Final Report

Radiation Spill, Chernobyl USA

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Area of Science: Ecology

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Executive Summary

The nuclear power plant in Chernobyl, Ukraine underwent a very bad disaster. It scared a lot of people, killed and injured many, and brought about a huge economic loss. It made the surrounding area a dangerous place to be with the amount of radiation that was released. It affected people's attitudes about nuclear power and their willingness to have such a power plant near their homes.

I learned about Chernobyl through a documentary I found on Netflix. It is through NOVA, called "Building Chernobyl's Megatomb". The documentary was over the building of a metal case over the affected area to slow the spread of radiation. It took a lot of time to build of course and it showed the process of the containment facility being made and moved over the Chernobyl nuclear plant. This film is what inspired me to make this topic into a project for the Challenge.

To bring the model closer to home and show a more local situation, I made a model representing the area of Palo Verde Nuclear Power Station, in the nearby city of Phoenix, AZ and the population that could be affected within the whole area shown. The model also has rings of radiation moving from the source in Palo Verde depending upon the extent of a possible disaster and the weather conditions at the time.

This model can show the possibility of what could happen if a disaster struck the Palo Verde Plant just like what occurred with the Chernobyl accident. I hope this model can help educate people about something they haven't really paid attention to any great extent. It is important to predict things like this, so we know what to prepare for, just in case…

Problem Statement

The US has huge power needs since everything a person uses tends to be electrically powered. Therefore we have many electrical power sources, like renewable energy from solar and wind farms, fossil fuels such as coal and natural sources, and hydroelectric. Nuclear power is safer than most of the sources we use today for power. Nuclear power releases less pollution than any other major energy source. Nuclear power plants create more power with less fuel being used. It also produces minimal waste comparatively, as it is dense and not much is actually created.

There is a nuclear plant that is within the United States near New Mexico that is called Palo Verde Nuclear Generating Station in Arizona. So, since is the largest and closest, I decided to use Arizona as a testing center for a computer model. I could show how it would affect the area around it if a Chernobyl type disaster ever occurred there.

Some people fear nuclear power because although it's cheap and efficient, people fear that it is dangerous to them. To most it is okay until it's a plant situated near them, there is a familiar saying: (NIMBY) "Not in My Back Yard!" The Palo Verde Plant has the second highest of safety violations amongst the United States nuclear facilities.

Problem Solution

To work on this project, I have created a computer model of the area around the Arizona power plant. As stated, it will show the surrounding area of Palo Verde along with the city of Phoenix. Each patch has a certain population count based on census data, with the red areas being the more heavily populated areas and the greener areas being less populated.

I have found data from Chernobyl that could be used to overlay the radiation spread from that disaster to this nearby location. With this data I can predict the amounts of damage that could likely occur given the data utilized. Data will also be adjusted from the Arizona plant based on differences in the sizes of the facilities, terrain, and environmental conditions. Using this, it all can be compared, and damage estimates made.

The main working components of my Netlogo model are many different variables, procedures, buttons, and maps. The first of the buttons is the 'set up'; it shows a map of the Palo Verde area and the city of Phoenix in Arizona. There are patches that vary in color with, each color having a population value. Red has the highest population density (up to 30,000) as where the green has the least amount of population since it is the open land (0-50). The next two buttons are 'census' and 'accident'. Census works with the color patches and it has a monitor to show the population of the whole area, while 'accident' creates the infected area based upon the disaster size. Then there is the 'accident-level' and 'wind sliders'. The 'accident-level' controls the size of the disaster, ranging from 0 to 6, with 1 being the least damaging. Wind controls how strong the winds are, starting from 0 going to 60 as the highest. The final slider that is for the direction of the wind. The last button, victim-count calculates the number of people affected by the disasters. This allows for special wind patterns to be created. Lastly there is a plot that shows the data from the disaster.

Conclusion

There are plenty of nuclear power plants around the US, as well as around the world. All of them are of different designs and in different locations. The disaster of the Palo Verde Nuclear Plant would be very different then the Chernobyl Nuclear Power Plant. There are vast differences between the two areas. Chernobyl has more forested areas and water around it, while

Palo Verde is on dry, desert-like flat land. Any particles around Chernobyl would tend to stick in place but in Palo Verde since the surrounding area flat, with sparse vegetation there is nothing to impede its movements. It could move faster and further than it did in Chernobyl. After the disaster of Chernobyl, the radiation from it was detected in the Swedish atmosphere within a 48-hour period. The speed of spreading from a disaster of Palo Verde would have quicker movement due to its terrain and more open area. I was able to show different scenarios of disasters and how many people could be impacted. I think this is all useful for us to be aware of.

One aspect with the program I had trouble with is that I was not successful with making the geometry of the wind direction as a wind variable. Since the dominant winds are from the west, I can still show the average effects of wind on any given day. But I couldn't get the geometry equation coded correctly to allow me to tilt the oval of radiation spread.

Achievements

I am doing this project by myself along with balancing my senior year and other extracellular activities along with it. It has been hard to do but I knew I was up to the challenge. Carrying it myself has been one of my biggest achievements with doing the Challenge. I have learned much about with doing research as well as improving my coding skills. I have had a lot of help from my advisor with the coding especially, and I appreciate the help I have gotten from other teachers as well. It's nice to know that I can do this on my own and finish the Challenge like others can.

For validation of my project I researched sites dealing with the safety of the Palo Verde Nuclear Power Plant. I found lots of information on it, some of the best information came from the Phoenix New Times. The Palo Verde is the largest nuclear power plant within the United

States, it has three separate reactors. With it being the largest, it also has the most worry of possible problems. Predictions have been made about what could happen to this plant in case of equipment failure or cyber-attacks. There are a wide range of possible predictions. While most say this plant has a low risk of disaster, some predications go as far as envisioning the complete loss of Phoenix. Between these extremes is where my model falls.

Citations

https://www.energy.gov/ne/articles/3-reasons-why-nuclear-clean-and-sustainable

https://www.azcentral.com/story/money/business/energy/2019/06/03/chernobyl-disaster-palo-verde-nuclear-generating-station-arizona-key-differences/1334886001/

https://www.world-nuclear.org/information-library/safety-and-security/safety-of-plants/chernobyl-accident.aspx

https://www.phoenixnewtimes.com/news/security-cyberattacks-how-safe-is-arizonas-palo-verde-nuclear-plant-9493582

http://archive.azcentral.com/arizonarepublic/news/articles/20110814palo-verde-nuclear-safety.html