The South Asian Bomb

Effects of a Nuclear Blast Over Bombay

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The explosion of a Hiroshima-sized (15 kt) nuclear weapon over Bombay would result in 150,000 to 800,000 deaths within a few weeks from the combined effects of blast, burn, and radiation. A weapon with a yield of 150 kilotons could cause between 2,000,000 and 6,000,000 deaths. The use of nuclear weapons over any densely populated city in South Asia would result in similar casualty figures. Fallout-related cancers and other illnesses would increase the casualty totals over time. Treatment of blast, burn, and radiation injuries in a region with relatively few physicians and hospital facilities would be compromised further by the devastation of medical and transportation infrastructures. The only way to make certain that a tragedy of such proportions never happens is the complete, global abolition of nuclear weapons. [M&GS 1998;5:74-77]

The recent series of nuclear tests conducted by India and Pakistan give particular relevance to an examination of what nuclear weapons and the possibility of nuclear war would mean in a South Asian context. The effects of a nuclear weapon explosion are so immense and so different from those of conventional weapons [1,2] that it is useful to present, as a case study, a familiar hypothetical "target." Therefore the effects of a single explosion of a Hiroshima-sized nuclear bomb (i.e., approximately 15 kilotons) at an elevation of 600 meters over Bombay (Mumbai), India, shall be described. The consequences of such an explosion for any other large, densely populated, South Asian city, such as Lahore or Dhaka [Figure 1], would be similar.

The short-term effects of a nuclear explosion—those that occur within the first few weeks—can be classified as either prompt or delayed effects. In addition there are long term effects, primarily related to radiation from fallout, that can develop over years.

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Prompt Effects

Initial Flash

Any person or object exposed to the explosion would first experience an extremely intense flash of heat and light, brighter than a thousand suns. Even looking at the flash could cause blindness. For 1.6-3.2 km around the point of explosion (the epicenter, or ground

zero), everything that could burn—wood, paper, clothes, vegetation, and all other combustible materials—would catch fire.

Radiation

Exposure to neutron and gamma radiation, resulting from the nuclear reactions responsible for the explosion, would occur almost simultaneously. Radiation exposure could lead to a variety of symptoms such as nausea, bloody diarrhea, and hemorrhages within a few days (other consequences of radiation could appear years later) [3]. These health effects are often fatal and include leukemia, thyroid cancer, breast cancer, and lung cancer, as well as non-fatal diseases such as birth defects, cataracts, mental retardation in young children, keloids, and others.

Blast

The third effect is the shock or blast wave, which would result in a forceful blow to any person or object in its path. The winds accompanying the shock wave would reach velocities of more than 110 km/h to a distance of 3 km or more. The shock wave would destroy everything within a circle with a radius of 1.1 km. Up to 1.7 km from the point of explosion, all houses not built with concrete would be destroyed. Many of the buildings in Bombay, especially older ones, are either badly designed or constructed with raw materials that are of poor quality (such as adulterated cement or improperly baked bricks). Every year several hundred buildings collapse by themselves, especially during the rainy season. Faced with the shock wave and these hurricane-force winds, buildings may collapse at significantly greater distances than those estimated here.

Delayed Effects

Firestorm

A few minutes after the explosion, the delayed effects would begin. The first of these is the firestorm that would result from the coalescing of individual fires started by the initial flash of light and heat [4]. In the case of a Hiroshima-sized explosion over a city like Bombay, the radius of the region under flames would be 1.7 to 2 kilometers [Figure 2]. Due to the large area of the fire, the fire zone would act as a huge pump, sucking in air from the surrounding areas and driving heated air upwards. This pumping action would create winds with velocities as high as 50-80 kilometers/hour. The temperature in the fire zone would reach several hundred degrees, making it almost certain that there would be no survivors. Furthermore, fire-fighting would be almost impossible due to the combination of hurricane-force winds, thick smoke, the destruction of water mains and tanks by the shock wave, and the presence of debris from the blast blocking roads and access routes.

Other factors would lead to a probability of small explosions in the fire region and, therefore, to a greater chance that people would be injured as well as burned. In Bombay, for example, many houses contain gas cylinders (containing liquid petroleum gas) that are used for cooking. These are known to explode when exposed to fires. In addition, compared to cities in Japan and Germany during World War II, Bombay and other modern cities have much greater concentrations of motorized vehicles such as cars, scooters, and buses that use petroleum-based fuels. The corresponding storage and dispensing facilities for such highly inflammable and explosive fuels would only increase the numbers of casualties.

Figure 1. Top South Asian cities with populations of more than 1 million.

	Population	Density (per sq. mile)
India		
Greater Mumbai	12,596,243	127,461
Calcutta	11,021,918	56,927
Delhi	8,419,084	63,612
Madras	5,421,985	51,270
Hyderabad	4,344,437	41,741
Bangalore	4,130,288	96,041
Pakistan		
Karachi	8,014,000	42,179
Lahore	4,376,000	76,779
Bangladesh		
Dhaka	4,419,000	138,108

Sources: 1991 India Census [4]; World Almanac and Book of Facts 1995. New York: St. Martin's Press. 1994.

Fallout

The second delayed effect is radioactive fallout. One of the more graphic images from Hiroshima and Nagasaki was the black rain carrying radioactive fallout that descended after the explosion. As in those two cities, radioactive fallout would affect Bombay, but the quantities would be difficult to predict.

When a nuclear bomb explodes at low altitudes, a large amount of material is vaporized and carried aloft into the mushroom cloud. This material then mixes with the fireball's radioactive materials, which results in a cloud of highly radioactive dust. This radioactive fallout can travel large distances on the winds created by the explosion, as well as in the atmosphere, before ultimately falling back to earth. The effects of exposure to fallout are similar to those of exposure to nuclear radiation.

Bombay, being close to the sea, has high levels of water vapor in the atmosphere. Water droplets would likely condense

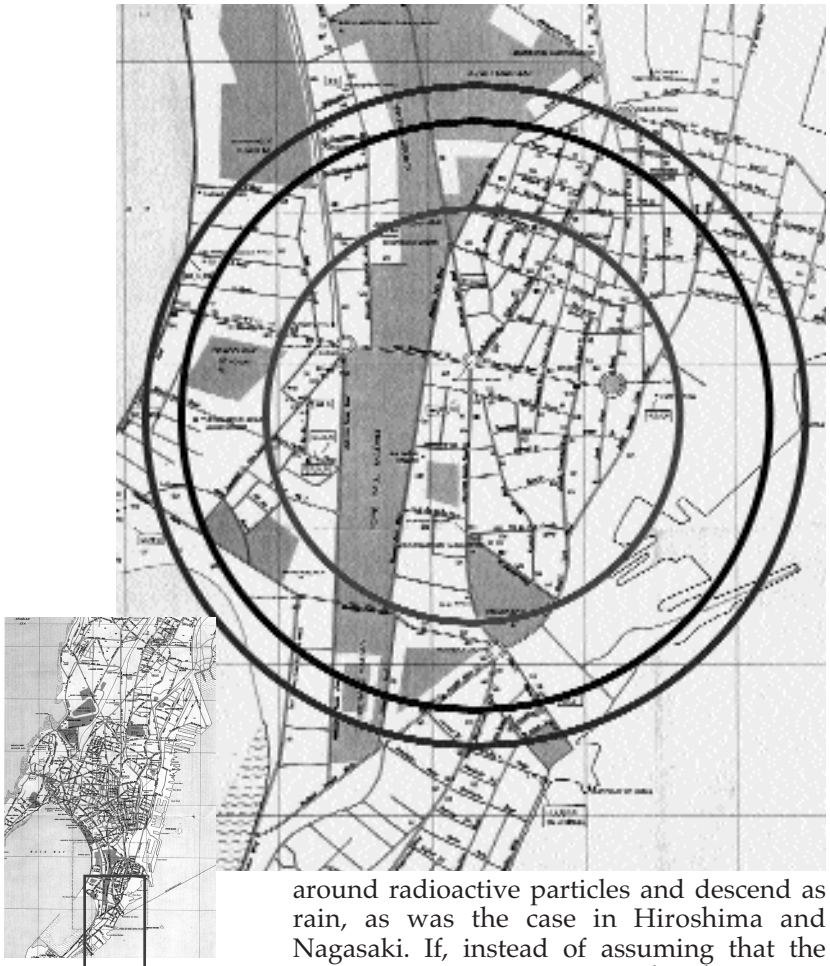

Figure 2. Enlarged section of southern Bombay shows effects of a 15-kt nuclear explosion. The innermost circle encloses the high radiation dose zone, the second circle is the blast damage zone, and the outermost is the firestorm zone.

around radioactive particles and descend as rain, as was the case in Hiroshima and Nagasaki. If, instead of assuming that the weapon is detonated at a height of 600 meters, we assume that the explosion happens at the surface with a wind velocity of 25 km/h, the area subject to levels of fallout that have a high likelihood of being fatal would be about 25-100 square kilometers. The wind direction during the period that the fallout is aloft (which could be fluctuating) would determine which areas would be subject to these levels of radioactivity. The regions subject to high levels of fallout would have high levels of casualties and radiation sickness.

Even people who live in areas subject to lower levels of radiation, unless they are immediately evacuated, would be susceptible to radiation sickness. Given the large population of Bombay and the likely damage to all forms of transportation infrastructure (train stations and tracks, roads, petrol stations, dockyards, airports, etc.) evacuation of survivors would be nearly impossible.

Figure 3. Ratios of physicians and hospital beds to populations in India, Pakistan, the U.S., and Japan.

	Physicians	Hospital Beds
India	1/2,337	1/1,324
Pakistan	1/2,364	1/1,706
U.S.	1/406	1/211
Japan	1/588	1/74

Source: World Almanac and Book of Facts 1995. New York: St. Martin's Press. 1994.

Population Figures and Casualty Estimates

According to the 1991 census, the population of Greater Bombay is 9,910,000; if the neighboring town of Thane is also included, the population is 12,572,000 [5]. Since the decadal growth rate for Bombay during the decade preceding this census was 20.21%, these numbers may understate the current population significantly. Furthermore, there is also some evidence of undercounting in the 1991 census [6]. The average population density of Bombay is about 23,000 people per square kilometer. There are regions, however, where the population density exceeds 100,000 people per square kilometer.

Prompt Casualties

Since a nuclear explosion and its effects are complicated physical phenomena, with different types of effects occuring around the same time, it is impossible to predict numbers of casualties or injuries with any reasonable accuracy. Assuming the above population densities, however, one would expect somewhere between 150,000 and 800,000 deaths within a few weeks of the explosion, resulting from just the blast and fire effects of one small (i.e., Hiroshima-sized) nuclear weapon, further assuming that the weapon is exploded in the atmosphere and that fallout effects are negligible (assumptions that lead to a very conservative casualty estimate). If the weapon used were to have a yield of 150 kilotons (i.e. ten times as large as the Hiroshima bomb), then the number of deaths would be about 2,000,000 to 6,000,000.

In the case of a weapon exploding at ground level, the areas damaged by fire and blast are somewhat less. But fallout would be a significant cause of deaths and sickness. Assuming that all the fallout is deposited in inhabited areas (with a population density of 23,000) the number of people dying of all causes could be as high as 350,000 to 400,000 for a 15-kiloton weapon. Many more people would be subject to lower doses of radiation, which in the case of already sick people, the old and the young, could well be lethal in the absence of medical care.

Long Term Casualties

The above numbers include only the "prompt" casualties (i.e. those who are injured or die right away or within a few weeks of the explosion). Many more people will certainly die from long term effects, especially effects with radiation-related causes. Several hundred Hiroshima survivors have died from leukemia, thyroid cancer,

breast cancer, and lung cancer [7]. Studies involving survivors at Hiroshima and Nagasaki reveal that the mortality rates for all diseases, for leukemia, and for malignancies other than leukemia, among people exposed to more than 200 rads, were 1.16, 17.6, and 1.42 times higher respectively, when compared to a control group that had not been exposed to radiation [7]. Leukemia accounts for 3% of all cancers for males and 3.5% of all cancers for females in Bombay [8]. Increases in the cancer rates of survivors of an atomic bombing of Bombay should be comparable to those among Hiroshima survivors.

There are a number of other reasons to believe that the casualty numbers cited above would be an underestimate in a city like Bombay. First, the assumed population densities are lower than the actual densities. Apart from undercounting and variations among regions, a substantial number of people come in every day from places as far away as Pune (four hours by train) to work in Bombay. The census does not take such commuters into account. Since an attack from the air is quite likely to take place during the day in order to maximize visibility, many commuters will also be killed or injured.

Second, casualties from fallout have not been included in the estimates. Since fallout, even if present only in small quantities, can spread out to large regions and cause local hot spots, this is an important omission.

Third, there are large numbers of industries in Bombay and its vicinity. India's highest concentration of chemical industries is in the Trans-Thane creek area, which has more than 2,000 factories. Central Bombay is home to several mills, which could cause additional fires and explosions, and which could spread toxic substances. The Union Carbide accident in Bhopal is an example of the kinds of effects that are possible due to escape of toxic chemicals. In addition to chemical industries, the largest nuclear laboratory in India—the Bhabha Atomic Research Centre—is in Trombay, just outside Bombay. A nuclear explosion in the vicinity of either reactor at the Centre (CIRUS and Dhruva) or near the reprocessing plant or the facilities storing radioactive waste and/or spent fuel could lead to the release of large amounts of radioactivity in addition to the quantities resulting from the explosion itself. This would increase the amounts of fallout significantly. Fourth, conservative figures for blast damage and fire regions have been deliberately chosen. The actual areas are likely to be higher, implying a greater number of casualties.

Hospitals and medical care in an overcrowded city such as Bombay are limited to begin with [Figure 3], and facilities within the affected area would be destroyed or damaged during the attack. The injured would be unlikely to find medical treatment to help them survive.

Conclusion

The immense scale of effects resulting from a single fission weapon with a low yield should make it clear that the use of nuclear weapons in South Asia would lead to a major catastrophe. The only guarantee that such a tragedy will never occur is the global elimination of nuclear weapons and of the means to manufacture them. ❧

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