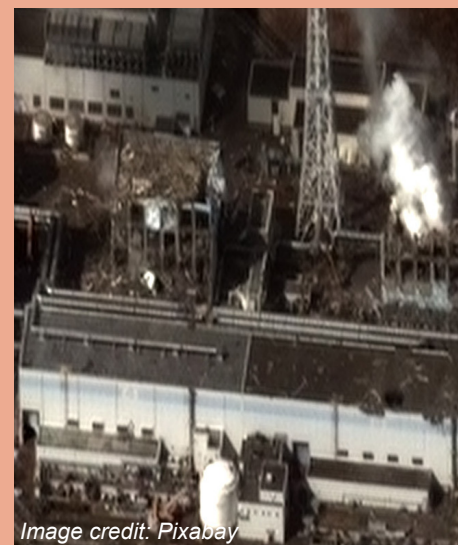


Can We Do Without Nuclear Energy?

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MARCH and April months are mired in nuclear controversy. Ten years have passed since the Fukushima Daiichi nuclear disaster. It was triggered off by a tsunami caused by an earthquake in the sea near Honshu. The Chernobyl disaster occurred much earlier in 1986 on 26th April completing 25 years. These disasters took away many lives and damaged property worth crores of rupees. What it did to the wellbeing of people and the environment is not that obvious. Many studies have been carried out to look into these aspects. The findings are quite a revelation.

Why did these disasters happen?

An earthquake occurred in the Honshu Sea on 11 March 2011. And as it generally happens when there is significant displacement in land below sea, a huge wave is generated, that moves all round and hits the land in the form of tsunami. The rocks break below the water, a vacuum is created, the water around it jumps towards it, bumps with a bang, huge energy is created that takes the water in all directions. The normal wave gets enhanced manifold and when it reaches the shore it grows up to between 4 to 10 meters.

Japan has a very complex geotectonic framework influenced by four plate boundaries – Eurasian, Pacific,

North American and Philippine Sea plate. There is subduction and collision along the Japanese islands. Northeastern Japan containing Honshu and Hokkaido region belongs to the North American plate, and southwest Japan, containing western Honshu and Kyushu, is part of the Eurasian plate. The Pacific plate is subducting below the northeastern part of Japan at a rate of 10 cm per year. This creates earthquakes, at almost regular intervals, and the spread of seismic waves are felt all across Japan.

Tsunamis are also seen to visit these islands from time to time. Because these two disasters are common, the Japanese have developed technology to enable their buildings to withstand the shock, and built walls in the sea to take out the vicious force of the giant waves.

The 11th March tsunami breached the seawall constructed in front of the Fukushima Daiichi reactor and the water entered the energy generating machines. This led to stoppage of cooling and energy storing equipment leading to anomalous increase in energy within the building complex. It set in motion a series of fires and explosions that threw out radioactive energy and particles. The accident led to the death of more than 11,000 people and displaced around 160,000 people.

At Chernobyl it was a human error that caused the accident. When the energy storing capacity of the reactor

reached beyond its capacity, the energy came out of the building with a bang. The radioactive energy was seen to spread all over Europe.

Seawalls and coastal forests

The impact and manifestation of this tsunami was seen along the 800 km shoreline of Japan. This country faces the twin dangers of earthquakes and tsunamis on a regular basis. They have built resilience and have adapted their lifestyle around these natural disasters. The technology used in building their houses and infrastructure is used everywhere else in the world. To save themselves from the tsunamis they have built seawalls and other aquatic fortifications. India experienced the fury of these giant waves generated at Sumatra, quite some distance away from our mainland shore. One can imagine the ferocity of these waves generated in close vicinity of ones shores. The Japanese know all too well the impact these waves can have on their lives.

The instrumented and historical records show that after every 100 to 150 years a tsunami hits the Sendai province of Japan. The average height of these waves is close to 4 meters. But the tsunami of 2011 created waves of over 10 meter height. This brought in such huge volume of water that it flooded almost 500 sq km land ravaging over 130,000 buildings.

This initiated a debate within the Japanese community on whether to rebuild these structures or not. The utter failure of these seawalls and coastal forests in dampening the energy of 2011 tsunami put a big question mark on spending money on these structures that were incapable of protecting the shoreline community. The rethink is throwing up many new ideas.

Japan has a 35000 km long shoreline, of which almost half of the shoreline is fortified by seawalls. These seawalls are variable in width and height. The Tohoku region of Japan is prone to assaults from tsunamis and the seawalls have been designed and built to withstand the tsunami generated by 8 magnitude earthquake. Magnitude of the earthquake refers to the energy required to move a mass of rock from one place to another. It also depends on the volume of the rock. Generally, the energy generated by successive number of magnitudes is 32 times. So, magnitude 2 earthquake will generate 32 times energy of magnitude 1 and 3 will generate 32 times more energy than 2. And so on.

11 March earthquake was magnitude 9

This was one of the largest earthquakes that occurred anywhere in the world. The energy generated was tremendously large. But was this earthquake an anomaly? Had it not occurred earlier in Japan? The geologists have something to say.

According to them magnitude 9 earthquake has occurred in Japan in its historical past. Geologists studied some sediment cores collected from the Tohoku province. The sediments are laid down in layers that contain almost similar size grains. However, in this core there was a particular layer that contained a mix of different size particles that can be brought in only by a tsunami. When this layer was radiometrically

dated it gave the age of 869. This proved beyond doubt the area has experienced 9 magnitude earthquake in the past couple of thousand years. If the interval between two 9 magnitude earthquakes and the consequent generation of tsunami is taken to be between 2000 to 3000 years, then the area needs enhanced protection to smoothly ride the next big tsunami.

Coastal forests

In Japan coastal forests have been built and nurtured to dampen the impacts of the tsunami. When the speed and energy of the tsunami is arrested by the coastal forests it is expected the inland damage reduces substantially. However, in 2011 the tsunami turned these jungles into lethal weapons. Some of the trees were completely uprooted and others broke into smithereens. The stocks and branches wounded the people and killed some of them. Also, the impact of these trees and its offshoots damaged buildings and felled the walls.

However, these jungles and seawalls did a fantastic job when the tsunami waves were just 6 meter in height. During the earlier tsunamis these coastal forests stopped the boats in their tracks and prevented them from reaching the inland communities. The damage was controlled to a large extent.

After the deluge scientists have carried out detailed study of the coastal forests. They built some models and simulations that revealed useful information that was verified in the field as well. The scientists cross-checked by visiting the forests through which the tsunami passed. The ground reality revealed trees having roots more than 3 meter deep had survived the onslaught of the tsunami. The shorter ones were uprooted.

However, in the previous tsunamis of shorter waves than the 2011, people used the uprooted trees and stocks to hold on to them like boats to ride over the tide. Some climbed on the upright trees above the water level and stayed put till help arrived.

Evacuation centers and mental health

In the eventuality of a tsunami hitting the shores, Japan has created many evacuation and rescue centers. However, the 2011 tsunami inundated all these centers since they were not designed for such a high intensity tsunami. Studies revealed that the evacuation centers were situated in low lying areas. To avoid a repeat, they are now constructed at an elevation. This has entailed enhancing the tsunami zone much further inland uprooting many residential areas and people.

Also, the mental health of 870 survivors was evaluated on different parameters. They were probed on different counts and the answers these survivors gave were quite revealing. Almost 60% went to a safe place at the sound of the tsunami siren. Of the remaining, 75% survivors started to finish off the work that they were doing. The rest did nothing. Scientists and psychologists are trying to understand the carelessness of some in the face of danger.

Nuclear disaster and health

This disaster is being studied on many different fronts. The Fukushima nuclear disaster released just 540 petabecquerel

energy into the atmosphere. Nuclear energy is measured in Becquerel. 1 Becquerel equals energy required to decompose one nucleus in one second. Thus, the radioactivity corresponds to one disintegration per second. This unit is named after Henri Becquerel who won the Nobel Prize in 1903. Petabecquerel is far too low than Becquerel. 1 PB is 1.10^{-15} B.

The total radioactive energy that was released in the Chernobyl disaster was 10 times more than that released at Fukushima. But the containment issues and the continued fires and explosions occurring in the nuclear reactor put the administration in a dilemma. They feared more energy release and appealed to people living within a 20 km perimeter of this reactor to relocate from their respective places. Some of them went to the evacuation and refugee centers while others bunked up with their relatives and friends. Many from outside of the 20 km periphery also vacated their houses out of fear of being in the radiation zone.

The images of mutilated bodies and deformities due to Hiroshima-Nagasaki bombings are still fresh in the minds of people. Not just in Japan but all over the world. The images are so powerful that they instantly strike fear and dread. After a couple of weeks of the Fukushima disaster almost 160,000 families had moved away from their homes. The administration, after some time, appealed to them to return to their homes. However, initially they seemed disinclined. The administration then decided to screen them for radioactive traces in their body. The residents near the disaster sites were screened and were found to not contain any anomalous radioactive readings. The radiation was within acceptable limits. However, some deaths were reported to be due to leukemia in some of the residents near the accident site. Efforts are now on to establish the reason for leukemia. Was it due to natural causes or because of radioactive emissions from the reactor?

Some of the studies carried out revealed 3 times increase in the possibility of death within the first month of the accident. In one of the refugee center 25% of its members died within the first 90 days of their arrival. Thus, it was inferred the deaths were not directly due to radiation but because of weakness, low health care and a feeling of despondency due to being away from their home and familiar environment. All these factors weakened them physically as well as mentally and their desire to live went down drastically. Low health care meant increase or enhancement in comorbidities that increased their risk of diseases like diabetes and BP. The feeling of being uprooted from their dwellings and loss of their loved ones and friends put an undefined burden and stress on their minds and hearts. This caused their health to deteriorate.

The after effects

The terrible accident at Fukushima set in motion the questioning of the philosophy of using nuclear energy. There have been questions and doubts raised on the desirability of using the energy that is prone to such terrible effects and consequences.

The atomic bombing created transgenerational fear and it is quite difficult for any sane person to forget the eerie images of deformational monstrosities. The Chernobyl and Fukushima disasters have exacerbated those fears. Nuclear disasters take away life and bring in illnesses of various sorts. They also put a huge drain on the financial resources of a country. The clean-up after the accident requires a lot of money. The Chernobyl explosion put back the then administration, and the successive ones, by over 15000 billion rupees. Fukushima has used, till date, almost double that amount to set straight the damages done to people and infrastructure.

Non-conventional energy

The burning of fossil fuel and wood has created conditions that are raising the temperature of our planet. It has led to global warming. The UN is bringing in resolutions and setting targets to bring down the greenhouse gases. Some countries are on course to achieving the targets, some are lethargic, while others are downright dismissive of such efforts.

One of the better ways to bring down carbon emissions is to generate energy by harnessing solar and wind energy. However, the technology available with us does not permit use of this energy in an efficient and economic manner. Nuclear energy is still the cleanest form of energy if one can dispose of the spent material out of harms length. If we avoid accidents and learn to settle the effluents then we are okay with this energy.

Has the downfall for nuclear energy begun?

The manufacture of nuclear energy is falling down considerably in the advanced and high income countries. Japan itself has permanently closed down 12 reactors and 24 temporarily. They are being audited for safety and other issues. Once these concerns are addressed satisfactorily they may be again made operational. This just goes to show that running a nuclear reactor is an expensive and risky proposition.

The first reactor started functioning in 1951 and the decades after that, in the 60s and 70s, reactors were being established at a brisk pace. Every year 20 to 30 new reactors were coming up in one part of the world or another. This pace slackened after the Three Mile accident in Pennsylvania. After the Fukushima disaster countries like Germany, Italy, Sweden, Switzerland decided to discontinue the use of nuclear energy. However, these decisions were overturned by some in the past. It may happen even now. America also is rechecking the safety of its reactors. Currently, the setting up of 50 nuclear reactors is going on in 16 different countries. China is at the forefront by constructing 16 reactors followed by India and South Korea.

With all the dangers and pitfalls associated with nuclear energy, it seems we cannot do without it!

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