosphere. Low-level radiation could continue to be accumulated in body organs in harmful quantities for as long as forty years after the initial explosion.[7] Such exposure can cause increased risk of cancer of all types.[8] It is also expected to cause chromosomal damage leading to increased abortions and genetic defects among newborns.[9] Calculations based on the effect of a large nuclear exchange between the United States and the Soviet Union predict an increase by several millions in cancer deaths. These figures are for attacks not specifically aimed at civilian areas and not using weapons designed to release high levels of radiation. If the latter were the case, much higher levels of cancer increases may be expected.[10]

Large nuclear explosions would also inject quantities of nitrogen oxide into the stratosphere. This is likely to contribute towards the thinning of the ozone layer.[11] Though nuclear exchanges of the intensity discussed here are unlikely to inject large quantities of nitrogen oxide into the stratosphere the impact of smaller amounts cannot be ignored.

Then there are the effects that nuclear war would have on the economic, social and political order in India and Pakistan. These too can be classified as long-term effects, some of which can be predicted and others cannot. The extent to which nuclear war would affect society in these areas is dependent upon the nature of the exchange and will be discussed under each of the scenarios below.

Incalculable Effects

The effects of nuclear war that cannot be predicted or calculated are as important as effects for which calculations can be attempted. Among the expected effects of nuclear weapons that cannot be calculated are irreversible changes in the weather pattern and environment,[12] mutations in plant and animal life,[13] and unpredictable changes in the social and political order which cannot be predicted. Though such effects would only be significant in a nuclear exchange of massive proportions, exchanges of the type likely to occur in South Asia could still have some impact in these areas.

Prediction of Effects

Any prediction of the effects of a nuclear war must be prefaced by a statement on the problems of making such predictions and their imprecise nature. This applies in particular to the long-term effects of nuclear war. For instance death and destruction caused by fires from explosions cannot be calculated with precision because they will be dependent on such variables as weather conditions, details of building construction, time of day, precise point of detonation of the nuclear device and the extent to which emergency services remain operational.

Similarly the number of casualties from fallout would depend upon variables such as size and nature of the attack, population distribution, population posture during and after an attack, wind speed and direction, time of day when attack occurs, etc.

Precise calculation of the number of deaths caused by cancer over a period of several decades is complicated by such uncertainties as age breakdown of the population, degree of protection available, population posture following an attack, and the time of year when the attack occurs.

Predictions about deaths caused by economic, social and political disruption are heavily dependent on the nature of the attack, warning time prior to attack, the psychological impact of the attack, and other unpredictable factors.

The rate and efficiency of political and economic recovery cannot be predicted with certainty. It is possible to calculate direct economic damage by assuming the size and location of the explosions, and the hardness of economic assets; however, the issues of bottlenecks and synergy cannot be addressed by such assumptions. Similarly economic and political recovery would be influenced by whether the war ended or continued after a nuclear exchange.

In calculating the damage from fallout we have assumed that the season is Monsoon/Winter, the wind direction is Northeast and wind speed 10 Mph, that the populations are unprotected, and that there is either very little or no warning time.

This study uses two sizes of weapons—20 kilotons and 1 megaton—to calculate the immediate effects of nuclear weapons. Several reasons dictate these sizes. First, a 15 to 20 kiloton bomb is within India's manufacturing capability. Second, if a fission-fusion-fission device (hydrogen bomb) is developed by either or both countries, the likely size will be 1 megaton, because weapons with larger yields would have a diminishing, marginal effect, given the size of likely targets. Large nuclear weapons are likely to be used against civilian targets as part of a countervalue strategy, and given the size of most urban centers in South Asia, a one megaton weapon would be of sufficient strength to achieve the objective of destroying them.

Because we only discuss the use of 20 kT or 1 MT weapons (and because some of the data on effects are available only for one of these sizes or for a different size altogether), a scaling formula is used to convert the area of a psi ring from an explosion of one size to the area of a psi ring of the same strength from an explosion of another size. This formula is:

$$\frac{D}{D'} = \left[\frac{W}{W'}\right]^{1/3}$$

Where W' is the kT yield from an explosion of known size, D' is the distance from the point of explosion of W' yield where a given overpressure occurs, W is the kT yield from another explosion, and D is the distance from the point of explosion of W yield where the same level of overpressure as in a W' yield explosion will occur.[14]

The psi ring is useful because some investigators calculate death and injuries by assuming that all people inside the 5 psi ring will die, and nobody outside it will die.[15] The same method is used in this study to predict deaths and injuries. The area (square miles) within the 5 psi ring is designated the lethal area, that is, the area within which all persons are killed. The lethal area is computed by means of the following formula: $A = \pi r^2$ where A is the area within the 5 psi ring, r is the radius of the 5 psi ring, and π is 3.1416. The number of deaths caused by a weapon Td is determined by multiplying the given population density Pd by the lethal area A (Td = Pd x A).

A study of casualty figures from the Hiroshima and Nagasaki bombings and projected casualties in simulated nuclear exchanges between the U.S. and the USSR[16] shows that in nuclear explosions injuries generally do not exceed deaths, and when they do so it is only by a small fraction. In this study, just as we have used the 5 psi ring as the limit of the lethal area, we have also used the 2.2 psi ring as the outer limit of the injury zone; all persons outside the 5 psi ring but within the 2.2 psi ring are injured, and none outside the area of the 2.2 psi ring are injured. This formulation is based on the following reasoning: a study of the casualty figures, real and projected, in the above sources showed that the number of deaths declines sharply beyond the 3.25 psi ring and becomes relatively negligible beyond the 1.2 psi ring, whereas the number of injured survivors is the highest within the area between these two rings. Taking the median point between the 3.25 and 1.2 psi rings, we have therefore estimated that everyone between the 5 psi ring and the 2.2 psi ring will be injured, and no one beyond the 2.2 psi ring will suffer injuries. Like the use of the 5 psi ring to determine the lethal area, the use of the 2.2 psi ring to determine the zone of injury will make the task of calculating casualties easier without making too great a sacrifice in accuracy.

Property damage is defined in terms of square miles of built-up area destroyed. The 2 psi ring is used to determine property damage.[17] Using the calculation system in Glasstone and Dolan,[18] the area likely to be destroyed is shown in Table 2.1. Variations in terrain and the possibility of a firestorm could affect these property damage figures by a factor of up to five.[19] As we shall see, certain features peculiar to South Asia would sharply increase the number of fatalities and injuries and amount of property damage implied by the method of calculation used in Table 2.1. Casualty and damage figures projected by the above means are somewhat optimistic; actual figures are likely to be higher. Finally, it should be remembered that the figures generated by the above method are only approximations.

Long-term effects from fallout have been calculated using the method described in Glasstone and Dolan.[20] The debris raised by the size and type of explosion (20 kT surface or 1 MT air) was calculated for each target. A wind speed of 10 mph is assumed and the amount of fallout descending over various distances from the explosion was calculated (See Table 2.2). Idealized unit-time dose-rate patterns created were then superimposed over a map of the area. Population density in the affected area was calculated to arrive at the number of people exposed to fallout radiation.

Factors Peculiar to South Asia

Some factors peculiar to the South Asian region could affect the extent of damage and number of casualties caused by a nuclear exchange between India and Pakistan. First, in terms of numbers the casualty figures in a South Asian nuclear exchange would be much higher than those likely to occur in a nuclear exchange in Europe, North America or the USSR. This is because of the higher population density in South Asia. However, lower levels of urbanization would mean that in percentage terms a smaller proportion of the total population would be destroyed in a South Asian nuclear exchange than in one in Europe, North America or the USSR.

Second, the damage caused by thermal effects is likely to be more severe than in Europe, North America, or the USSR because of the limited firefighting capabilities in the two South Asian countries.

Third, burn injuries would be a more severe medical problem. The high death rate among burn victims who do not receive prompt treatment and the relatively sparse medical resources available could lead to very high mortality rates among the initial survivors of the attack. There are only 48 physicians and 61 hospital beds per 100,000 persons available in Pakistan.and only 35 physicians and 74 hospital beds per 100,000 persons in India.[21]

Fourth, although in more economically developed countries post-attack casualties could be limited by relying on the medical, shelter, and economic resources of small- and medium-sized cities, this may not be true in South Asia. Except for a few large cities, neither India nor Pakistan (and especially the latter) has the necessary resources. In fact, it is very doubtful that post-attack recovery is possible for either country without massive outside assistance. Consequently, one more point should be borne in mind: it is misleading to compare nuclear wars involving countervalue attacks (strikes against cities) with natural disasters. Nuclear attacks focus on the destruction of industrial, techno-

TABLE 2.1 Property Damage from Nuclear Blasts

Weapon Yield	*Type of Burst*	*Radius of 2 psi Ring (miles)*	*Area Destroyed (mi.^{2})**
20 kT	Air	2.2	15.2
20 kT	Surface	1.4	6.1
1 MT	Air	8	200.9
1 MT	Surface	5	78.5

*$A = \pi r^2$ = column 3

TABLE 2.2 Calculations for Idealized Unit-Time Reference Dose-Rate Contours for 20 Kilotons, 50% Fission, Surface Burst, 10 mph Effective Wind Speed

1 Reference Dose Rate (rad/hr)	*2 Downward Distance (miles)*	*3 Max Width (miles)*	*4 Ground Zero Width (miles)*	*5 Scaled Down Distance Column 2 x F*
3,000	3.66	0.10	0.15	3.05
1,000	6.93	0.35	0.33	5.77
300	0.94	0.85	14.43	17.33
100	2.30	1.40	28.54	34.56
30	4.07	1.80	51.31	61.60
10	6.85	2.32	77.00	92.40
3	9.83	3.04	96.20	115.50
1	14.00	5.12	128.30	154.00

Wind scaling factor = v= 1+ = 0.833

Source: Contour Calculation based on Table 9.93 in Glasstone and Dolan, *Effects of Nuclear Weapons*.

Note: Wind scaling neglected in calculation of width of contours.
Average width of 30 rad/hr Contour = 3.0 miles
Average length of 30 rad/hr Contour = 51.31 miles
Average area of 30 rad/hr Contour = 154 sq miles
Average width of 1 rad/hr Contour = 9.6 miles
Average length of 1 rad/hr Contour = 128.3 miles
Average area of 1 rad/hr Contour = 1227 sq miles

logical and administrative structures; those very institutions and assets that allow recovery from the effects of a natural disaster would themselves be totally destroyed.

Fifth, in economically less-developed countries a very high percentage of national value (administrative, technical, and industrial infrastructures) can be destroyed with relatively few warheads, since these are concentrated in small areas. Further destruction would require a large number of warheads. Only a few populated centers have to be hit to destroy what a nation values. The positive aspect, if there is any, is that such concentration of infrastructure will keep civilian casualties confined to a few areas. This point should be kept in mind when discussing effects of a nuclear exchange between India and Pakistan and is especially applicable to the latter.

There are political and social factors peculiar to South Asia which are likely to affect casualties and destruction. These include the "soft" nature of both India and Pakistan as states and, in the case of India, communal violence. Both states have within their borders linguistic and ethnic minorities which may not share war objectives and may see in the destruction caused by the war the chance to break away from the state. Regional and ethnic tensions are also likely to be exacerbated by disagreement over the regional priority in allocation of scarce resources for recovery. In the case of India communal rioting between Hindu and Muslims on a large scale is a possibility. Such riots are likely to be the result of Hindu anger towards "Muslim" Pakistan. These political crises are likely to further hamper the task of post attack recovery. It is conceivable that the political crises following a nuclear exchange may lead to the breakup of both India and Pakistan.

Weapon Systems and Their Impact on Strategy

Certain basic characteristics of any future Indo-Pakistani nuclear balance should be noted. In a nuclearized South Asia India's greater resources and higher level of technological achievement would probably allow it to develop and maintain a substantial lead over Pakistan in the number of warheads. In the absence of a weapons manufacturing program in either country, it is not possible to project accurate figures about the number of warheads likely to be possessed by the two countries at a given future point in time. A recent study of small nuclear forces estimates that in 1982, India had the potential to produce enough fissile material for a maximum of 53 warheads per year. Similarly Pakistan's potential production capacity would be 21 warheads per year in 1990.[22] It must be noted that these figures are upper boundary estimates that assume efficient production and use of fissile material. The yield of these warheads would be the smallest possible needed to achieve an explosive chain reaction. Therefore these figures should be considered a loose general estimate rather than a precise measure of the equivalent megatonnage (EMT) or throw-weight capacity that the two nations are capable of producing.

The second chief feature of an India-Pakistan nuclear balance would be the relative vulnerability of the two countries. Pakistan's smaller size and greater accessibility to Indian attack aircraft make it more vulnerable than India in case of a nuclear exchange. Even one-way suicide attack missions which would substantially increase the range of Pakistani aircraft would not cover all of India.

What about delivery systems?. At this time both countries have modern aircraft capable of delivering nuclear weapons. India has the MiG-23, MiG-25, and MiG-27, Jaguar, and Mirage 2000, while Pakistan has the Mirage III and V and the F-16. Whereas all of Pakistan is within range of Indian aircraft, only the Northwestern and Western regions of India are within range of Pakistani aircraft unless Pakistan launches one-way suicide missions. However, there are other delivery systems. It is well within India's capability to develop IRBMs by the end of this decade. It already has successfully carried out tests of the medium range *Agni* missile which has a range of 930 miles (see maps 2.1 and 2.2). India has developed the capability to put reconnaissance satellites into orbit, and the INSAT satellites, now in orbit, substantially upgrade India's command and control capabilities. India is currently designing a powerful liquid-fuel rocket which could also serve as a delivery vehicle for nuclear warheads.[23] If India were to deploy IRBMs with a range of about 930 miles, it could maintain a nuclear strike force out of the range of Pakistani aircraft, yet capable of hitting almost all of Pakistan. Thus if and when the two countries acquire nuclear weapons, they will also have delivery systems; there need not be a time lag between the acquisition of the two.

Use of Nuclear Weapons in South Asia

The crucial issue remains: What are the chances of actual use of nuclear weapons by India and Pakistan against each other? Assuming that rationality and perspective are retained by regional decisionmakers during a period of crisis, an examination of the constraints and incentives involved leads us to the conclusion that such use is very unlikely for a series of pragmatic reasons—domestic, regional, international, and geographic.

Deterrence

Pakistani debate on nuclear doctrine seems to have followed the line of thinking associated with the evolution of nuclear strategy elsewhere; that is, to adopt the general principles of deterrence, the main adversary being India. Advocates of nuclear weapons in India also justify their demands on the basis of the deterrence value of nuclear weapons against both China and Pakistan.

For Pakistan, the threats to strategic and military security are permanent and lethal. Most of these threats are associated with Pakistan's security dilemma vis-à-vis India, and until recently, the Soviet occupation of Afghanistan. These external threats are compounded by internal instability and inadequate resources.[24] For Pakistan, the possession and use of nuclear weapons for deterrence is very attractive and the idea could become even more acceptable as the imbalance in conventional military strength between Pakistan and India increases in favor of the latter. Indeed, it is possible to stand the proliferation chain argument on its head. The argument has been that if China acquired nuclear weapons, India would acquire them and this in turn would lead to a Pakistani bomb. We can instead argue that Pakistan needs nuclear weapons to offset India's conventional military superiority. In order to prevent Pakistan from using these nuclear weapons for compellence (for example, in Kashmir) rather than deterrence, India needs nuclear weapons. As K. Subrahmanyam puts it (although in a different context), "nuclear weapons can be deterred only by nuclear weapons."[25] The proliferation of nuclear weapons into South Asia may follow this pattern.

If the two nations develop striking power to the extent that their respective nuclear forces serve only to cancel each other out, diplomatic, political, and perhaps even conventional military interactions may proceed in much the same manner as before. There would be, however, one important difference. Direct external threats from India to the very existence of Pakistan as a state could no longer exist. On one hand, this could lead to fewer restraints on adventurist tendencies among Pakistani leaders; on the other hand, it would remove what is felt by many to be the root cause of the continuing conflict between the two countries, the widespread feeling in Pakistan that India is bent on dismembering their country. The possession of nuclear weapons could enable Pakistan to inflict unacceptable punishment on India should the latter threaten its very existence. The positive effects of an increased sense of security among the Pakistani elite might outweigh any negative impact caused by increased adventurism in its leadership. Although both nations have committed acts of brinkmanship in the past, policy formation and crisis behavior have on the whole been pragmatic and sober. Indeed, the acquisition of nuclear weapons by both sides may prevent even conventional wars between the two countries as leaders exercise extra caution for fear of starting a nuclear conflagration.

The successful maintenance of a credible deterrence posture by the two countries against each other would, however, not be a simple matter. First of all it would require superior Pakistani technical ability to offset India's larger nuclear arsenal (which is inevitable given India's greater resources and the threat it faces from a nuclear China), and the fact that, whereas all of Pakistan is within strike range of Indian planes and missiles, all of India, including potential missile launching areas is not within range of Pakistan (see Figures 2.1 and 2.2). Thus Pakistan would need superior technology to prevent India from carrying out a preemptive first strike against Pakistani nuclear forces. Given India's current technical superiority, it is hard to envisage Pakistan acquiring the needed. In the absence of such security for a Pakistani force, acquisition of nuclear weapons would be more destabilizing than stabilizing, because the temptation to use the weapons before they are destroyed would be great.

A related factor that could lead to similar premature use is Pakistan's possible inability to deliver a nuclear weapon under certain wartime conditions. It has been pointed out that if Pakistan were in such dire military straits that it actually decided to use nuclear weapons against an attacking enemy, it might have already lost the military ability to deliver the warheads.[26] As in the case of insufficiently protected nuclear weapons, such a situation would be very destabilizing. Since it alone would be capable of determining when the capability to deliver warheads is about to be lost, the decision when to use nuclear weapons in a conventional war could be left solely to the military.

A third problem with nuclear deterrence in the India-Pakistan dyad is that of command and control. Unless both countries developed strong C^3I (command, control, communications, and information), Pakistan, and to a more limited extent, India, would face a trade-off between viability and stability. In Pakistan's case weak C^3I might encourage the adoption of Launch on Warning (LoW) postures. Needless to say, LoW is not conducive to confidence in robust mutual deterrence.

These three major problems would destabilize nuclear deterrence. If the two countries were to acquire nuclear weapons, it would be imperative that steps be taken to overcome these problems so that credible deterrence might be established. We have already pointed out the conditions necessary for establishing credible deterrence by Pakistan and the problems that it is likely to encounter in meeting them. It must be asserted here that unless these problems are overcome, the introduction of nuclear weapons into the region would be extremely destabilizing. If Pakistan were to acquire nuclear weapons but not the necessary technology to make them invulnerable to an Indian first strike, the incentive to launch a preemptive strike during a crisis or adopt a Launch-on-Warning strategy would be great. Such vulnerability of Pakistani weapons could also provide India with incentives to use nuclear weapons. First, the option of neutralizing Pakistani nuclear weapons with little or no loss would be available to Indian decision makers. Second, the fact that, being aware of the vulnerability of their weapons, the Pakistanis might launch a preemptive strike would in turn serve as an incentive to India to preempt them.

Protection is not enough. Pakistan must develop a capability to deliver such weapons during a crisis situation, even after its armed forces have been severely mauled. Lack of an ability to do so would have the same impact on the deterrence strategy and decision-making calculus of both India and Pakistan as the vulnerability of actual warheads.

Adequate C^3I is needed not only to deter adoption of such strategies as Launch on Warning, but also to ensure that unauthorized use does not occur. Both sides would have to know enough about each other's C^3I to promote confidence in the unlikelihood of preemptive and unauthorized use. It would therefore be necessary to establish communication links between the two that are specifically

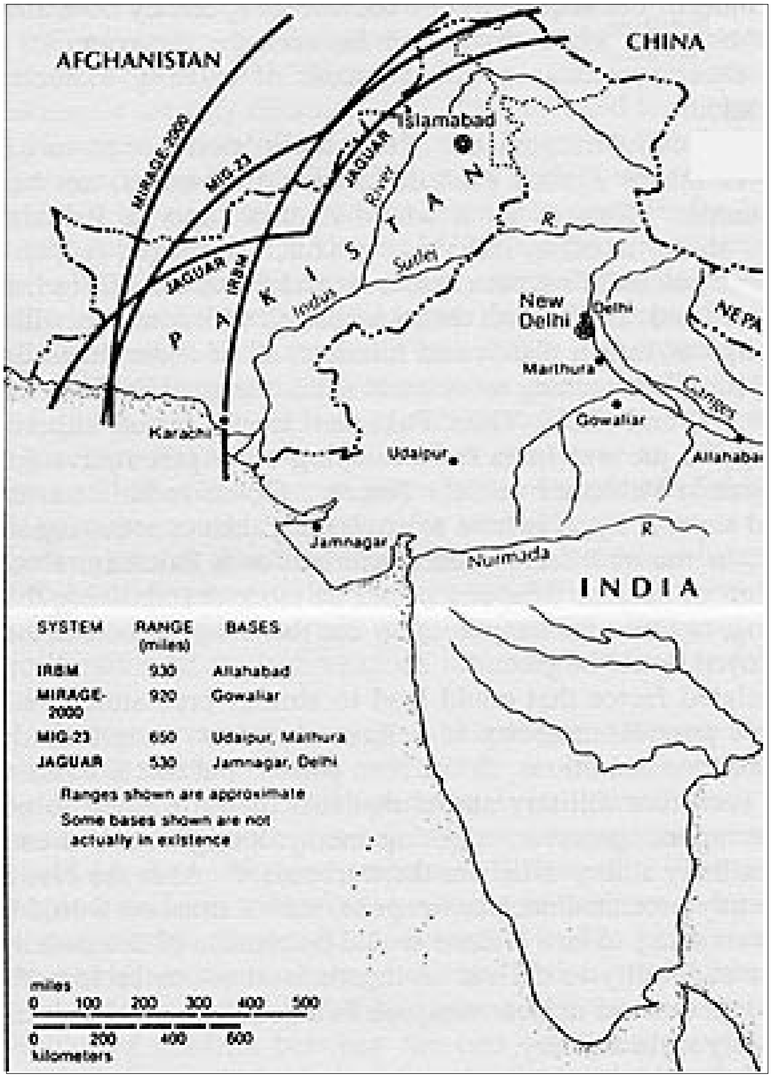

FIGURE 2.1 Range of Indian Delivery Systems.

geared to such exchange of information. Finally, other measures are necessary to establish a credible deterrent. These measures would include successful communication by one side to the other of an ability and will to use nuclear weapons if the security of the state is threatened beyond a certain point. It would also be necessary for both countries to enunciate a clear deterrence doctrine that would inform the other side about the conditions under which a non-nuclear conflict situation would escalate into nuclear conflict.

Compellence

Compellence—forcing another state to do something by threatening a nuclear strike—would only work if one side were to have a monopoly of nuclear weapons or a military superiority that would make it impossible for the "compellee" to retaliate against the "compellor." At the very least, the demands made by the "compellor" should not be viewed as so outrageous or so destructive to the nationhood of the "compellee" as to make these demands unacceptable even under threat of nuclear attack. If the "compellee" had a nuclear force of its own, chances of successful compellence would be very low indeed. One of our assumptions has been that both sides acquire nuclear weapons and the means to deliver them. Under such conditions, using nuclear weapons for compellence is impractical.

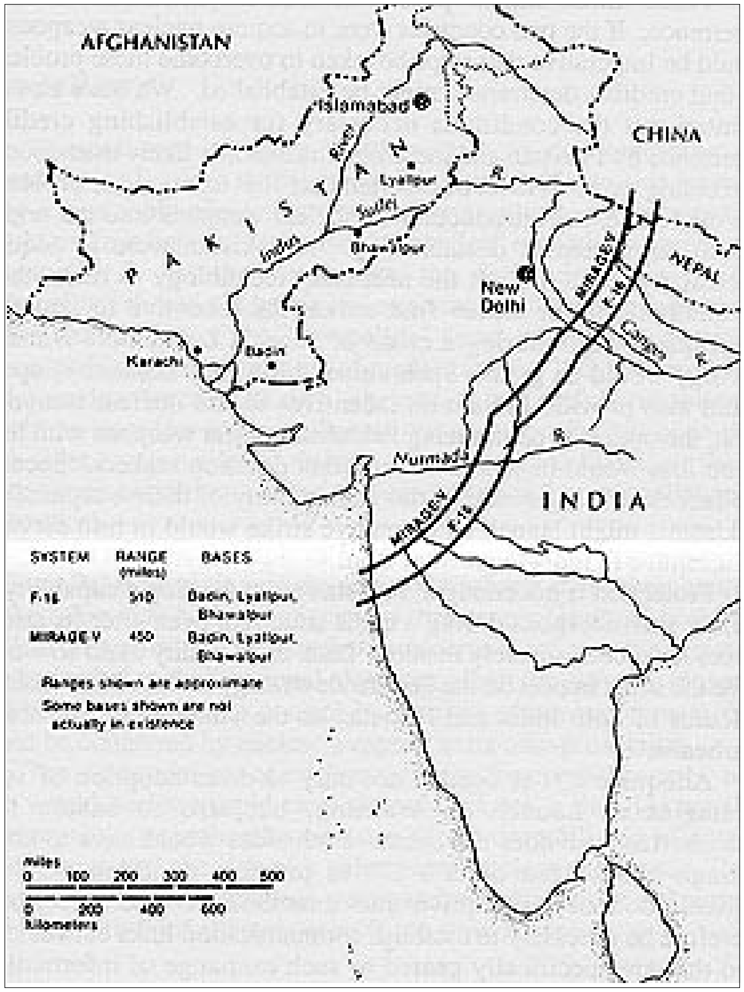

FIGURE 2.2 Range of Pakistani Delivery Systems.

Let us take the example of Kashmir. It is hard to imagine either India or Pakistan giving up the areas of Kashmir under their control to the other side because of nuclear threats, especially if both had nuclear weapons. Both countries consider control over their part of Kashmir vital to their national character, albeit for different reasons. Neither would give up control in the face of nuclear threats that could be countered by nuclear weapons in its own possession.

The successful use of nuclear weapons for compellence by one side would lead to a rapid escalation of such use, a situation equally unacceptable to both sides because of the destabilizing effects it would have and the risk of a subsequent nuclear exchange. Thus constraints on use of nuclear weapons for compellence are strong, and it is doubtful if attempts at such use would succeed.

Tactical Use

Nuclear weapons may also be used to attack field formations during battle. It is our contention that differentiating between the tactical and strategic uses of nuclear weapons in the South Asian context is fallacious because of the number of civilian casualties that would occur on both sides. The situation here is different from that in Europe, where the use of “tactical” nuclear weapons would not kill Russian and American civilians. European civilians would of course die, and it is for this reason that the Europeans don’t see much difference between strategic and tactical weapons. The damage and loss of life that would occur in South Asia from “tactical” use makes distinctions between tactical and strategic a cruel and dangerous joke. Escalation of tactical use into counter-city strikes is almost inevitable, given the extent of damage that would be caused by tactical use. Any quick, decisive result in a war is likely to come out of a battle in Punjab or Kashmir. It is this sector of the India-Pakistan border that has the highest level of troop deployment, and it is in this area that tactical nuclear weapons are most likely to be used. Given the high population density along both sides of the border in the Punjab-Kashmir sector, collateral civilian casualties and damage are likely to be very high. Once nuclear weapons, even tactical ones, have caused extensive damage and casualties in such border urban centers as Amritsar, Gujranwala, Ferozpur, Gurdaspur, Pathankot, Srinagar, Fazilka, Baramula, Lahore, Sialkot, Kasur, Gujarat, and Jhelum, the chances of escalation into counter-city strikes are very great. Using tactical nuclear weapons against field formations in the Punjab-Kashmir sector would be tantamount to a large scale exchange between the two parties.

Use of tactical nuclear weapons further south along the Rajasthan and Gujarat border would not cause widespread collateral civilian casualties because of the relatively sparse population along both sides of the border in that sector. Therefore tactical use of weapons in this sector would not necessarily escalate into counter-city strikes. The danger remains, however, that once the nuclear threshold is crossed, such escalation would occur.

This discussion on use of tactical weapons has assumed that such use would be made against military formations of the other side before they cross the border. Once forces of one side have crossed the border and occupied populated areas of the other side, the latter would face a situation where use of tactical nuclear weapons against the enemy would cause the deaths of large numbers of its own population. Under such circumstances a country might choose to use nuclear weapons in a warning or symbolic attack to force the enemy to stop his advance, vacate occupied territory, or both. The dangers of escalation from such use to counter-city strikes have already been discussed. On the other hand if a country decides to use tactical nuclear weapons against enemy forces on its own territory and incurs substantial civilian casualties in the process, it may launch attacks on some of the enemy's population centers to compensate for its losses. The chance of an escalation to large-scale attacks on civilian targets in such a situation is self-evident.

Besides the danger pointed out above, two additional factors add to the risks of actual use of nuclear weapons if "tactical" weapons are developed and deployed. First, tactical nuclear weapons would provide policymakers with what could be perceived as an intermediate option between no-use and annihilation: this would undermine deterrence. Second, and because of the first, it would be easier to make the decision to use nuclear weapons in the hope that "tactical" use against military targets would limit retaliation by the other side to similar levels. As we have seen, however, once nuclear weapons have been used in any form, rationality and restraint are likely to be weakened, creating a situation that could lead to counter city strikes. Such escalation might result from miscalculation about the enemy's real intentions, or a steady escalation of use of smaller yield weapons into use of larger yield weapons.

The development of tactical nuclear weapons by India and Pakistan is not unlikely and is the main danger that would arise from acquisition of nuclear weapons by the two countries.

Other Constraints

The ultimate constraint on using nuclear weapons in a situation where both sides have them is of course Mutual Assured Destruction (MAD). However, other international, regional, domestic, and geographic constraints, some fairly strong, also exist in South Asia.

Use of nuclear weapons in any but the most extraordinary situation is unlikely because of several international and regional factors. For India, the main regional constraint is the China factor. Any use of nuclear weapons against Pakistan would have to take into consideration the impact on Chinese-Indian relations. Even if China were to stand by and do nothing, such an attack would be likely to lead to a nuclear arms race with China.

Then, of course, devastation from a nuclear war would open the door for the penetration of outside powers—China, the Soviet Union, and the United States—into the subcontinent. There is also the problem of setting a precedent. Small and medium-sized powers do not want to legitimize the use of nuclear weapons because they would then be open to similar attacks or threats from the big powers, with whose huge arsenals of nuclear weapons they cannot hope to compete.

Another constraint on the use of nuclear weapons might be the composition of India's population. Any strikes on major urban centers in India would cause many casualties among India Muslims (who are intermixed with the non-Muslim population). Table 2.3 shows the percentage of Muslims in the populations of towns likely to be hit in a counter-city strike of the sort outlined in Scenario C.

It is not my contention here that the Indian Muslim factor would prevent an attack on Indian cities; rather, for several reasons, it would be a major constraint on Pakistani behavior in all but the most severe of crises, e. g., where the very existence of Pakistan was at stake. The more important of these reasons are: the ideology behind the creation of Pakistan, the maintaining of which is essential for the continued existence of the state; the role that Pakistan has sought to play in the Muslim world; the support and concern, at least rhetorical, for the Muslims of India expressed by all sections of the Pakistani elite; the likely rise in influence of Hindu communal organizations in India which would take advantage of heightened anti-Muslim sentiments, and, last but not least, close familial ties between Indian Muslims and Pakistanis of Indian origin (*Muhajirs*). The latter are an important force in Pakistani politics and hold key political and bureaucratic positions. Here it is important to note that, contrary to the arguments made by some Indian analysts,[27] the more conservative, religious, and Jihad-oriented a Pakistani government is, the less likely it is to use nuclear weapons against India because of the impact, both direct and indirect, such an attack would have on Indian Muslims, and on Pakistan's own position within the Muslim world. It must be noted that once the decision to use nuclear weapons is taken, targeting is unlikely to be influenced by these considerations.

TABLE 2.3 Percentage of Muslims in Projected Population of Indian Towns Likely to Be Targets in a Pakistani Counter-City Strike

City	*Population (1990)**	*Percentages Muslim*	*Muslim Pop. (col 1 x col 2)*
Bombay	11,914,900	14.12	1,682,400
Delhi	9,118,600	7.40	674,800
Ahmedabad	3,164,100	14.58	461,300
Agra	1,041,800	16.34	170,200
Gwalior	944,300	15.00	141,600
Jaipur	904,600	18.71	169,300
Baroda	821,400	12.00	98,600
Amritsar	813,500	0.42	3,400
Indore	798,900	12.41	99,100
Ludhiana	775,800	0.10	800
Surat	693,500	24.00	166,500
Jalandhar	590,900	0.08	500
Meerut	528,400	39.00	206,100
Jodhpur	467,000	20.00	93,400
Ghaziabad	174,700	24.00	41,900
TOTAL	32,752,400		4,009,900

* Based on 1971 or 1981 census. The prevailing growth rate in each city has been used to project the 1990 population.
Source: *Statistical Pocket-Book of India 1980* (New Delhi: Ministry of Planning, Government of India, 1981), pp. 5, 10-12; N. A. Siddiqui, *Population Geography of Muslims of India* (New Delhi: S Chand & Co., 1976), pp. 66-98.

On the other hand, Indian Muslims would also be a factor in the Indian government calculations if that government ever planned to launch a nuclear strike against Pakistan. It should be understood clearly that although the loyalty of Indian Muslims to India is not in question, at the same time the fact that Indian Muslims have close familial ties with a large percentage of the population of Pakistan's largest urban center, Karachi, cannot be ignored. Again, such considerations might restrain rather than prevent Indian decision makers from using nuclear weapons. In this regard it is worth noting that in past conflicts between the two countries, some of them very bitter, neither side has resorted to indiscriminate attacks on population centers. In the case of the 1971 civil war in Pakistan, atrocities were committed against fellow Muslim South Asians by the Pakistani army. Given the consequences that followed, the likelihood that this will occur again is not very high.

There are also regional meteorological and geographical constraints on the use of nuclear weapons. The "heartland" of Pakistan—the Indus Valley region of Pakistani Punjab—runs parallel to the strategic, rich, and now restless state of Punjab in India. Any attack on Pakistani cities in this heartland would mean deaths and damage from fallout in Indian Punjab. Similarly, attacks on Indian Punjab cities, indeed even on Delhi, would result in some fallout deaths and damage in Pakistani Punjab. The extent of damage would depend on wind direction and force, which varies during the year. During the period of the Northeast Monsoon (December to March), fallout would be carried back to India. Similarly, during the Southwest Monsoon (June to September), fallout would be carried back to Pakistan. (See Figure 2.3) Therefore, to prevent damage to itself from fallout from its own weapons, India would have to attack during the months of April through October, whereas Pakistan would have to attack during the months of October through May. Even without strong winds, damage to the border regions of the two countries would be substantial. Fallout damage to the two Punjabs would be of great economic and political significance if the two countries were to survive as states after a nuclear war.

It is thus clear that besides Mutual Assured Destruction, other constraints exist on use of nuclear weapons in general and on their use for any other purpose than deterrence. These constraints would play an important restraining role. At the same time the importance of these constraints should not be overestimated. The best and most effective constraint would still be MAD.

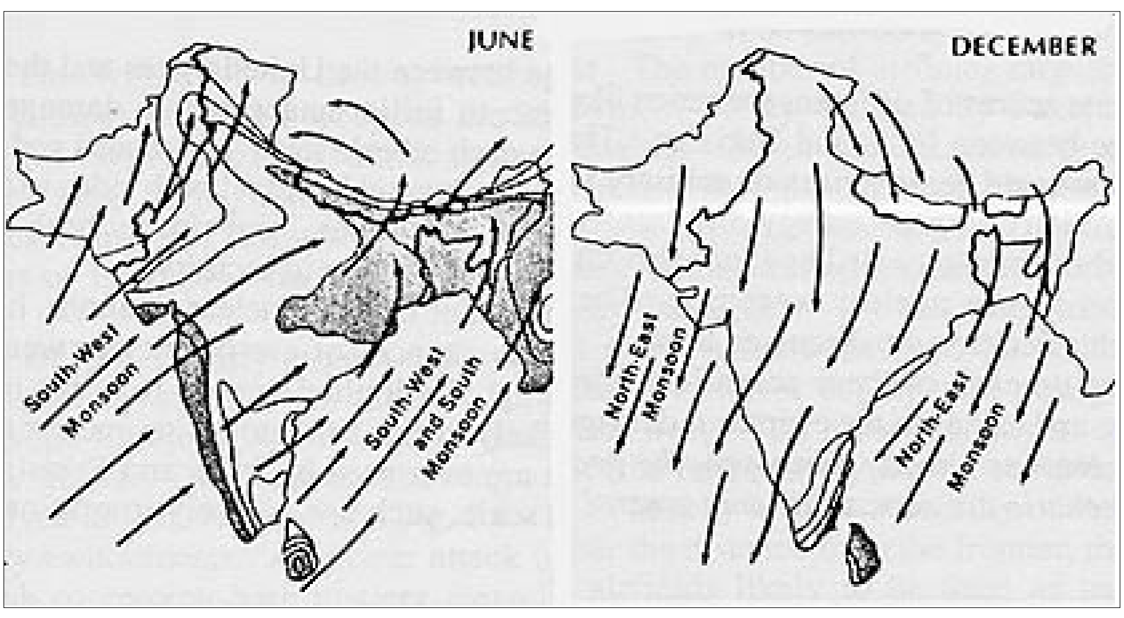

FIGURE 2.3 Seasonal Wind Patterns in South Asia.
Source: J. Bartholomew, *Oxford School Atlas of India, Burma, and Ceylon* (London: Oxford University Press, 1968), p. 15

As already noted, the chances of a strategic nuclear exchange between India and Pakistan (provided the conditions necessary to achieve nuclear stability outlined above are met) are very low. The probability of such an exchange is about the same as that of a strategic exchange between the United States and the Soviet Union. The ability of both to inflict unacceptable damage on the other, indeed, to threaten each other's survival as states and even societies, is deterrence enough. It would compel both sides to limit ambitions at the expense of the other, and force both elites to end exaggerations of external threats to security.

The development of tactical nuclear weapons, however, would sharply increase the chances of use of nuclear weapons. Even if such use is initially of a limited nature, it is, for reasons already discussed, very likely to escalate into major nuclear strikes. Thus if nuclear weapons are ever used by India and Pakistan against each other on a large scale, such use is likely to originate in a tactical exchange.

Scenarios

One can create scores of different scenarios likely to occur in a nuclear exchange between India and Pakistan. Three of the most likely ones are discussed here: attacks on military targets (Scenario A), attacks on military targets, energy and transportation centers (Scenario B) and counter-city strikes (Scenario C). All assume a political decision to use nuclear weapons. The dynamics and likelihood of such a decision are discussed later.

We will take up each of these scenarios, briefly identify the goals and targets, and calculate the estimated damage likely to result from each. For reasons already discussed, *the projected casualty figures in each scenario are necessarily only general estimates.*

Scenario A

This scenario envisages an attack by India and Pakistan on military targets and formations. Such an attack would hit major cantonments within striking range and would be a part of a strategy of compellence or would be designed to fulfill tactical military purposes. The goal would be the destruction of the enemy's major military formations either to preempt a conventional attack, or as a prelude to military action by the attacking side.

Since the aim would be to destroy concentrated military personnel and equipment, 20 kT weapons are likely to be used. These would fulfill the purpose of the attack and minimize collateral damage. For the same reason surface bursts are likely to be used which would result in 5 psi rings of a radius of .8 miles, 2.2 psi rings of a radius of 1.3 miles, and 2 psi rings with a radius of 1.4 miles.[28]

Tables 2.4 and 2.5 identify targets and summarize casualties likely to be caused by such an exchange. They also show the number of persons likely to be exposed to dangerous levels of fallout from the blasts. The contours showing areas likely to be affected by delayed fallout are shown on Fig. 2.4. The targets listed are mainly army cantonments. A nuclear attack by either country would also seek to destroy both nuclear weapons and delivery systems and would involve attacks on air fields and on missile sites. These attacks are likely to be carried out using 20 kT weapons set for surface burst. The number of airfields targeted would depend upon the deployment policy adopted by Pakistan. Two broad options are available. Given the accessibility of almost all of Pakistan to Indian aircraft, Pakistan might choose to concentrate its nuclear weapons and aircraft committed to a nuclear attack mission on a few air bases, concentrating its defenses on protecting these bases from a surprise attack. On the other hand, a strategy of dispersal might make it more difficult for India to

TABLE 2.4 Casualty and Damage Projections: Limited Attack on Military Centers of Pakistan

Target Cantonments	*Population of City (1990)**	*Immediate Estimated Deaths*	*Estimated Injuries** From Blast*	*Property Destroyed (sq mi)*	*Population of Area affected by 30 Rad/Hr Fallout *****	*Population of Area Affected by 1 Rad/Hr Fallout *****
Karachi	8,337,100	128,900	211,541	6.16	30,000	206,000
Lahore	4,599,900	66,100	10,800	6.16	236,000	165,000
Rawalpindi	1,427,100	68,300	11,200	4.12	177,000	1,240,000
Hyderabad	1,088,000	44,600	73,200	4.12	118,000	825,000
Peshawar	383,100	27,500	45,100	3.08	138,000	962,000
Sialkot	283,200	20,400	33,400	6.16	217,000	1,513,000
Quetta	282,600	35,500	58,300	6.16	16,000	110,000
Bhawalpur	261,900	18,800	30,900	6.16	59,000	413,000
Wah Cantt.***	222,100	148,000	74,000	6.16	59,000	413,000
Gujrat	212,500	15,300	25,100	6.16	118,000	825,000
Sahiwal	51,600	3,700	6,100	6.16	138,000	962,000
TOTAL	17,149,100	577,100	579,641	60.60		

* Based on the 1972 census, the prevailing growth rate in each city has been used to project the size of the 1990 population. The exception is Wah, which grew by 194% between 1962 and 1972, because of the establishment of a major arms production center. The growth rate between 1972 and 1990 for Wah has therefore been calculated at 5.92%, the average growth rate of Pakistani cities. The 1962 and 1972 population figures are from *The Statistical Abstract of Pakistan 1980* (Government of Pakistan: Islamabad 1981), pp. 5-7. Figures have been rounded off.
Population density and city area figures are from K.U. Kureshy, *A Geography of Pakistan* (Karachi: Oxford University Press, 1979), pp. 86-96. The population density throughout the area of each city is considered to be uniform. Figures have been rounded off.
** Population density throughout the area of each city is taken as being uniform. Figures have been rounded off.
*** 100% of the population of Wah cantonment will be affected because the large military contingent is located in the cantonment.
**** Based on Table 2.2.

TABLE 2.5 Casualty and Damage Projections: Limited Attack on Military Centers in Northwest India

Target Cantonments	*Population of City (1990)*	*Immediate Estimated Deaths**	*Estimated Injuries From Blast*	*Property Destroyed (sq mi)*	*Population of Area Affected by 30 mRad/Hr Fallout ***	*Population of Area Affected by 1 Rad/Hr Fallout ***
Bombay	11,914,900	136,900	224,600	6.16	120,000	822,000
Delhi	9,118,600	40,700	66,900	4.62	240,000	1,624,000
Ahmedabad	3,164,100	153,500	251,900	3.08	120,000	822,000
Gowaliar	944,300	18,000	25,400	6.16	120,000	822,000
Baroda	821,400	4,200	6,900	6.16	120,000	822,000
Amritsar	813,500	15,500	21,900	6.16	240,000	1,624,000
Ludhiana	775,800	14,800	20,900	6.16	120,000	822,000
Jullandhar	590,900	11,300	15,900	6.16	120,000	822,000
Rajkot	529,100	10,10	14,200	6.16	59,000	431,000
Meerut	528,400	10,100	14,200	6.16	240,000	1,624,000
Jamnagar	408,400	79,300	13,000	6.16	30,000	206,000
Jhansi	337,300	6,400	9,100	6.16	30,000	206,000
Ajmer	334,300	6,400	9,000	6.16	30,000	206,000
Jammu	273,400	5,200	7,400	6.16	240,000	1,624,000
TOTAL	30,554,400	503,310	701,300	81.62		

Based on 1971 or 1981 census, the prevailing growth rate in each city has been used to project the size of the 1990 population. The figures are from *The Statistical Pocket Book of India 1980* (New Delhi: Ministry of Planning, Government of India, 1981), pp. 5, 10-12.
* Ground Zero is located at the center of each city. Population density and city area figures are from various sources, including Statistical Pocket Book. Figures have been rounded off.
** Based on Table 2.2.

carry out a preemptive strike. Whatever deployment policy is adopted, the location of nuclear weapon air bases is likely to optimize distance from the frontier (the farther away the better, giving more warning time in case of an attack) with penetrability of Pakistan's own air strikes (the shorter the distance from the frontier, the better). Given the above, the airfields likely to be used as bases for nuclear weapons include Badin, Bhawalpur, Peshawar, and Lyallpur. These would be targets of an Indian attack.

The greater range of Indian nuclear capable aircraft along with the fact that all of India cannot be reached by Pakistani aircraft (at least the new modern sophisticated aircraft—Canberra bombers, which have greater range, are slow and vulnerable) makes the Indian task of deployment less complicated. Likely air bases include Delhi, Mathura, Gwalior, Udaipur, and Jamnagar. Air bases located close to the frontier would not be used because they would be more vulnerable without any payoff in terms of increased penetrability of aircraft based there. India could deploy its IRBMs as far east as Allahabad and still cover the core areas of Pakistan. These missile sites could only be reached by Pakistani aircraft if they were to carry out one way attack missions.

Both countries might locate their nuclear attack forces at new air bases. Such bases may be built away from population centers to reduce casualties in case they are attacked. On the other hand, they might be built close to civilian centers and thus signal to the opposing side that an attack on these bases would cause so many civilian casualties that any chance of limiting the war and preventing more destructive scenarios was an illusion.

The discussion here has concerned itself with attacks on military targets in cantonments and on some air bases; it has not discussed attacks on units deployed on the frontier. Use of nuclear weapons against the latter would constitute tactical use. The probability of such use has already been discussed. Because of the mobility of these targets and changing deployment postures, it is difficult to project targets and casualties if field formations are threatened. No such attempt is made here.

It is clear from the above discussion that even an attack limiting itself to military targets in cantonments and airfields using relatively small weapons (20 kT), and trying to minimize collateral damage (surface bursts) would produce substantial death, injury, and destruction of property. Approximately 577,000 people are likely to be killed and about 580,000 injured in Pakistan (See Table 2.4). In India approximately 604,000 people would be killed and about 850,000 injured (See Table 2.5). Some of the reasons for high casualty figures have already been discussed above. An additional factor is that many major cantonments which would be targeted are located within or adjacent to cities. Some of the reasons for high casualty figures have already been discussed above. An additional factor is that many major cantonments are located within or adjacent to cities.

Long term effects are also likely to be as serious as the immediate effects. In Pakistan a total of 1,306,000 persons would be exposed to fallout of over 30 rad/hr and 7,634,000 would be exposed to fallout between 1 and 30 rad/hr.(See Table 2.4) In India a total of 1,829,000 persons would be exposed to fallout of over 30 rad/hr and 12,477,000 would be exposed to fallout between 1 and 30 rad/hr. (See Table 2.5) Such exposure will lead to a sharp increase in cancer caused by radiation. Besides this large parts of the manufacturing and agricultural area of Northwest India and Northern Pakistan will be contaminated by fallout (See Figures 2.4 and 2.5). This will lead to major reduction in industrial and agricultural production.

Scenario B

This scenario envisages attacks by India and Pakistan on not only military targets but also on major transportation and energy centers. Such an attack would again aim at achieving compellence goals.

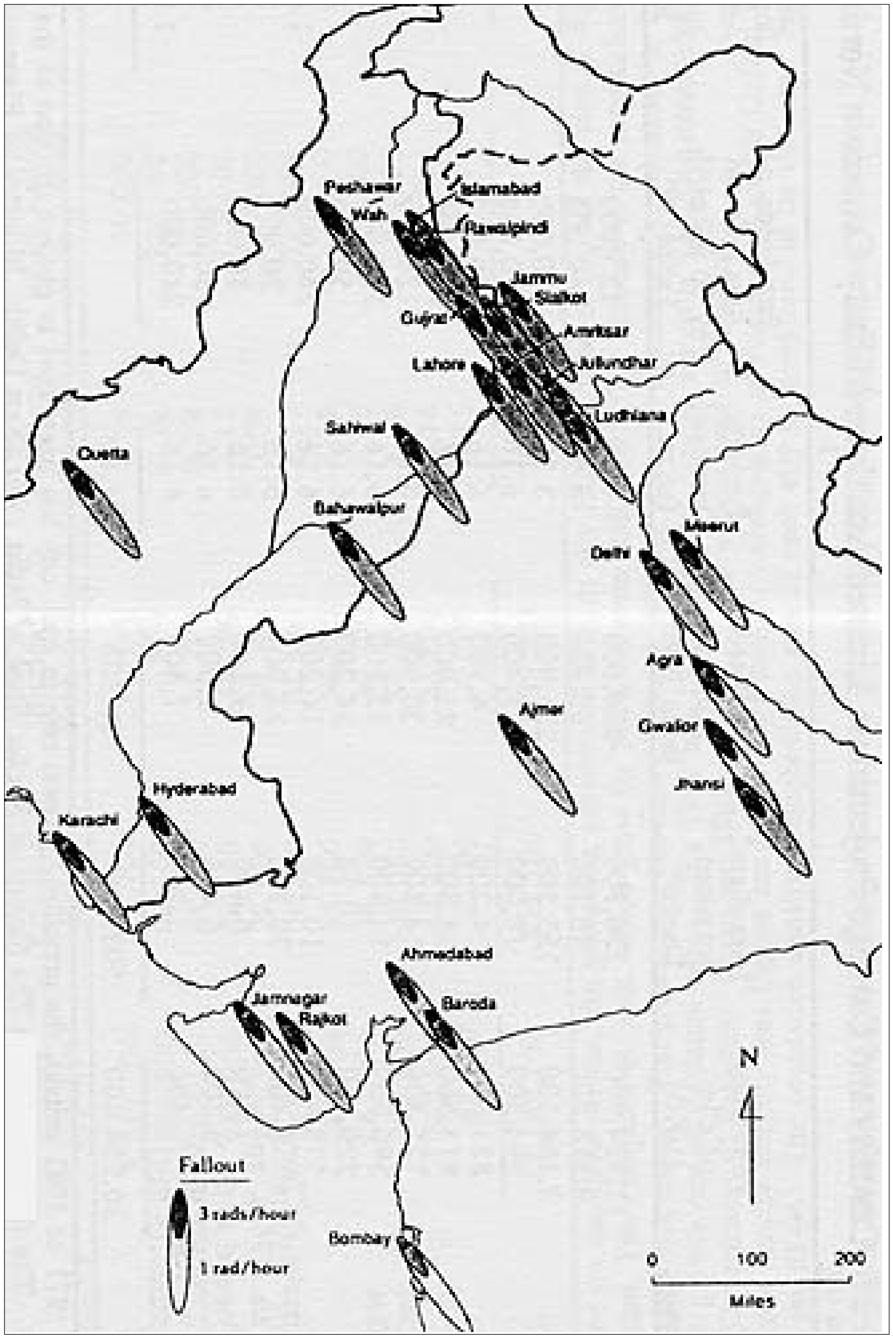

FIGURE 2.4 Fallout Contours from an Attack upon Selected Military Targets in Pakistan and Northwest India.

The attacks on economic targets would be more harmful to Pakistan for several reasons. First, whereas India can attack almost any economic target within Pakistan, large parts of India's industrial heartland—central Uttar Pradesh, most of Maharashtra, and West Bengal—will be out of range of Pakistani aircraft (unless one-way suicide missions are undertaken). Second, attacks on economic targets would mean a decision to fight a prolonged war, which would enable India to mobilize its superior resources and wear down Pakistan's ability to resist.

The military targets in this scenario would be the same as in the first scenario. Tables 2.6 and 2.7 list likely economic targets in an exchange aimed at major transportation and energy centers.

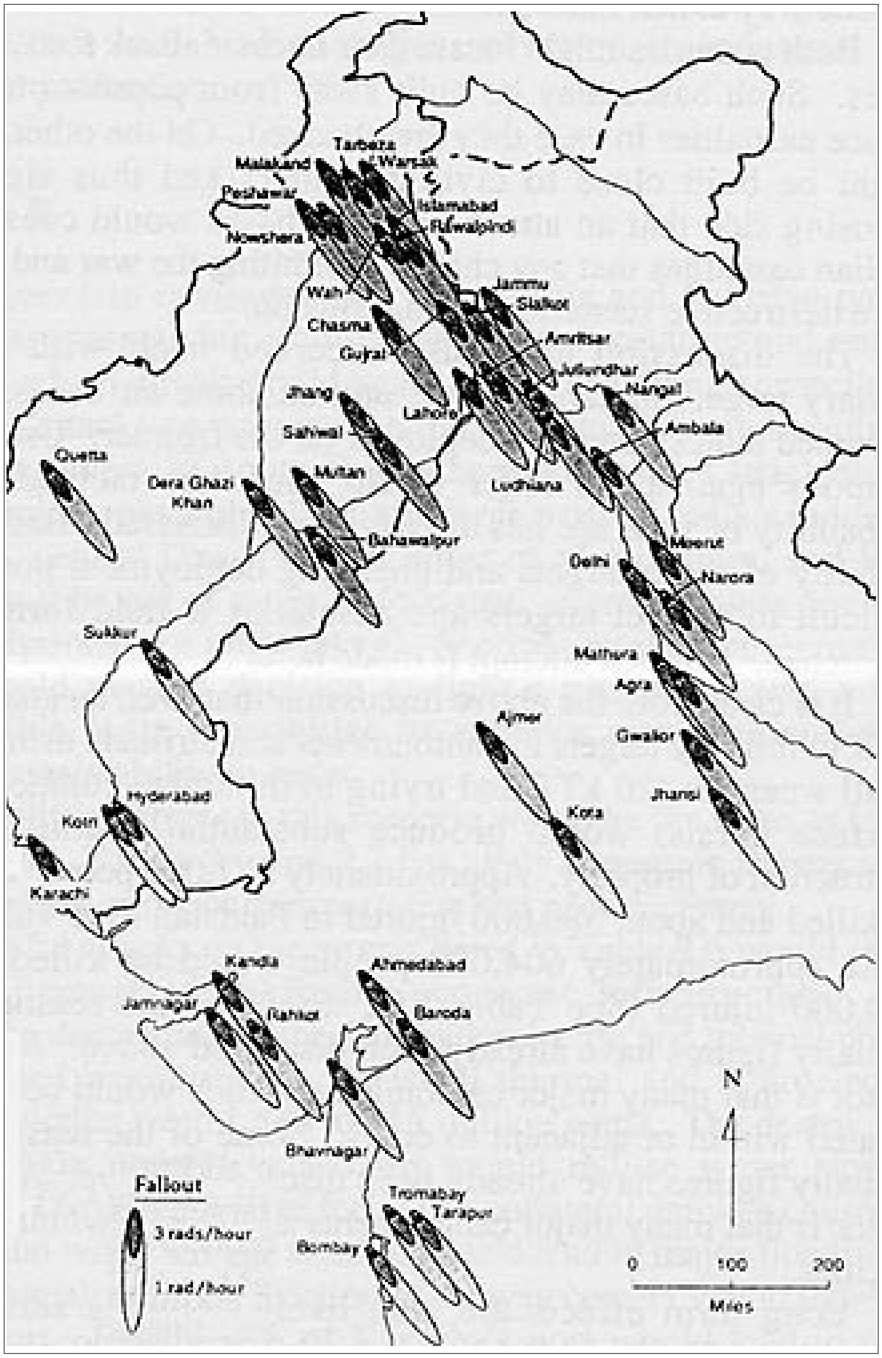

FIGURE 2.5 Fallout Contours from an Attack upon Selected Military, Energy and Transport Targets in Pakistan and Northwest India.

Successful attacks on the targets listed in Table 2.6 would result in severe damage to Pakistan's economic infrastructure. For example, the destruction of the four hydroelectric and thermal power stations listed would reduce Pakistani thermal and hydroelectric power production from 1,583 to 715 million watts. The destruction of the Mangla and Tarbela dams would reduce water storage capacity by 16.6 million acre feet. The collateral damage caused to irrigation and water control systems would lead to major flooding in Southern Punjab. The destruction of railway centers would paralyze rail transport. Destruction of Karachi's port would lead to total disruption of sea communications. Large areas of Pakistan's Punjabi heartland would be exposed to fallout (see Figure 2.5). Much of the best agricultural land in the country would be contaminated.

TABLE 2.6 Energy and Transport Targets in Pakistan*

Energy	*Nuclear Facilities*	*Transportation*
1) Hydroelectric power stations a) Mangla b) Warsak c) Tarbela d) Malakand	1) Heavy water a) Multan b) Karachi	1) Jhang Railway Junction
2) Thermal power stations a) Multan b) Sukkur c) Sahiwal d) Gudu e) Hyderabad f) Kotri	2) Enrichment a) Kahuta b) Sihala	2) Hyderabad Railway Junction
3) Nuclear power station a) Karachi	3) Fuel fabrication a) Chashma	3) Mianwali Railway Junction
4) Gas a) Sui gas fields	4) Reprocessing a) Chashma b) Rawalpindi	4) Karachi Railway Junction
5) Oil refineries a) Multan b) Attock	5) Research reactor a) Rawalpindi	5) Karachi Port

* Choice of target is based upon economic value and size.

TABLE 2.7 Energy and Transport Targets in Northwest India*

Energy	*Nuclear Facilities*	*C. Transportation*
1) Hydroelectric power stations a) Trombay b) Bhakra c) Kotla	1) Heavy Water a) Nangal b) Baroda c) Kota	1) Railways a) Agra Junction b) Delhi Junction c) Amritsar d) Ambala Cantt e) Bombay Central V.T. f) Baroda
2) Thermal power stations a) Bhavnagar b) Agra c) Ahmedabad	2) Reprocessing/Enrichment a) Trombay b) Tarapur	2) Ports a) Bombay b) Kandla c) Jamnagar
3) Nuclear power stations a) Narora b) Tarapur c) Kota	3) Research Reactor a) Trombay	
4) Petroleum a) Bombay b) Baroda c) Mathura		

*These targets are within range of Pakistani Mirage III and Mirage V and F-16 aircraft.

Although all economic targets in India will not be within range of Pakistani weapon systems, the damage there would still be grave. The fertile agricultural states of Punjab and Haryana as well as western Uttar Pradesh would be contaminated (see Figure 2.5). The substantial industrial base of these parts of the country would also be wiped out or severely damaged. As in Pakistan collateral damage to dams and irrigation control systems would lead to widespread flooding.

Besides the deaths and injuries that would result immediately, the long-term impact of attacks on economic targets could include widespread famine, rampant epidemics, and the destruction of the two countries as viable economic systems.

The weapons used to achieve these results could have small yields. The civilian casualty figures in both countries would, of course, be much lower if attacks were limited to military targets only. Casualty figures for an exchange involving attacks on military, energy and transport targets have not been calculated because data is unavailable on the size and density of population in some of the areas listed in Tables 2.6 and 2.7.

A more widespread attack on military and economic targets could occur, but this would be a case of overkill because damage done by destroying targets listed in Tables 2.6 and 2.7 would be enough to cause total economic disruption in both countries. Such a scenario involving attacks on more targets could evolve, however, as a result of steady escalation during a war in which retaliatory strikes would gradually lead to attacks on relatively minor economic or military targets. Such a development is unlikely, if only because the number of nuclear warheads that will be available to the two countries in the near future is limited. In case of a really savage war, the following scenario is likely to occur.

Scenario C

A more deadly use of nuclear weapons would involve strikes aimed primarily at civilian population centers. This is possible if deterrence fails. Unlike the other scenarios, this would involve the deliberate destruction of urban centers and the infliction of the maximum possible civilian casualties. Therefore, weapons with higher yields and air, rather than surface, bursts are likely to be used. Either a 1 MT weapon or several weapons with smaller yields could be used against each target.

The 5 psi ring from a 1 MT air burst would have a radius of 4.4 miles, the 2.2 psi ring radius of 7.6 miles, and the 2 psi ring a radius of 8.1 miles.[29] Given the nature of most South Asian cities, very high casualties would result. For example, the entire area of the city of Lahore would fall within the "Lethal Zone." Tables 2.8 and 2.9 give likely targets in a counter-city strike scenario. It is estimated that a total of 17,508,000 people would die from the immediate effects of such an exchange in Pakistan and a total of 29,414,000 would die immediately in India.

Casualties are likely to be very high because of the congested nature of South Asian cities, the limited fire-fighting capabilities in most cities, limited medical facilities, and the total disruption of the administrative infrastructure on a national scale. More deaths are likely over the long term as many of the injured are unlikely to survive. Unlike the more developed countries, India and Pakistan would not be able to rely on the medical, administrative, and economic resources of the small- and medium-sized towns not hit in a nuclear war for relief operations.

The breakdown of political authority which is likely to follow such a widespread use of weapons could trigger an upsurge of secessionist activity in both India and Pakistan. Such events are likely to further slow the rate of economic and political recovery. Certainly, democratic political processes would be threatened.

Assuming that a fifteen mph wind is blowing over each city, fallout of 3,000 rem would cover a downwind area of 140 sq mi. (Exposure to more than 300 rem per week is likely to be fatal.) Thus eight such patterns covering an area of 1,120 sq. mi. would hover over Pakistan. Similar fallout patterns would cover an area of 2,100 sq mi in India, which would cause additional deaths from exposure to radiation. These deaths are not included in the estimates in Tables 2.8 and 2.9. Given the population density of some of the areas surrounding the major cities targeted in this scenario, the number of such deaths would be very high.

Conclusions

We reach the following conclusions about the usability of nuclear weapons in South Asia:

- The introduction of nuclear weapons into South Asia would not necessarily be destabilizing, provided that it was not too rapid and asymmetrical in nature.

TABLE 2.8 Targets in a Counter-City Strike against Pakistan

City	*Projected Population (1990)**	*Immediate Estimated Deaths*
Karachi	8,337,100	6,252,000
Lahore	4,599,900	4,500,000
Lyallpur	2,064,300	2,000,000
Rawalpindi	1,427,100	1,400,000
Hyderabad	1,088,000	1,088,000
Multan	1,007,200	1,000,000
Gujranwala	885,300	885,000
Peshawar	383,100	383,000

* Populations have been calculated by projecting the growth rate for each city between 1962-72 to 1990. The 1962 and 1972 population figures are from *The Statistical Abstract of Pakistan 1980* (Islamabad: Government of Pakistan, 1981), pp. 5-7. Figures have been rounded off. Ground Zero is located at the center of each city. Population density and city area figures are from Kureshy, pp. 86-96. Figures have been rounded.

TABLE 2.9 Targets in a Counter-City Strike against India

City	*Projected Population (1990)**	*Immediate Estimated Deaths*
Bombay	11,914,900	8,936,000
Delhi	9,118,600	9,100,000
Ahmedabad	3,164,100	3,100,000
Agra	1,041,800	1,020,000
Gwalior	944,300	940,000
Jaipur	904,600	900,000
Baroda	821,400	800,000
Amritsar	813,500	810,000
Indore	793,900	790,000
Ludhiana	775,000	770,000
Surat	693,500	690,000
Jalandhar	590,900	500,000
Meerut	528,400	500,000
Jodhpur	467,000	390,000
Ghaziabad	174,700	168,000

* Based on 1971 or 1981 census, the prevailing growth rate in each city has been used to project the size of 1990 population. The figures are from *The Statistical Pocket Book of India 1980* (New Delhi: Ministry of Planning, Government of India, 1981), pp. 5, 10-12. Ground Zero is located at the center of each city. Population density and city area figures are from various sources. Figures have been rounded.

- Nuclear weapons would probably be used to maintain a deterrence posture by both countries. However, four potential problems exist with regard to Pakistan's ability to maintain a stable and credible deterrence posture: its technical backwardness compared to India. The danger that Pakistan might lose the ability to deliver nuclear weapons because of losses suffered during conventional warfare; the relatively greater vulnerability of Pakistan to Indian attack than of India to Pakistani attack, and the need for the two sides to develop C^3I. These problems will have to be overcome to establish credible deterrence.

- The use of nuclear weapons for compellence would be impractical unless only one side had nuclear weapons. If both have nuclear weapons, their use to compel compromise on vital issues of national interest would not be possible.
- The major destabilizing effect of nuclear weapons would be caused by any policy to use them as tactical weapons. The adoption of such policies and the development of tactical nuclear weapons must therefore be prevented, if and when the two states acquire nuclear weapons.
- Besides MAD, other international, regional, domestic, and geographic constraints exist on use of nuclear weapons for any purpose besides deterrence. These constraints are significant.

The following conclusions can be reached about the nature and extent of damage caused by a nuclear exchange between India and Pakistan and the degree of confidence with which such effects can be predicted:

- Any use of nuclear weapons in the region, even on a small and limited scale, would cause very high civilian casualties and collateral damage and would be likely to cause escalation from a limited nuclear exchange into a major counter-city strike.
- The delayed effects of the use of nuclear weapons are as likely to be as important as the immediate effects.
- These delayed effects are difficult to calculate with precision, and decision makers must keep these incalculable effects of the use of nuclear weapons in mind when making decisions on the acquisition and use of weapons.

Thus the acquisition of nuclear weapons by India and Pakistan will not necessarily lead to instability in the region. If both sides acquire nuclear weapons, a policy of using them for deterrence would be established and, if rationality and perspective were retained by decision makers in times of crises, acquisition of nuclear weapons might actually lead to more stable relations between the two states. But if nuclear weapons are introduced into the region, it is imperative that this introduction be gradual and symmetrical and that the conditions necessary for a credible and robust deterrence be established.

Notes

*"After Midnight" was originally published in *Nuclear Proliferation in South Asia*, editor Stephen P. Cohen (Boulder, CO: Westview Press, 1991).

1. S. Glasstone and P.J. Dolan, eds., *The Effects of Nuclear Weapons* 3rd ed. (Washington, D.C.: Department of Defense and Department of Energy, 1977), p. 276.
2. Office of Technological Assessment (OTA), Congress of the United States, *The Effects of Nuclear War* (Washington, D.C.: OTA Congress of the U.S., 1979), p. 20, and Glasstone and Dolan, *The Effects of Nuclear Weapons*, p. 277.
3. OTA, *Effects of Nuclear War*, p. 21.
4. *Ibid*.
5. K.N. Lewis, "The Prompt and Delayed Effects of Nuclear War," *Scientific American* , July, 1979, p. 40.
6. OTA, *Effects of Nuclear War,* pp. 19-20.
7. *Ibid*., pp. 110-111.
8. *Ibid*., pp. 111.
9. *Ibid*.
10. *Ibid*., pp. 112.
11. *Ibid*., pp. 112, 114.

12. See E.S. Batten, *The Effects of Nuclear War on the Weather and Climate* (Santa Monica: RAND Corporation, 1966); R.U. Ayers, *Environmental Effects of Nuclear Weapons* (Hudson Institute, 1965).

13. OTA, *Effects of Nuclear War*, pp. 114-115.

14. Glasstone and Dolan, p. 101.

15. OTA, *Effects of Nuclear War*, p. 19.

16. See Glasstone and Dolan, *Effects of Nuclear Weapons*, p. 544; OTA, *Effects of Nuclear War*, p. 37; and J H Barton & L D Weiler, *International Arms Control* (Stanford: Stanford University Press, 1976), p. 47.

17. OTA, *Effects of Nuclear War*, p. 35.

18.These calculations were made on the "Nuclear Bomb Effects Computer" in Glasstone and Dolan.

19. Lewis, Prompt and Delayed Effects, p. 38.

20. Glasstone and Dolan, chapter 9.

21. Figures based on Federal Bureau of Statistics, Government of Pakistan, *Pakistan Statistical Yearbook 1990* (Karachi: Manager of Publications, Government of Pakistan, 1989), p. 387 and Department of Statistics, Ministry of Planning, Government of India, *Statistical Abstract of India, 1985* (New Delhi: Department of Statistics, Ministry of Planning, Government of India, 1987), pp 547-48.