Coronavirus Cases Within Urban Areas of the Puget Sound Area

By: Joshua Ji

1. Introduction

Throughout human history, there have been 26 pandemic incidents which find their origins in different parts of the world. Ranging from the “Spanish Flu” in the 20th century, the Cholera outbreak in the 19th century, the black death in the 14th century and so on. Although the sources and causes of these diseases are different, one thing in common is that they have all impacted a large population of people’s lives. The latest and still ongoing pandemic (announced by the CDC that the COVOD-19 has been classified as a pandemic as of March 10th, 2020), the coronavirus has found its way from Wuhan, China to every continent in the world. Being one of the later countries to embrace this impact, the United States have seen a drastic increase in confirmed Coronavirus cases in the past couple of weeks week. This leaves people a daunting question, how did the virus travel across the globe? Without doubt The coronavirus has been the biggest health topic within the past couple of months. Tenth of thousands of people have been diagnosed with the virus, and more than one thousand people have died from this fatal pandemic. The United States have been heightening their alert status due to the virus being fast-spreading, highly contagious and high death rate. Many experts and scientists have been investigating the origin of the virus, while many are trying to find a timely cure to put a hold on this situation. Many people suggested a complete lockdown of cities in the United States to seal the deal on the coronavirus outbreak crisis.

Washington State was the first state in the United States to have a confirmed case of the coronavirus, a man from Snohomish county was the first patient after traveling back from Wuhan, China. While people thought the virus was contained and it was reported the person was cured from the virus and released from Providence Reginal Medical Center. The virus strikes back to quickly took several lives of elderlies residing in nursing homes. This alerted the

Washington state government to take a series of actions, following the shutdown of schools ranging from elementary to Universities. And if the virus is not contained in a timely manner, a perceivable shut down of restaurants, supermarkets and even all businesses could take place. Seattle being one of the most advanced and fast-growing cities in the United States, this would bring a lot of difficulties and inconveniences to people's lives. And as more and more cases are tallying up, and the seemingly inevitable trend of the virus spreading throughout the globe, government around the world are slowly picking up the pace of taking precaution actions to prevent the spread of the virus. However, no one knows for sure how the virus spreads yet and people are panicking for many reasons.

In this project, I would be discussing the necessity of people isolating themselves, I would also be discussing the safety levels of traveling around the Puget Sound during this time. Nine counties compose most of the area defined as the Puget Sound, I would be discussing how each county are impacted by the coronavirus, and even more specifically, discussing how safe it is to travel through certain areas in each county. People who currently resides in the nine counties would find my project useful. I would be discussing where my data came from, the workflow of my project and how I got to my conclusion. I would also be discussing the results of my project and provide further recommendations for people as of which areas should they be mindful of traveling around during this time.

Last but not least, my project will also include maps that provide people with a general idea as of what does the infectious level currently looks like within the Puget Sound. This may provide people that have scarce knowledge about the spread of the virus with some basic background knowledge and allow people to understand the severeness of the virus. This project aims to help people discuss the necessity of containing the virus, and the necessity of

quarantining patients as of whether restricting forms of traveling would be an optimal action to reinforce.

2. Project Method

Source datasets:

- **Layout of urban cities in central Puget Sound shapefile**, acquired from Puget Sound Regional Council
- **Puget Sound County Boundary shapefile,** acquired from Esri
- **Puget Sound Marine shapefile**, acquired from Esri
- **Individual Coronavirus Cases in Puget Sound**, acquired from multiple websites including WHO, CDC and local news
- **Puget Sound Geographic layout shapefile**, acquired from Esri
- **Puget Sound Developed Cities layout shapefile**, acquired from Esri

The first major challenge I have faced in the project was how am I going to collect the data for coronavirus cases in Washington state. The data of the aggregated cases for the whole state was available during this time, but my project requires me to find the cases in respective counties. The state government did not release this information during the time I was collecting the data. Therefore, I had to go on multiple websites to search for data and compiled them into a .csv file, I also had to cross reference with official information released by WHO (World Health Organization). After I compile all the data I needed, I manipulated them into where the patients were held while they were undergoing treatment. I input the Longitude and Latitude data for easier plotting. (See more details in image 1)

date	county	state	lng	lat
3/10/20	Island	WA	-122.698	48.296646
3/12/20	Island	WA	-122.665	48.191609
3/6/20	Jefferson	WA	-123.6	47.748106
2/28/20	King	WA	-122.308	47.35083
2/29/20	King	WA	-122.1817	47.715642
2/29/20	King	WA	-122.1817	47.715642
2/29/20	King	WA	-122.2081	47.707213
3/1/20	King	WA	-122.2159	47.44329
3/1/20	King	WA	-122.3299	47.609997
3/1/20	King	WA	-122.1817	47.715642
3/1/20	King	WA	-122.1817	47.715642
3/1/20	King	WA	-122.1817	47.715642
3/1/20	King	WA	-122.1817	47.715642
3/2/20	King	WA	-122.1817	47.715642
3/2/20	King	WA	-122.1817	47.715642
3/2/20	King	WA	-122.1817	47.715642
3/2/20	King	WA	-122.3446	47.45757
3/3/20	King	WA	-121.8043	47.490118
3/3/20	King	WA	-121.8043	47.490118
3/3/20	King	WA	-121.8043	47.490118
3/3/20	King	WA	-121.8043	47.490118

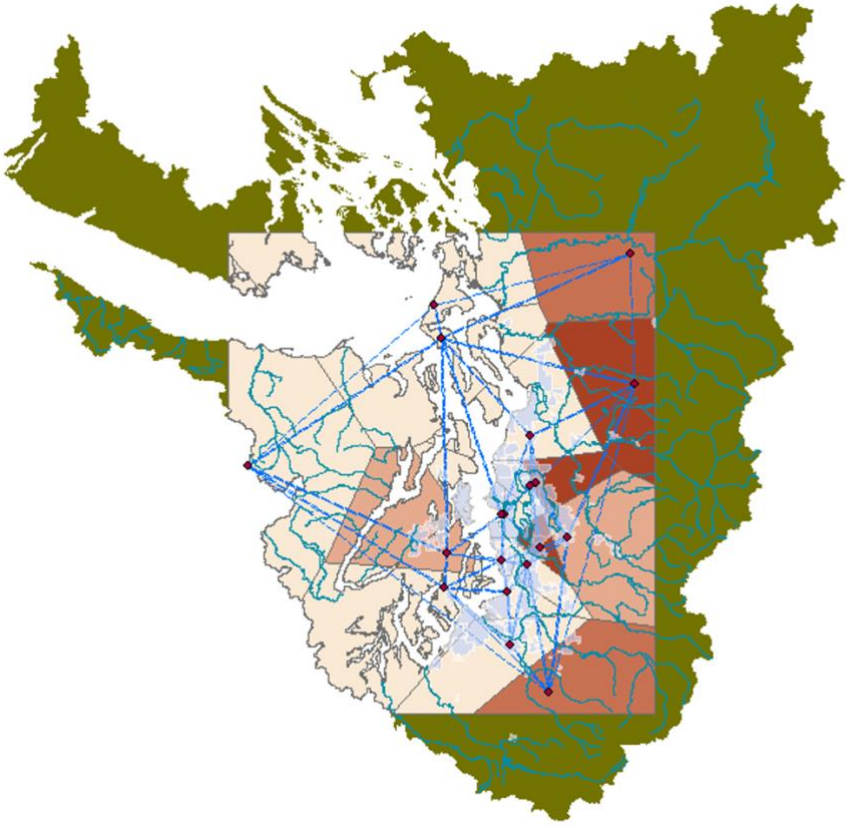
(Image 1. A fraction of the dataset I have created)

The plotting and analyzing part of the project was accomplished through ArcMap. I was able to find the major shapefiles I needed from Esri. I encountered my second major challenge in this project after plotting the shaepfiles, which is how to define the safety levels for different areas. Then I remembered in class we discussed the Voronoi Network and Delaunay Triangulation, this dual network which are complements of each other creates “zones of influence” that works perfectly for what I want to find out from this project. While ArcMap provides a tool that helps mapping out the Delaunay Triangulation, it was quite difficult for me to map out the Voronoi Network. I was able to figure out the algorithm through lines of python code in ArcMap. After I created my Delaunay Triangulation boundaries, I calculated the

weighed triangulation based on how many cases resided in each of the Delaunay Triangles. And last but not least, I clipped out the Delaunay Triangles according to the land areas in Puget Sound and added the urban city layer on top of all of this to see which parts of the developed cities were affected the most. The weighted Voronoi Diagrams are calculated by dividing the area of the Delaunay Triangle area by the total area, but due to the patients number are not uniformly spread, I then multiplied this number by a factor of how many patients the area has with proportion to the total amount of patients in Puget Sound.

3. Findings: Results and Discussions

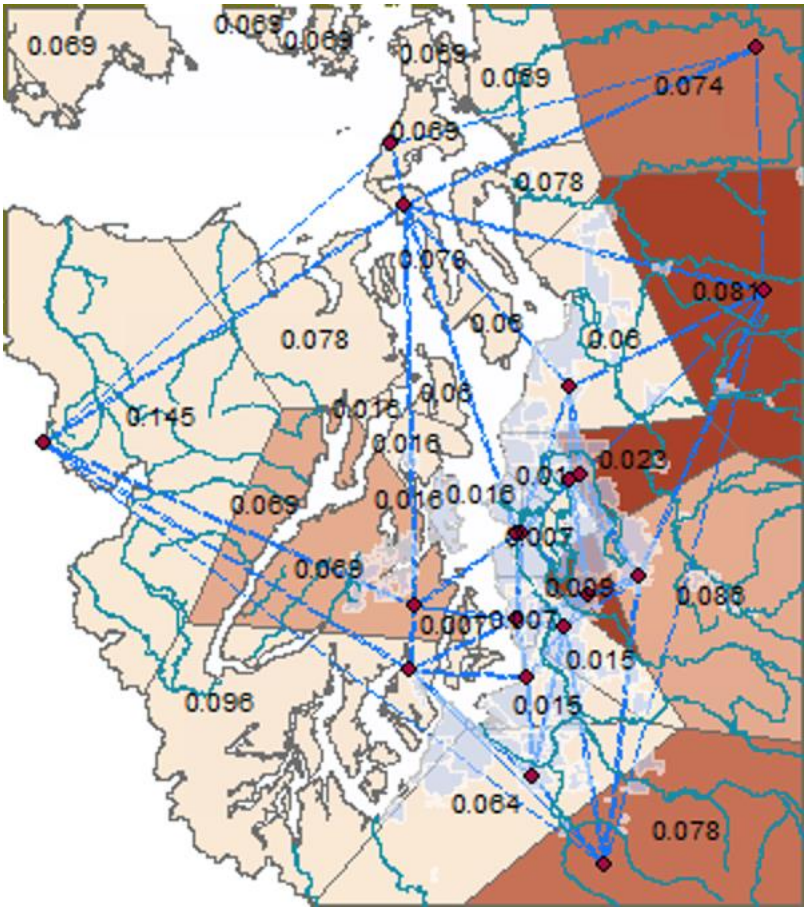
3.1 Results



(Image 2. Final Results)

Image 2 shows my final results. The red dots indicate specific areas (mostly hospitals) that currently or have previously hosted patients with the coronavirus. There are also cases which I could not find where the patients were specifically resided, so I included them altogether in a general area of their respective counties. I have divided up Puget Sound into several Delaunay Triangles with darker colors indicating the areas hosts a larger number of patients.

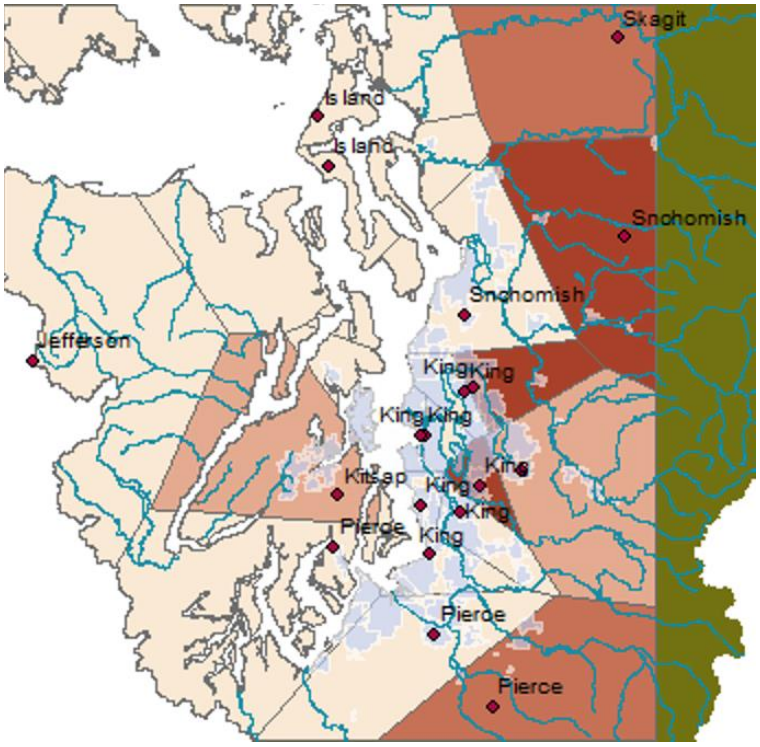
3.2 Discussion of Results



(Image 3. Weighted Voronoi Diagrams)

Image 3 shows the Weighted Voronoi Diagrams along with the Voronoi network, this can give people a clearer sense as of how each area are related with each other in the context of

how they are affected by the coronavirus. I have only included the area in the Puget Sound that can be mapped within the Delaunay Triangles. The light blue shape file is mostly composed of the urban areas in central Puget Sound we can see parts of it lies within areas of high Weighted Voronoi value.

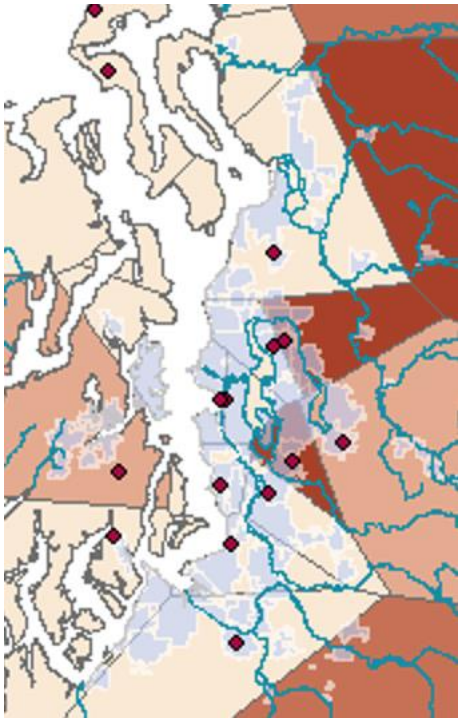


(Image 4 Cases by County)

Image 4 shows each case within each county and gives people a more detailed view of where to avoid. From the map we can see parts of Snohomish and King county have been affected the most, those areas have the most cases of coronavirus. We can also see a large part of the developed urban area is composed by the King county area which indicates a larger population resides there. It is extremely helpful for people who are still traveling around the greater Seattle area and would give suggestions for people if they are travelling through those areas, they should take precautions actions or avoid traveling to those areas as a whole.

4. Conclusions and Recommendations

Conclusions & Recommendations:



(Image 5 Zoomed-in View Urban Areas and Coronavirus Cases)

I have provided a zoomed-in view of the Urban Areas in the Puget sound and how where are some coronavirus cases either within or around the area. I have turned off all other features except a plain map of the urban area layer (light blue), coronavirus cases layer (red dots) and the Delaunay Triangles layer. I have concluded that the Urban Area in Puget Sound has fallen to be one of the most affect areas within Washington State. There are a lot of individual cases within this area, some areas even lie within the most affected areas in the Puget Sound. Urban Areas where there are a large population usually falls victim to such pandemics due to the fast-spreading nature of the virus. I think it is a valid point to make that people who live in neighborhoods that are in close proximity to one another should take the advice of either self-

isolating themselves along with their family members. People should stay home and not attend social events during this time to prevent the virus from further spreading.

The virus is not likely to just suddenly disappear in the close future, and this topic would be carrying on for at least several more weeks. For people who are interested in this issue and would want to follow up on the study I would recommend them to create maps with even more detailed information. A map that is able to include street names and a street view would provide more guidance to living in urban areas of the Puget Sound. But in order to accomplish this task, this requires a lot of burden and cost to collect data. I would also recommend including, if possible, a demographic map of age and gender distribution. The COVID-19 is reported to be more susceptible by older folks. If the map can include information like these, it would be helpful and relevant to much more people. These tasks are more likely to be accomplished by a team effort.

Last but not least, it is everyone's highest hope that the virus will be eradicated in a short amount of time. I would be closely following news concerning the COVID-19 and provide further details with any major updates on this map.

References

Coronavirus Cases Database_1. (2020). Baidu. [Table]. Website. Retrieved from: https://voice.baidu.com/act/newpneumonia/newpneumonia

Coronavirus Cases Database_2. (2020). Baidu. [Table]. Website. Retrieved from:https://baike.baidu.com/item/%E4%B8%AD%E5%9B%BD%E5%9F%8E%E5%B8%82%E4%BA%BA%E5%8F%A3%E6%8E%92%E5%90%8D%E8%A1%A8/16620508?fr=aladdin

Coronavirus disease (COVID-2019) situation reports. (2020). World Health Organization. [Table]. Website. Retrieved from: https://www.who.int/emergencies/diseases/novel-coronavirus-2019/situation-reports/

Coronavirus Disease 2019 (COVID-19). (2020). Centers for Disease Control and Prevention. [Table]. Website. Retrieved from: https://www.cdc.gov/coronavirus/2019-ncov/index.html

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Triangulation Tools. (2020). Esri. [Dateset]. Website. Retrieved from: https://www.arcgis.com/home/item.html?id=6e9bc6cbf93d4939b2eb04ff8519be47

Puget Sound Geographic Layout (marine, topology and major river). (2018). Esri. [Shapefile]. Website. Retrieved from: https://www.arcgis.com/home/group.html?id=24838c2d95e14dd18c25e9bad55a7f82#overview

6. Appendices

Documentations:

Coronavirus General Information:

https://experience.arcgis.com/experience/685d0ace521648f8a5beeeee1b9125cd

https://www.cdc.gov/coronavirus/2019-ncov/index.html

Coronavirus Situation Report:

https://voice.baidu.com/act/newpneumonia/newpneumonia

https://www.who.int/emergencies/diseases/novel-coronavirus-2019/situation-reports/

Delaunay Triangulation:

https://geogra.uah.es/patxi/gisweb/NOModule/NOtheorylesson.htm

Voronoi Network:

https://pro.arcgis.com/en/pro-app/tool-reference/analysis/create-thiessen-polygons.htm