Nuclear Power: Environmental Effects of The Chernobyl Disaster

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As the intelligence of humans continues to flourish, human created technologies and biological systems are merging. With the creation of technologies such as roads, landfills and power plants, humans are forcing the merging of biology with technology by causing irreversible changes to the environment. The demand for energy sources continues to grow as the human population increases at an exponential rate (Keinan and Clark, 2012). Nuclear power, which is accomplished through nuclear fission, produces approximately 13% of the world's energy (Swain and Guttman, 1983). Even though nuclear power is a dangerous method for energy production, the world is dependent on the energy it creates; therefore this technology will not be terminated in the foreseeable future. The largest unintentional release of radioactive particles to occur in the world was the explosion at the Chernobyl Power Plant in 1986. Before the Chernobyl disaster, the environment around the power plant consisted of a bustling city, many forests, farmlands, and waterways leading to the Pripyat River (Steinhauser et. al, 2014). When the reactor exploded, radioactive dust was released into the air, blown across Europe, and contaminated 63,000 square miles of land. This radioactive dust settled on not only the homes and buildings of the city of Pripyat, but also on the trees, soil and water surrounding the area. After the evacuation of the city, the Soviet Union sent in hundreds of workers called "liquidators" to clean up the area (Korkov and Ustyantsev, 2012). Although it was cleaned, the area remained destroyed due to the massive amount of radiation. The disaster at the Chernobyl Power Plant is an irreversible merging of biology and technology due to the amount of radioactive contamination of the environment around the reactor.

The city of Pripyat was built outside of the Chernobyl power plant in 1970 in order to house the plant workers and their families. At the time of the accident, the population of Pripyat was approximately 49,000, however the city was built to hold 80,000 (Pripyat.com). The intended purpose of the power plant was to create energy through nuclear fission, and to produce plutonium for usage in nuclear weapons. Nuclear fission is the process of splitting atoms into smaller pieces, which produces free neutrons and protons. The products of nuclear fission create energy through the process of radioactive decay (Steinhauser et. al, 2014). The Yanov railroad was built within Pripyat to serve as a major cargo port in the Ukraine (Pripyat.com). Outside of the city, there were many villages and farms where people grew vegetables and raised cattle. Before the accident, a 4-km^2 forest of Scots pines surrounded the city. This forest was home to a diverse array of animals including lynx, wolves, eagles, and deer ("A Tale of Two Forests", 2013). Flowing through the forest and the city is the Pripyat River, a 761 km long river that empties into Dnieper River (4th largest river in Europe). The disaster at the Chernobyl power plant released large amounts of radioactive dust into the air, which eventually settled on the forest, river, and farmlands surrounding the city (Steinhauser et. al, 2014). This release of radioactive particles caused irreversible damage to the area due to the evacuation of the city and amount of contamination of the surrounding ecosystems.

The disaster at the Chernobyl power plant took place on April 26th 1986. The workers at the plant were completing a routine test on the fourth reactor, causing the power levels within the reactor to decrease below their normal capacity, therefore increasing the internal pressure, resulting in an explosion. The major radioactive elements that were released due to this explosion include, ^{133}Xe, ^{132}Te, ^{131}I, ^{137}I, ^{89}Sr, ^{140}Ba , and^{144}Ce (Steinhauser et. al, 2014). The release of these elements into the environment caused many changes to the surrounding ecosystems. The most notable change to the environment was the dramatic color change and eventual destruction of the Scot pine forest surrounding the city. The settling of the radioactive dust on the trees and in the soil throughout the forest caused the pine needles of the trees to turn red, and led the eventual death of the trees. To clean the area, liquidators bulldozed approximately 400 hectares of forest ("A Tale of Two Forests", 2013). In the days and months following the accident, the biota around the area suffered from acute radiation syndrome, and many areas died due to large concentrations of radionuclides ("Environmental Consequences of The Chernobyl Accident", 2014). However, since there has been limited human interaction within this area, the biodiversity has increased over the past thirty years. The area has been able to grow and flourish without the stress of human interactions ("A Tale of two Forests, 2013).

The largest agricultural concern after the accident was the intake of iodine through the consumption of milk. For the people living in the area, the high levels of contamination in the soil and pastures have caused many diseases, including thyroid cancer and leukemia ("Environmental Consequences of The Chernobyl Accident", 2014). In order to control the amount of radiation consumed by the public, the government implemented rules regarding the food intake of animals, where crops could be planted, and milk and water were placed under rigorous tests to determine radiation concentration. Even though many areas have been thoroughly cleaned, there are still many areas around the reactor that are not safe human habitation ("Environmental Consequences of The Chernobyl Accident", 2014).

The release of radioactive chemicals from the reactor explosion caused a large deposit of radioactive material in the water systems surrounding the area. The amount of run off from nearby contaminated soil caused the water ecosystems to become highly toxic (Kinley, 2006). In the days following the accident, the aquatic animals were highly contaminated because of the contamination of their entire ecosystem. However, since the accident the amount of radiation seen in the aquatic environment has dropped dramatically, causing little concern for the water systems in the future (Kinley, 2006).

In the future, the contamination to the ecosystems surrounding the area will not change dramatically due to the large half-lives of the elements that were released. The half-life of iodine is approximately eight days, meaning that the element has degraded over time and is not seen in high dosages around the area anymore. However, the half-life of cesium and strontium is approximately 30 years, meaning that these elements have not degraded much since the accident, and are still a point of concern. The largest half-lives seen are that of ^{239}Pu and ^{240}Pu. The half-lives of these elements are 24,000 years and 6,580 years respectively (Muck et. al, 1994). Even though some of the elements that were released have decreased over time due to short half-lives, the extremely large half-lives of the other elements will cause the area to be contaminated for thousands of years.

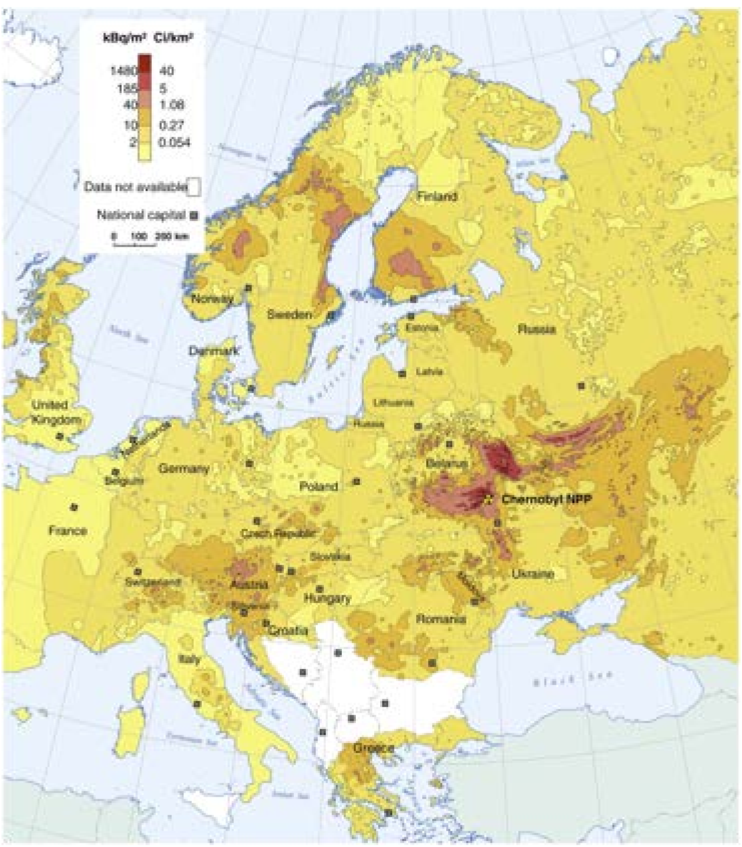

Figure 1. (Steinhauser et. al, 2014). Surface contamination of ^{137}Cs after the explosion. Dark red areas indicate highly contaminated areas.

As seen on the map, the amount of contaminated land after the explosion at the Chernobyl plant was massive. The dark red areas indicate highest concentration of contamination. The area around the power plant was highly contaminated, as well as other areas in Europe such as Finland, Norway, Sweden and Austria. The radioactive dust released by the reactor was blown across Eastern Europe, and settled in these areas, causing high amounts of contamination.

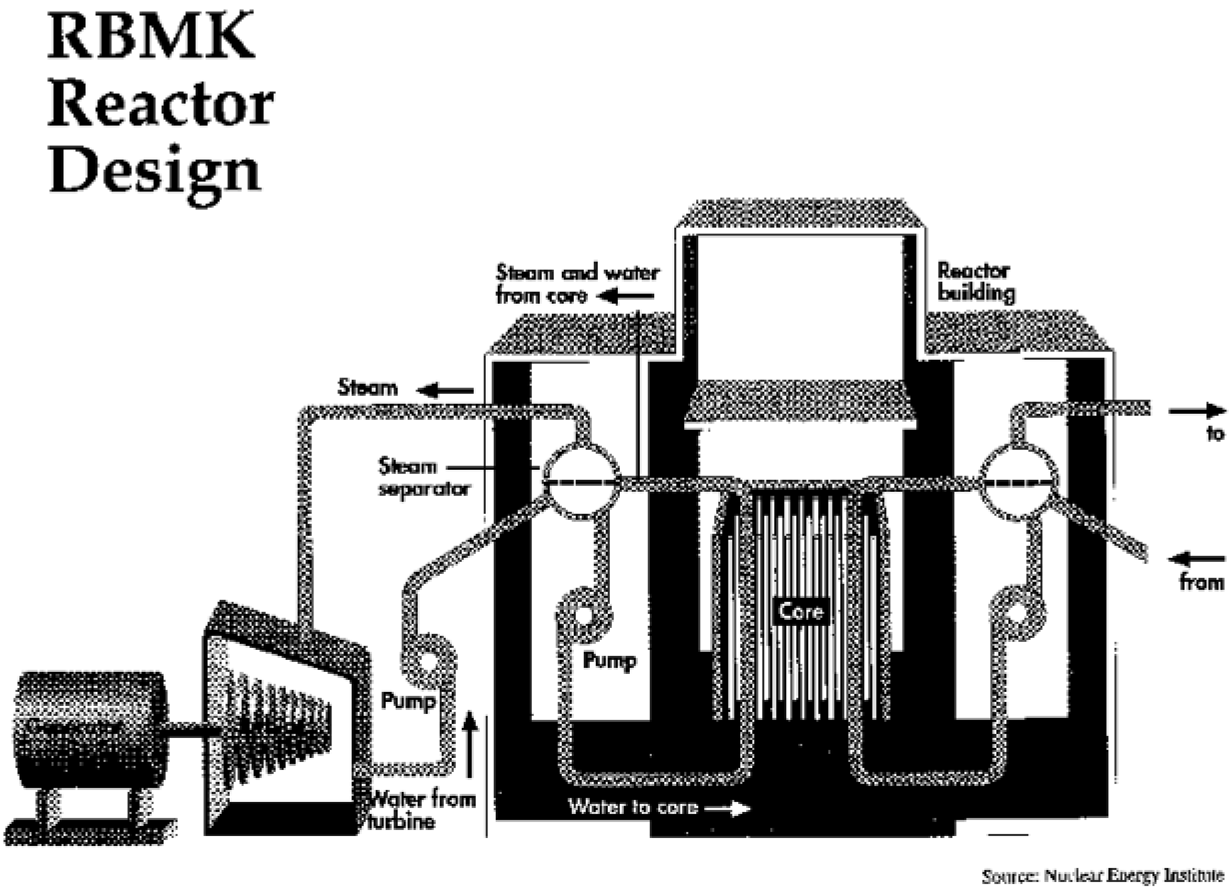

Figure 2 (Steinhauser et. al, 2014). Diagram showing the mechanism of RBMK reactors.

As seen in the diagram, a RBMK reactor works to create energy by nuclear fission, and the heat from this fission is used to create steam. The steam is then pumped to a turbine, turning the turbine to power the generator.

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