# Nuclear Threat and Disaster Management[1]

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Commentators speak of two types of nuclear threat. Attack with a stockpile nuclear weapon by an adversary State during a conflict is one of them. This would most probably be set off high above the ground to maximise damage. It may not be a solitary attack.

Surprise attack by a terror group with an improvised device is another possibility. This is likely to be of a lower yield and explode at ground level. There are significant differences between the two.

Many reports have been published about the likely mass casualties in the event of a nuclear explosion. Our focus here is on the management of the consequences to facilitate early rescue and recovery.

Most of the published reports take their cue from the well documented open sources of the US experience in tests in dry desert environment. The attacks on the Japanese cities are the only instances of an explosion in the urban environment. There are however differences between the Japanese cities then and modern cities now.

The aerial photo of Hiroshima taken presumably by the US forces before the explosion shows a crowded array of low slung wooden houses.

There is also a model in the Hiroshima museum providing a contrast of the city scene before and after the explosion. It highlights the total decimation of the houses. The houses collapsed like a pack of cards due to the shock wave. A fire storm that began to rage about 20 minutes after the explosion razed them to the ground. A closer look of the model shows a few structures still standing.

One of those structures was found to be an RCC building about 300 m from Ground Zero (GZ). It suffered no serious structural damage from the shock wave or the fire. Although so close to GZ, half of the inmates of the building

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are reported to have survived. Some other buildings about 500 m from the GZ also were seen to have survived.

An aerial view of a part of BLR would reveal rows of brick and concrete buildings typical of big cities in India. Recent structures among them may not be as sturdy as those buildings in Hiroshima due to poor quality of construction and workmanship. They could collapse due to the shock wave. The buildings themselves may not be fire prone, but they could contain much combustible material. One can think of the gas cylinders in the kitchen, fuel tanks of the vehicles, plastics and so on. Then there are the petrol filling stations and LPG cylinder storage areas that dot the city. We need to have estimates of the combustible load in cities to be able to assess the likely scale of destruction due to fire.

A brief account of what happens in a nuclear explosion would be useful. Consider the case of the much studied Hiroshima bomb. It was set off at a height of 600 m from the ground. The height was chosen to maximise the area of destruction by the shock wave. It had a yield of 16 kT. The explosion created a temperature of ten million degrees vapourising everything in the device and forming a fireball.

At the instant of explosion, there was a pulse of intense nuclear radiation followed by another pulse of intense heat radiation. These two together killed most people near GZ who were in the direct line of sight of the explosion.

Within a fraction of a second the temperature in the FB dropped and the radioactive vapour cloud had begun rising higher still.

In less than a minute the cloud had risen to a height of 2.5 km and to 8 km by 4 minutes. It finally settled at a height of about 12 km in 11 minutes. The high speed winds at that height dispersed the cloud in the downwind direction. The rapid gain in height and the dispersion after that resulted in the radioactivity content being diluted. There was little fallout over the city itself and the fallout elsewhere caused radiation levels not so significant to be of concern.

In post attack analysis by the US Army, it was estimated that 90 % of the people within half a km were killed. There was a gradual decrease in deaths with distance, dropping to about 30% at a distance of 1.5 to 2 km and less than 10% beyond. Those who survived the instantaneous pulses of nuclear radiation and heat by being indoors were killed when the buildings collapsed due to the shock wave. The secondary fires also took their toll.

In a city like BLR, the intensity of the instantaneous pulses of heat and nuclear radiation would be attenuated inside the brick and concrete buildings. Likewise, the power of the shock wave is likely to borne by the buildings in front while those behind would face less of it. The shock wave is likely to advance farther along the roads. Those survivors inside the buildings, but near glass windows, might be injured seriously by flying glass pieces. As a result, these survivors who are closer to GZ would need immediate medical assistance. Reaching them will pose a great challenge as the debris of fallen buildings would block access.

A nuclear explosion at ground level, whether a war-time attack or a terror attack leads to a different scenario that poses more formidable challenges. The fireball from the explosion touches the ground and vapourises everything in its path. A crater is formed at GZ. Large amounts of the soil are also picked up by the rising cloud. Radioactive material from the weapon sticks to the soil particles in the cloud. The heavier particles fall out nearer GZ, while the lighter ones are carried farther. The winds at ground level are slow and could vary in direction over time.

In the absence of buildings, burns and serious radiation injuries can be expected all around in a 2 km range for a 10 kT explosion. But the presence of buildings changes the picture. The yield in a terror attack with an improvised crude device could be much less.

As mentioned earlier, one may expect survivors in places close to GZ and they may need timely assistance. Some of them may choose to get away quickly. It would be safer for them to wait indoors unless there is fear of fire spreading to their area. If they choose to move, without proper instruction, they could run into the areas contaminated by the fallout and receive dangerous levels of exposure.

**Management of Emergency**

The degree of protection from fallout to be expected inside the brick and concrete buildings can vary. Estimates for buildings in the US range from a factor of three at the ground level of a house with just one floor above. The middle floor of a three storeyed building provides a PF of seven. In apartment blocks of many floors, the PF can rise to a factor of 20. In basements meant for car park, the PF is much higher of the order of 100 to 200.

Let us now turn to information needed for management of emergency.

First indication of a nuclear explosion could come from people far enough not to be affected by it, who might notice the brilliant flash and the ascending cloud. In an aerial explosion, the flash blindness could occur even at distances of over ten kilometers on a clear day. Vehicle drivers who see the flash directly could lose control resulting in road accidents. Instant disruption of communications and transport would serve to confirm the explosion. Proper plans for response would require information on the yield, height of burst and the location at the earliest.

Optical sensors can provide information on location and yield by detecting the light signal emitted in the explosion. These can be mounted in satellites or on the ground. Infrasonic detectors can also indicate the yield, but they need to be located in places with low background noise. We need to have a detection capability, if it is not already there. The International Monitoring System of the Comprehensive Test Ban Treaty has the capability and could immediately put out the information. But, we must have our own.

Nothing can be done to prevent the prompt effects of heat, nuclear radiation and the shock waves. But, in the case of a ground explosion, it is possible to save people from getting undue exposure to residual nuclear radiation from the cloud overhead and the fallout.

Computer codes have been developed in the country that can draw meteorological information from open sources and use it to predict the path of the fallout subsequently. National Centre for Environmental Predictions (NCEP) of the US and National Centre for Medium Range Weather Forecast (NCMRWF) of India are two such sources of information. The data from these can be used with local met data to generate local weather forecast. The dispersion of the radioactive particles in the cloud is then followed to obtain the path and progression of the fallout.

These predictions can become available within about an hour if we are so organized.

With that information it should be possible to decide what advice should be given to people, whether to stay indoors, if so for how long and when to move out and in what direction and so on.

The codes developed in the country to predict fallout paths have been validated for the Fukushima case. There is fair agreement between the calculations and the measured values.

Seasonal variations in the way the radioactive cloud disperses must be taken into account. It would be useful to generate a database for any given city in India, for different seasons, and for a typical yield, to provide a ready reference when needed.

Following a nuclear explosion, multiple agencies each with their large teams and special expertise will swing into action to provide help to the people in the affected parts of the city. Their work has to be coordinated well to ensure success.

We can utilize the vast memory and high processing speed afforded by present day computers and develop modeling techniques for dynamic analysis of the event and the actions as they unfold. We can exploit the GIS system, data mining and statistical analyses for the purpose.

Visual representation of all the information so generated on multiple screens in what can be called a decision analysis approach can facilitate decision making by central authorities.

The Centre for Study of Science, Technology and Policy (CSTEP) in Bangalore has embarked on development of DARPAN, a Decision Analysis platform for Research and Planning for emergency management in general. In the context of nuclear threats, it is engaged now in modelling the destruction in the inner zone through heat, initial burst of radiation and the blast wave for a given yield, and height of burst. This will need to be supplemented by dynamic estimates of fallout as time passes. Modelling is however only one part of the task.

Comprehensive data base of the rescue assets available in the city is vital for any disaster management. A sound data base must be established to know which of the assets remain unaffected and can be used. Much of the relevant data on the various wards of the city of Bengaluru have been collected by CSTEP. It is a work in progress.

The data base to be established for each municipal ward should contain details of assets for rescue and recovery such as fire stations, police stations, petrol bunks, doctors, hospitals and clinics, pharmacies, large public places where people can take shelter and so forth.

First responders moving towards GZ can carry radiation detectors that transmit the readings instantly to a central location to provide ground information. After the Fukushima accident, individual citizens have formed teams that are even now continuously mapping radiation levels in that part of the country using inexpensive instruments. And they are making the information available on their website. Government sources will have to match the speed of volunteer groups of that kind.

The first responders can also provide information about citizens needing help, state of roads, telephone towers and power supplies etc. If the Agencies responsible for emergency management can tap into the social media they would find that it can serve as a very useful means of acquiring situational awareness and provide much useful information in planning their next steps. It is already being done by the Red Cross in some countries.

The Government has wisely invested in the establishment of a National Disaster Management Agency and a trained National Disaster Relief Force. These agencies generally encounter flood, cyclone, landslide and earthquake events fairly frequently. Based on that experience, they are in a position to continually upgrade their action plans for such cases.

Only simulation exercises can assure ready and successful response in the case of radiological and nuclear threats. If information about the preparedness of Authorities is made available, it would generate public confidence. Periodic exercises required to be conducted in the vicinity of nuclear power plants may be somewhat helpful in this context. But, a nuclear threat is very different because of the scale of destruction.

**Management of Disaster**

For effective management of any type of disaster, whether due to chemical, biological, radiological or nuclear attack, two important recommendations warrant attention out of the many that can be thought of.

The role of medical professionals is very crucial. There will be cases of injuries compounded with radioactive contamination in a nuclear or radiological attack. The doctors should be able to handle such cases with care and without fear. After the Fukushima accident, the Japanese Medical Association is said to have sent its members, numbering over a thousand to monitor the people. The members were all trained to handle cases of radioactive contamination and in monitoring people for radiation exposures. If our medical professionals can equip themselves for providing such a service they would be making a very useful contribution. Courses for such familiarisation should be introduced at the MBBS level itself so that all doctors are capable of rendering such service.

Public education on how to respond to such an emergency until proper advice from the Authorities is received is essential. With communications suffering total disruption in the affected area, there would be no means of providing instructions to people in the immediate hours of the explosion until restoration of the services. For several kilometres beyond the blast zone, those with the mobile phones can neither make nor receive calls, because mobile towers would be non-functional due to EMP effects. If the public are educated, they can themselves function as first responders and help others.

Such education must begin from the schools.

The anniversary of the bombing of Hiroshima is not only an occasion for reminding ourselves of the need for abolition of nuclear weapons. Until that comes about, the logical conclusion would be that we need to be able to protect the citizens from nuclear threat.