SSPC RESEARCH PAPER

September 2018

ULTIMATE UPHEAVAL: REVISITING THE NUCLEAR WINTER SCENARIO AND OTHER POSSIBLE ENVIRONMENTAL CONSEQUENCES OF NUCLEAR WAR

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This paper attempts to compile nuclear events, including weapon use and tests as well as debates surrounding nuclear winter. It also briefly discusses these devastating environmental effects in the light of a hypothetical nuclear war between two South Asian nuclear neighbours.

It is a widely known fact that nuclear weapons, the ultimate among weapons of mass destruction and disruption, have the ability to wreck physical environments when used against adversaries and do all possible damage to the living beings in those environments. The use of these deadly weapons in two Japanese cities during World War II has already shown us the scope of their destructive power and effects. The various long-term and immediate effects of nuclear weapons, however, had not been studied until the early 1950s. With the proliferation of this lethal weapon, both the scientific community and civil society have finally taken the phenomenon of radioactive fallout and its effects on global health and environment seriously. Among these effects, the threat to the ozone layer, an invisible atmospheric shield that protects animals and plants from ultra-violet light, is the most alarming. The threat of a 'nuclear winter', which is a long period of darkness and extreme cold conditions that are predicted to follow a nuclear war, also gained worldwide attention during the 1980s. Scientists believe that a layer of dust and smoke would cover the earth's atmosphere and block the rays of the sun, as a result of which most living organisms would perish.

During a nuclear detonation, multiple types of energetic ionising radiations are produced. The initial radiation consists of neutrons and gamma rays, most of which are emitted simultaneously with the explosion and within a minute of the detonation. The intensity of the radiation depends on the density and humidity of air as well as the explosive yield of the bomb. More than half the individuals subjected to radiation doses develop diarrhoea, malaise, and tensions in the mucous membranes.[1] While there is uncertainty about the acute effects of radiation, under war conditions it is likely that the majority of people exposed to it will die. Destruction from a nuclear explosion also leads to fallout, which is one of its most unpredictable effects. Unlike other effects, which are immediate, fallout danger extends in time as well as space. It consists of radioactive fission products created at the very instant of the explosion. If the bomb detonates at great height and the fireball does not touch the ground, then the fission products, which are in gaseous form, rise with the fireball to high altitudes, spreading into the stratosphere. These particles are then carried by winds all over the world and eventually come down to earth as rain to have a global effect. Exposure to this fallout may cause long-term side effects like cancer and genetic damage. On the other hand, surface explosions vaporise vast quantities of soil and rock, which are sucked into the fireball and become radioactive by mixing with the radioactive remnants of the bomb. This radioactive soil and rock material can then contaminate vast areas with lethal levels of radioactivity, depending on the winds. This is called local fallout. Global fallout is considerably less harmful than local fallout because it is far more dispersed and has had longer to decay.

This paper attempts to compile the aforementioned nuclear events, including weapon use and tests as well as debates surrounding nuclear winter. It also briefly discusses

[1] Eric Chivian et al., eds., "Last Aid: The Medical Dimensions of Nuclear War," (W.H. Freeman and Comp., San Francisco, 1982): 236.

these devastating environmental effects in the light of a hypothetical nuclear war between two South Asian nuclear neighbours, India and Pakistan.

The Saga of Hiroshima and Nagasaki

The detonation of the world's first nuclear device was carried out in the Alamogordo desert in New Mexico on July 16, 1945. Barely twenty days later, the first military use of this new but lethal weapon occurred over two Japanese cities: Hiroshima and Nagasaki. These bombings initiated an arms race that continues to this day, as countries develop nuclear weapons and secretly stockpile them in their respective arsenals. Presently, at least eight countries have the capacity to launch a nuclear weapon, with a couple of more striving to achieve that status. The threat of nuclear proliferation has only recently become the focus of public attention due to certain dangerous developments, like accidents in nuclear plants and the risk associated with storing radioactive waste materials. The dangerous potentiality of nuclear weapon production and its tests also expose workers and communities to a wide variety of radiation related and other hazards.

A description and critical analysis of the effects of nuclear weapon use since World War II cannot be done without assessing history's most inhumane act, the first and (so far) last military use of the weapon on Hiroshima and Nagasaki. The bomb which destroyed Hiroshima on August 6, 1945 was dropped at 8.15 a.m. and exploded 510 metres above the centre of the city.[2] 'Little Boy', as it was called, released an energy equivalent of about 12.5 kilotons of TNT. The atomic bomb which was dropped on Nagasaki just three days later, exploded 500 metres above the city at 11.02 a.m. It was known as 'Fat Man' and is thought to have had a yield of around 22 kilotons of TNT.[3] These two weapons give only an approximate idea of the effects of modern warheads, as they were small and had the efficiency of a primitive nuclear weapon. Yet, the effect of these two small devices on the Japanese cities was catastrophic.

The immediate effects varied considerably in the two cities because of their geographical differences. Hiroshima is built on a plateau and was damaged symmetrically in all directions, while Nagasaki is built on mountainous ground and the damage varied according to the direction of the wind. The number of people killed at a given distance from the hypocentre was roughly the same in both cities. Though the exact number of people killed is still unknown, almost everyone within 500 metres of the hypocentres was dead by the end of 1945. About 60% of those within 2 kilometres also died.[4] The difficulty in estimating the exact number of people killed is attributed to the lack of figures for the population of Hiroshima and Nagasaki at the time, which

[2] AMBIO, *Nuclear War: The Aftermath* (Pergaman Press, Oxford, 1983), 16.
[3] Ibid.
[4] D. Holdstock and F. Barnaby, eds., *Hiroshima and Nagasaki: Retrospect and Prospect* (Frank Cass, London, 1995), 2.

included thousands of Koreans and forced labourers too. The best estimates tell us that the total number of people killed by the two bombings exceeds 260,000.[5]

The intensity of the heat generated by the nuclear explosions is estimated to have been 3000^0-4000^0C at ground level near the hypocentres and it lasted one second. At 500 metres from the hypocentre in Hiroshima, thermal radiation was emitted at the rate of 60 calories per square centimetre in the first three seconds. At 3 kilometres from the hypocentre, the heat in the first three seconds was about 40 times greater than the heat of the sun. The heat in Nagasaki was sufficient to burn exposed skin at distances as great as 4 kilometres. Within 20 to 30 minutes of the explosion, a massive fire began from the hypocentres, lasting for almost half day in Hiroshima. The fire was accompanied by black rain containing radioactivity from the explosion, and fell on Hiroshima for 7 to 8 hours.

Half the energy generated by the explosions manifested as blast. The front of the blast moved like a shock-wave, which is a wall of air at high pressure spreading outward at a speed equal to or greater than the speed of sound. As a result, all buildings within 2 kilometres of the hypocentre in Hiroshima were reduced to rubble. The death toll was severe. Blast injuries occurred mostly among people in concrete buildings and were less severe among people in Japanese-style houses.

The Hiroshima and Nagasaki atomic bombs afforded the first opportunity to observe the effects of massive ionising radiation exposure in humans. Although little is known about the effects of initial radiation, nearly everyone who died within three weeks of the bombings had signs of radiation injuries. The prodromal syndrome, which is the period of early manifestation of an illness lasting one or more days, consists of prostration and gastro-intestinal symptoms including nausea, vomiting and loss of appetite. This syndrome was marked in most severely exposed people, a lot of whom died within two weeks, with blood cell abnormalities. Others died about 30 days after the explosion with milder prodromal syndromes.[6]

Those who had survived by the end of 1945 suffered the late effects of nuclear explosion. These delayed effects comprised of a variety of illnesses like eye diseases, blood disorders, psycho-neurological disturbances, and disturbances of reproductive function.

After the bombing, blood cells of survivors were subject to extensive investigations which have continued for years. The most significant effect of radiation has been the induction of malignant tumours in survivors who had been exposed. The earliest evidence of radiation-induced malignant change was the increase in leukaemia cases during the late 1950s and early 1960s.[7] The mortality rate for leukaemia reached a level 30 times higher than that of the non-exposed Japanese. Clinical studies in

[5] Ibid.
[6] Eric Chivian et al., eds., "Last Aid: The Medical Dimensions of Nuclear War", 83.
[7] Ibid., 103.

Hiroshima and Nagasaki during the late 1950s and early 1960s showed that the frequency of thyroid cancer was higher among survivors who had been exposed to radiation, especially women. The incidence of other malignant tumours like breast, lung, prostate, and bone has also been higher among survivors. The absence of any genetic damage in survivors exposed to radiation is surprising; however, physicians and scientists believe that it is still too early to draw this conclusion.

Environmental Effects of Nuclear Weapons Tests

Nuclear weapons tests are usually conducted for the development of new types of nuclear weapons. Some tests, however, are conducted randomly in order to maintain confidence and reliability in weapon stocks. Till 1996, six countries had conducted approximately 2,048 nuclear tests; of these about 530 were conducted in the atmosphere, underwater, or in space.[8] In 1963, the Partial Test Ban Treaty prohibited nuclear tests in these three areas. Among the five nuclear armed states, it was the U.S., U.K., and the erstwhile Soviet Union - all signatories to the treaty, that first resorted to underground testing, whereas France continued its atmospheric tests till 1974 and China till 1980. It is estimated that from 1945 to 1996 a total of 1518 underground tests were conducted.[9] Warring South Asian neighbours, India and Pakistan, have also conducted several underground tests. After the 1974 underground test, India detonated five nuclear devices in May 1998 at Pokhran. Even though there were reports of Pakistan's covert but 'cold nuclear device test' in March 1983, it openly detonated at least six nuclear devices in Chagai hills in May 1998. The latest entrant into the nuclear weapons club is North Korea, which has tested nuclear devices twice - in October 2006 and May 2009. Both Israel and Iran have developed nuclear capabilities but are yet to test a device.

Following the bombing of Hiroshima and Nagasaki, the Pacific region gradually became the most nuclearized region in the world by way of testing, dumping nuclear waste materials, and other related activities. Besides the Pacific, some countries used their own territories for these purposes. Let's take a look at the nuclear activities of major nuclear armed nations of the world.

USA: The United States, being a pioneer in the nuclear arms race, has conducted around 1,032 atmospheric and underground nuclear tests so far at eleven locations within its boundaries, four island locations in the Pacific and over the Atlantic ocean.[10]

Post World War II, the United States took possession of Micronesia, a group of islands in the Pacific Ocean consisting of the northern Marianas, Belau, the Federated States of

[8] SIPRI, *Armaments, Disarmament and international security: SIPRI Yearbook 1997* (Oxford University Press, New York, 1997), 434.
[9] Ibid.
[10] Ibid.

Micronesia and the Marshall Islands. Soon after the war, the United States decided to set up 'Operation Cross Road', the first in a series of atomic tests at the Bikini Atoll in Marshall Islands to conduct research on the nature and effects of nuclear explosions. The inhabitants of Bikini Atoll were given a month's notice to evacuate the island following which they moved to Rongerik Atoll, 200 kilometres to the east. After the world's first underwater nuclear blast 'Baker', the entire lagoon was engulfed in radioactive mist as the radioactive column of air from 'Baker' rose up to 6,000 feet. As a result, the third test of the series, 'Charlie', was cancelled due to high levels of contamination and the testing site was shifted to Eniwetok. On December 21, 1947 the islanders of Eniwetok were forcibly relocated Ujelong Atoll in preparation for 'Operation Sandstone'. In 1954, the Bikini Atoll made it to the news again when the US exploded its largest hydrogen bomb, 'Bravo', over it. The operation led to international furore over the highly radioactive fallout of the blast. This fallout was carried by the winds to Rongerik, Uterik and a Japanese trawler in the area, 'Lucky Dragon'. This unfortunate consequence occurred due to the meteorological situation being misjudged and unexpected changes occurring in the direction of the winds.[11] Five hours after the detonation, the fallout began at Rongelap Atoll, consisting mainly of mixed fission products with small quantities of neutron-induced radio-nuclides and traces of fissionable elements. It took 24 hours post fallout to evacuate the residents of Utirik and around 50 odd hours for Rongelap, with the assistance of the Navy in the latter case.[12]

The immediate complaints reported after drinking contaminated water were nausea, skin-burns, headaches, and numbness. About 90% people from Rongelap whose hair had become white due to fallout ashes, experienced hair loss. Long-term ailments included miscarriages in women up to four years after the test and increase in thyroid related ailments and leukaemia. The displaced Bikini Islanders on Rongerik also suffered severe food shortages due to limited resources on the island. A survey conducted by the U.S, government has predicted that the Bikini will not be habitable until at least the first half of the next century.

United Kingdom: Up till 1962, Britain had tested its nuclear weapons at the Nevada test site in the United States. The search for an alternative to the Nevada test site led them to the Montebello Islands of Australia. Between 1952 and 1957, 12 atmospheric tests were carried out in Australia - three at Montebello, two at Emu and seven at Maralinga.[13] By 1996, Britain had conducted 45 nuclear tests in total, of which 21 were atmospheric and 24 underground. [14]

[11] L.W. Nordaeim, "Tests of Nuclear Weapon," *Bulletin of the Atomic Scientists* Vol. XI, no. 7 (September 1955): 255.
[12] IPPNW and IEER, "Radioactive Heaven and Earth," (Apex Press, New York, 1991): 76.
[13] Ibid., 105.
[14] SIPRI, *Armaments, Disarmament and International Security: SIPRI Year Book 1997*, 434.

The first British nuclear test, 'Operation Hurricane', took place in the hull of an old warship called the HMS Plym on October 3, 1952. Subsequently, the location changed to Emu field, and then Marilanga and Christmas Islands. After Totem I, a 10 kiloton bomb exploded in October 1953 at Emu field, the aborigines saw a black cloud drifting over Wallatinna and Melbourne Hill. The aborigines later claimed that many of their members had fallen ill and died, which was blamed on the British and Australian authorities' ignorance of aboriginal lifestyles. The South Australian Health Commission in 1985 identified 30 cases of cancer amongst aborigines. Most of the affected aborigines had lived north of the testing sites of Emu field and Maralinga. Twenty-seven cancer victims among them died.[15] The Totem I blast also proved to be an unexpected radiation hazard for the British, Australian and American forces involved in the test.

Till today, these three sites remain contaminated by the effects of the test. The major hazard is from plutonium-239, which was scattered near the site, with deposits amounting to about 1,350 curies.[16] As a result, Maralinga continues to be marred by a number of radiological and toxic hazards.

France: French nuclear tests were conducted in Algeria between 1960 and 1965, with the first one taking place at Reggan on February 13, 1960. Before Algeria won its independence, fourteen nuclear weapons tests had been conducted at two Algerian locations in the Sahara desert. France then shifted its test sites to Polynesia in the Pacific, where two atolls - Moruroa and Fangataufa - became its major testing sites till 1996.

After three years of feverish preparation, the French tried out their new atomic test site at Moruroa Atoll in July 1966. The first bomb, a plutonium fission device, was placed on a barrage anchored in the lagoon. Upon its detonation, all the water in the shallow lagoon basin was sucked up into the air, which then rained down. France has been estimated to have conducted around 210 nuclear tests till 1996, including 50 atmospheric and 160 underground tests.[17]

The environmental effects of atmospheric and underground testing are both short-term and long-term. Though underground tests have less dangerous immediate effects on the environment than atmospheric tests, they leave long-lasting radio-nuclides in the ground, which sooner or later make their way into the biosphere. In French Polynesia, all inhabitants faced the insidious hazard of the steady absorption of radioactive fallout. Since the effects of fallout take at least 10-15 years to become apparent, a sharp increase in the number of cancer patients has been expected from the early 1980s.[18] A recent study confirmed the presence of radionuclides in the waters of Moruroa, whose land area has been used to store radioactive waste in a huge heap on the north coast of

[15] R. Milliken, "Australia's Nuclear Graveyard", *Bulletin of the Atomic Scientists* Vol. 43, no. 3 (April 1987): 43.
[16] Ibid.
[17] SIPRI, *Armaments, Disarmament and International Security: SIPRI Yearbook 1997*, 434.
[18] B. Danielssion, "Poisoned Pacific: The Legacy of French Nuclear Testing," *Bulletin of the Atomic Scientists* Vol. 46, no. 2 (March, 1990): 28.

the atolls. As time has passed, most of the radioactive materials deposited on land have made their way into the lagoon, contaminating the active marine life. There is evidence of plutonium-239 accumulating in the food chain.[19]

A major test-related landslide and tidal waves occurred in Moruroa on July 25, 1979, when a 120 kiloton weapon, which was supposed to be lowered into an 800 meter long shaft, got stuck at a depth of 400 metres and could not be dissolved. The explosion resulted in a major underwater landslide of at least one million cubic meters of coral and rock and created a cavity.[20] It then produced a huge tidal wave, which spread through the Tuamotu Archipelago and caused damage to the southern part of Moruroa and its people.

Other countries: Besides the aforementioned nuclear armed countries, other declared nuclear powers like the Soviet Union and China have also conducted several nuclear tests at their respective sites. The former Soviet Union conducted its first nuclear test in 1949, and is estimated to have conducted over 715 nuclear tests till date, including 219 atmospheric and 496 underground tests.[21] Its main test sites are near Semipalatinsk in Kazakhstan and on the Arctic islands of Novaya Zemlya. Besides these two foreign sites, there are over 50 other test sites within the Soviet Union. Although the environmental effects of these tests are not known yet, research is underway at all the sites.

China has conducted all its nuclear tests so far at Lop Nor in Xinxiang province. It tested its first fission weapon in 1964 and first thermonuclear weapon in 1967. Between 1964 and 1996, it conducted 45 tests including 23 atmospheric and 22 underground tests.[22] There are no official records or data regarding fallout and environmental contamination caused by these tests. This is not unexpected, since the Chinese government maintains utmost secrecy about its military activities. Similarly, North Korea too has little to no information available on the effects of North Korean tests on the human and physical environment.

Nuclear Winter and South Asian Nuclear Scenario

There is no doubt that the direct blast, heat, and radiation resulting from a large scale nuclear war would be disastrous beyond any previous experience. Hundreds of millions of people would die from the prompt effects of such a war, but even if the majority of the world's population were to survive, they would have to deal with the long-term effects of the explosion. The study of global environmental effects of nuclear war and its consequences for survivors is, therefore, immensely valid and important.

[19] Ibid.
[20] IPPNW and IEER, "Radio-active Heaven and Earth," (1991): 145.
[21] SIPRI, *Armaments, Disarmament and International Security: SIPRI Yearbook 1997*, 434.
[22] Ibid.

During the early 1980s it became apparent that the nitrogen oxide produced and injected into the stratosphere by large nuclear fireballs could significantly damage the ozone layer. This would lead to an increase in ultra-violet-B radiation reaching the earth's surface, which would negatively impact the health of humans, animals, and plants. A Soviet analysis showed that the detonation of explosives in the megaton range with an overall explosive force of 10^4 megatons would destroy 30-60% of the total amount of ozone in the Northern Hemisphere.[23] The large-scale pollution of radioactive particles also affects ecosystems by altering the radiation and electrical characteristics of the atmosphere, affecting weather and climate, and causing deterioration of ecosystems. According to some American scientists, the principal adverse environmental consequences that will follow a nuclear war are: obscuring smoke in the troposphere; obscuring dust in stratosphere; fallout of radioactive debris; and partial destruction of the ozone layer.[24]

Before 1982, the potential environmental effects of nuclear explosions were thought to be radioactive fallout and ozone depletion. The discovery of a new concept called 'nuclear winter' has, however, banished all scepticism about the environmental effects of a nuclear war leading to doomsday. Initially, the scientific basis of the nuclear winter hypothesis rested exclusively with the "TTAPS" groups and their first calculations. This group consisted of five American scientists: Turco, Toon, Ackerman, Pollack, and Sagan (TTAPS).[25] Later on, several American and Soviet scientists took over the research for a more comprehensive opinion on the nuclear winter concept and the resulting climatic catastrophe. Despite some disagreements, it was concluded that the effects of a nuclear war would reach the most remote areas of the world. No one would be spared.

It has been known for a long time that a nuclear explosion on or near the ground would lead to particulate matter being sucked up into the air along with other ground matter. This matter would first be gasified by the heat and later form particles again, due to condensation. Larger explosions would result in greater quantities of these particles being transported into the higher atmospheric layers of the earth, where they could remain for years. By shielding the sunlight, this layer of particulate matter would eventually lead to the cooling of earth's surface. An even more detrimental effect could be produced by the soot-ridden layers, which would build up from the extensive fires after explosions. Materials such as oil and plastics give off a black sooty smoke when burned. The soot cloud would then rise several kilometres up into the atmosphere and spread over the greater portion of the Northern Hemisphere within weeks. Soot particles are very effective absorbers of sunlight. An extensive cover of soot would

[23] A.S. Ginsburg et al., "Global Consequences of a Nuclear War: A Review of Recent Soviet Studies", *SIPRI Year Book 1985* (Taylor and Francis, London, 1985), 109.

[24] L.Grinspoon, ed., *The Long Darkness: Psychological And Moral Perspectives on Nuclear Winter* (Yale University Press, New Haven, 1986), 18.

[25] In 1982, The TTAPS team comprising five scientists namely Richard P. Turco, Owen Toon, Thomas Ackerman, James Pollack and Carl Sagan, undertook a computational modelling study of the atmospheric consequences of nuclear war. They have published their results in Science Journal in December 1983. Subsequently, they have carried out further research works independently or as a team.

result in the warming of the upper side of the layer and a cooling of the earth's surface below the layer. The dark cloud layer would diminish the intensity of daylight on the ground to only a few percent of the normal value and lead to a perpetual twilight.

The cold and darkness would envelop the entire land surface of the Northern Hemisphere within just weeks of the war and persist for several months. Under such conditions it is likely that agricultural production in the Northern Hemisphere would be almost totally eliminated, leading to scarcity of food for the survivors. It is also quite possible that severe worldwide photochemical smog conditions would develop with high levels of tropospheric ozone that would interfere severely with plant productivity.[26] The dispersion of radioactive particles to the Southern Hemisphere would occur due to strong air flows from the Northern to the Southern Hemisphere. Within a few more weeks, the dust and soot layers would spread to the tropics.

In a situation like this, people would develop hypothermia and die due to losing body heat very quickly. Although shortage of food could be the most widespread and serious problem among human survivors, poor health would be a major concern too. A health crisis would rise from the combination of three factors – the breakdown of medical and public health services; the effects of worldwide radiation pollution; and most importantly, the spread of diseases and eventually epidemics as a result of poor living conditions, malnutrition, and lack of sanitation.[27] The Scientific Committee on Problems of the Environment (SCOPE), a sub-group of the respected International Council of Scientific Unions, has calculated that at least hundreds of millions of people would die from starvation in non-combatant nations from disruption of the food trade alone.[28]

The study of the global atmospheric consequences of a nuclear war and nuclear winter contains many uncertainties; however, these are uncertainties that cannot be overlooked nor eliminated. It is no longer possible to escape the general suspicion that the ultimate result of a large-scale nuclear exchange would be a nuclear holocaust.

India conducted one underground test in the Thar Desert of Rajasthan in 1974. Since then, it has kept the international community guessing about its nuclear weapons capability. On May 11 and 13, 1998, India conducted a series of five nuclear weapons tests and a thermonuclear device test at the Pokhran test site. The Indian government claimed no fallout and radioactivity from either the 1974 test or the recent ones. This claim has been contradicted by some reports about the 1974 test that have become available recently. According to these reports, there have been ten deaths due to cancer and radiation effects have been seen in livestock.[29] Like India, Pakistan also conducted six nuclear tests in the Chagai Hill region in Baluchistan, but except for some immediate blast effects, the full environmental effects are still unknown.

[26] AMBIO, *Nuclear War: The Aftermath*, 90.
[27] Owen Greene, I. Percival, I. Ridge, *Nuclear Winter* (Polity Press, Cambridge, 1985), 113--14.
[28] S.L. Thompson and S.H. Schneider, "Nuclear Winter Reappraised", *Foreign Affairs* (Summer 1986): 990.
[29] Bobby J. Varkey, "Blast in the Desert," *The Hindustan Times*, Sunday Magazine (May 17, 1998): 1.

In 2010, a Scientific American article about the effects of a local nuclear war on global climate and human civilisations, by Alan Robock and Owen Brian Toon (of TTAPS fame), led to intense debate on the efficacy of nuclear weapons in a real time war scenario.[30] The article concluded that a limited regional nuclear exchange between India and Pakistan, with each side attacking the other's major cities with 50 low-yield Hiroshima-sized weapons, would cause major concentrations of soot into the stratosphere which would remain there long enough to cause unprecedented climate cooling worldwide along with disrupting global agriculture. The study estimated that more than 20 million people in the two countries could die from the blasts, fires, and radioactivity. This regional nuclear war could stunt agriculture worldwide for 10 years.

Even though it is difficult to ascertain the actual size and composition of India and Pakistan's nuclear arsenals, Pakistan is estimated to have 90-110 nuclear weapons with advanced delivery systems, ranging from short-range, medium, and longer-range ballistic missiles. India too have stockpiled around 80–100 nuclear warheads, with equally capable delivery systems in its arsenal.[31] The numbers might vary, but it is certain that both countries have stockpiled nuclear weapons to be used against each other in any future event of war. Historically, India and Pakistan have fought four major wars and as many skirmishes in the last six decades.

Conclusion

The world's concern for complete elimination of all nuclear weapons has evidently faded away with the recent developments in South Asia. The prospects of peace and disarmament also seem to have receded. In the light of the above discussion about nuclear weapons and their lethal effects on humans and physical environments, one can easily see that the aftermath of a global nuclear war would be more than devastating. In such a war, no nation on earth would remain untouched and no people unaffected. The so-called 'nuclear winter' would make life miserable and ultimately impossible for the survivors. It is believed that global nuclear war would drive human civilisation back to Stone Age.

[30] "South Asian Threat? Local Nuclear War = Global Suffering" *Scientific American* (January 2010): 74-81.
[31] Cited in Ray Aches, ed., "Assuring Destruction Forever: Nuclear Weapon Modernization Around the World," *Reaching Critical Will* (2012): 5-6.

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Published by: Society for the Study of Peace and Conflict. Post Box: 10560, JNU Old Campus, New Delhi-110067. Website: www.sspconline.org

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