PostGIS Project

GIS 5003 Data Management

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Department of Geography and Environmental Sustainability

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Abstract:

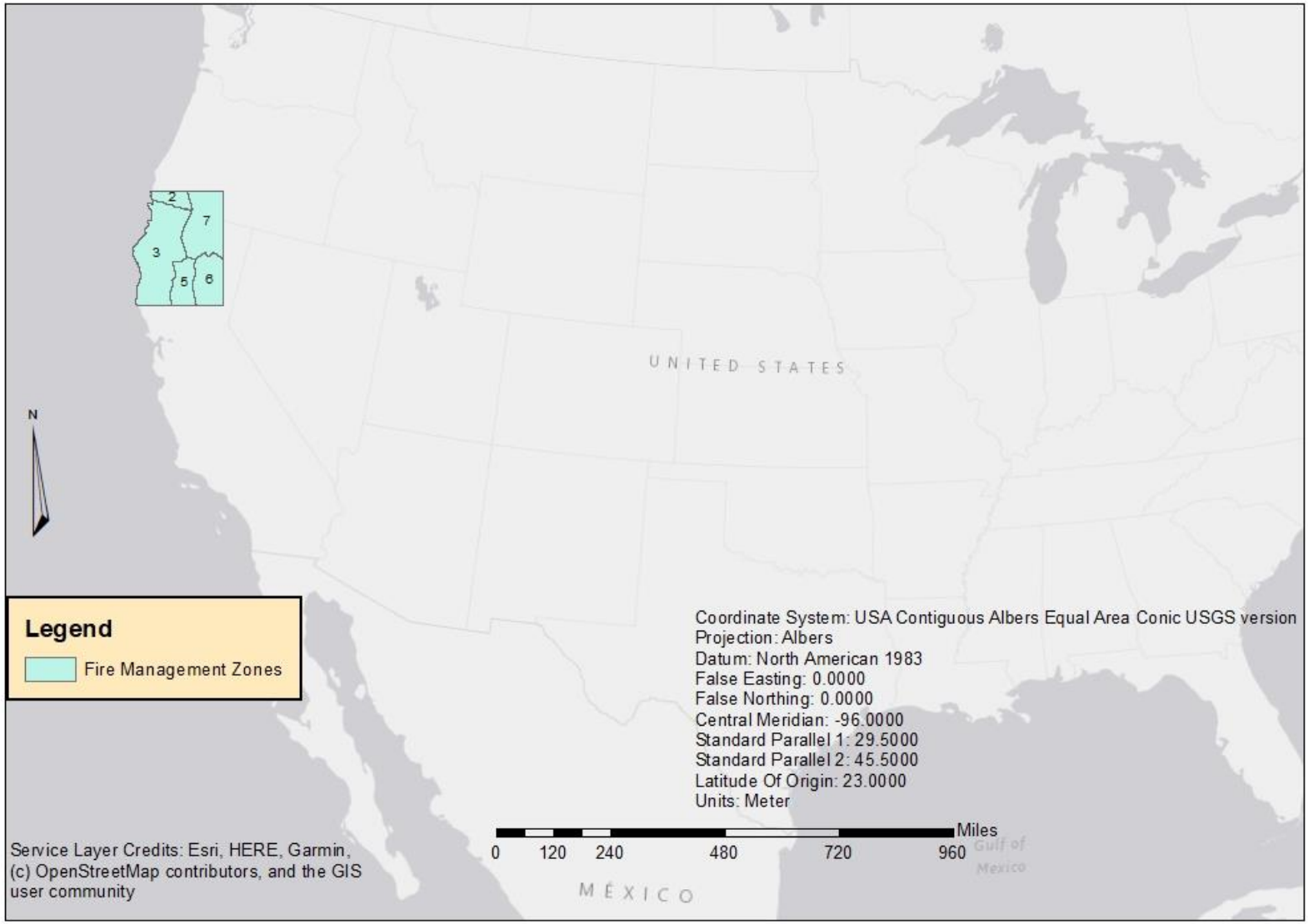
The purpose of this project is to provide additional resources to wildland firefighting crews battling future fires. By querying data from the US Forest Service and the US Department of Agriculture, in an attempt to isolate the vegetation that is responsible for fires that tend to get out of control and damage large tracts of land is the main focus of this study. By isolating this vegetation, fire crews will be able to predict where fires are most likely to occur or crews can chose to go out and remove the vegetation and replace it with more suitable vegetation that is not as likely to become a major fuel source for fires.

Introduction:

Wildfires are not a new phenomenon; a recent dataset was created using information dating back to 1878, mapping all the known wildfires in the United States. Most of these fires were not battled up until the mid - 1900's. In fact, the Native Americans were known for creating fires each year to burn the under growth of an area to prevent major fires (USGS 2020). Within the last 60 years, Environmentalists have fought to create legislation preventing the removal of under growth and trees in the areas prone to wildfires. Over the last decade fires have gotten bigger and more damaging. Causing hundreds of millions of dollars in damage to cities and towns, as well as destroying millions of acres each year. There is a direct link between the legislation that was created and the size and location of most of these fires. As of July 14, 2021, there are 36,467 large fires that have burned 2,770,454 acres across US in 2021 (NIFC 2021). There are many factors that play into creating these major fires. Weather is one of those contributing factors. Above normal temperatures combine with high pressure systems and dry air

fuel these fires and make it difficult for fire crews to contain these fires. Additionally, the dry air and draught like conditions dry out vegetation creating additional fuel sources. Fire requires three main components to burn. Fuel, oxygen, and heat are known as the fire triangle. If any one of these is removed, then the fire goes out. When battling wildfires only two of these variables can be removed, fuel and heat. When discussing heat, fire crews use water to extinguish the blaze but when we are talking about 100 plus acres that are ablaze, that would take an unrealistic amount of water. Crews use many ways to get water to remote areas, one of those is by using aerial tanker systems. Airplanes and helicopters that are designed to carry large amounts of water to a fire site and drop its contents on the blaze. The other method is to remove the fuel from the path of the fire. Crews will use bulldozers and heavy machinery as well as hand tools to remove small and large amounts of vegetation from the path of the fire. The idea being, if the fire as nothing left to burn, it will simply go out. However, the hypothesis of this report is if the land was managed properly by removing large amounts of vegetation in block patterns, fires would naturally be contained to small areas that would be more manageable and less damaging. The focus of the following report is the middle western coast of the US. In Map 1, the area of focus is mainly in California and Oregon where many of these fires burn each year. The US is divided into fire protection zones by the US Forest Service. Zones 2 – 7 are the area of extent for this report. These 6 zones are made up of Northern Cascades, Oregon Coastal Range, Northern California Coastal Range, California Central Valley, Southern California Coastal Range, Sierra Nevada Mountain Range and Cascade Mountain Range. Don’t mistake the names for locations. These are simply the names that these zones have been assigned and do not represent geographic locations on a map.

United States Fire Management Zones



Author: Jeffrey Ledbetter, 2021

Data:

The data sets that have been assigned for this report were created by the United States Forest Service using United States Geological Survey and National Weather Service data. The datasets were located and retrieved from https://landfire.gov/getdata.php. Each data set is comprised of attributes of location, zone name, vegetation index, climate, and imaging bands data. The focus was zone name, climate, and vegetation index. By querying between the three attributes, we can identify the vegetation of each zone and neighboring zones to isolate the underlaying fuel associated with the fires. Additionally, by querying climate data, the most likely time of year for firers can be identified and prevailing wind patterns. The climate dataset is comprised of points of temperature data and lines that show wind direction both being geometry data. Now, ultimately none of this is actually needed because we know that this region of the country gets very little rain in the summer months and all of the vegetation dries out and a simple lightning strike can create a major fire very quickly. Also, most of the area that is covered in this report is rural and difficult terrain to travers for fire crews. This is an additional difficulty for crews to quickly contain any of these fires.

Methods:

By using simple SQL querying we can identify where zones intersect [ST_Intersect], resulting in a return of Northern California Coastal Region and Oregon Coast Range. With this information we can cross reference our vegetation index and find that area is covered mostly by Upland Woodland, Upland Shrub, Upland Herb and Wetland Forest. By block cutting these areas by a distance of less than one-acre paths, the fire probability would be reduced by 40% in

most areas. However, to do this, there would need to be changes to current forestry legislation in California creating the ability for forestry companies to clear cut in this way. Additional SQL queries such as ST_Within, returns a result of Upland Woodland and Sparsely Vegetated. Knowing this area is mostly mountainous, the tree harvesting programs have been halted because of aggressive legislation banning the clearing of forested lands, therefore this area has massive forested areas. Resulting in one of the largest wildfires in history. In Image 1 and 2, below we can see the Cascade fire of 2020. Using Sentinel 2 imaging, the post burn affects on vegetation can clearly be seen in the two images below.

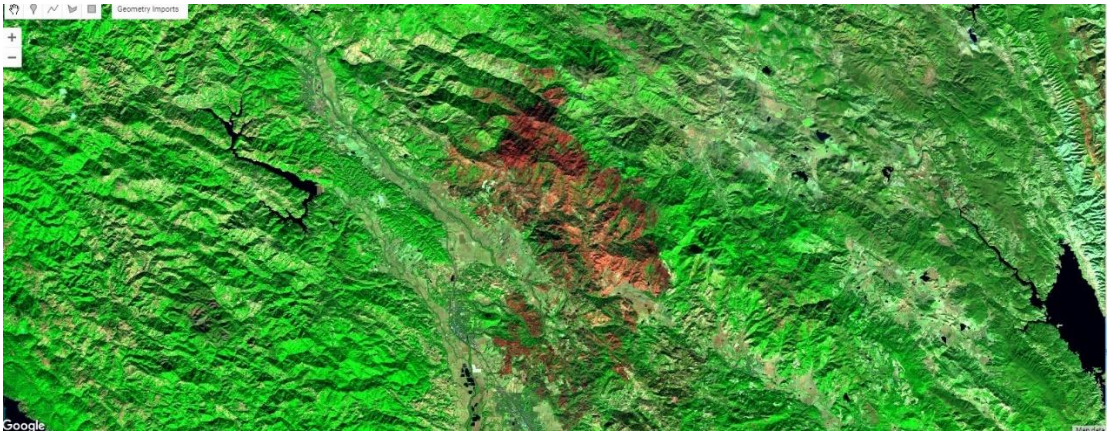


Image 1: *This image is of the post burn results of the Cascade California wildfire from the Sentinal-2 in true color.*

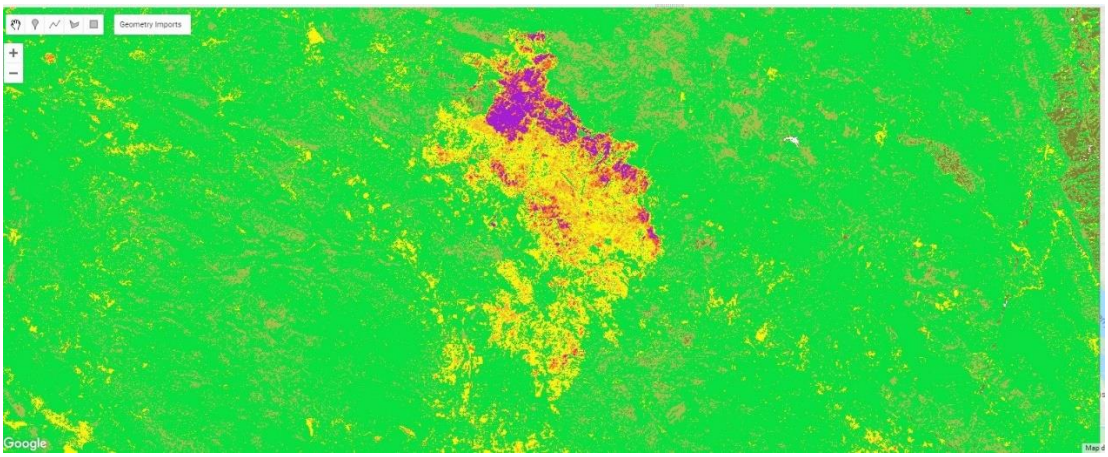


Image 2: *This image is the NDVI return of the post burn results of the Cascade California wildfire from the Sentinal-2 in false color.*

Knowing and understanding the information gained from the post burn affects can be helpful when planning harvesting efforts and vegetation mitigation. We can further query our tables and find the prevailing winds for these areas by using ST_Crosses and find that our prevailing winds for this fire were out of the west but also Mountain and Valley winds from aloft creating a situation where the fire was moving faster than crews could keep up. Currently in California two major wildfires are underway. The Dixie and Sugar fires are being pushed by 60 -70 mph winds from the coast (NIFC 2021). Understanding these patterns can allow crews to better plan the block patterns discussed earlier. The Dixie fire has three major hotspots. By using the SQL query ST_Overlaps, we find that this fire in inside two separate fire zones. Hindering fire crews with multiple fires inside two zones, creates logistical complications. When looking at the NIFC fire map, we find that there is a second fire, Fly, within the Dixie fire. Image 3, below, shows this relationship from the National Active Fire map. To better understand the geographic size of these two fires, Dixie has consumed 212,799 acres and has been burning for 14 days and Fly has consumed 5,175 acres and has been burning for 5 days.

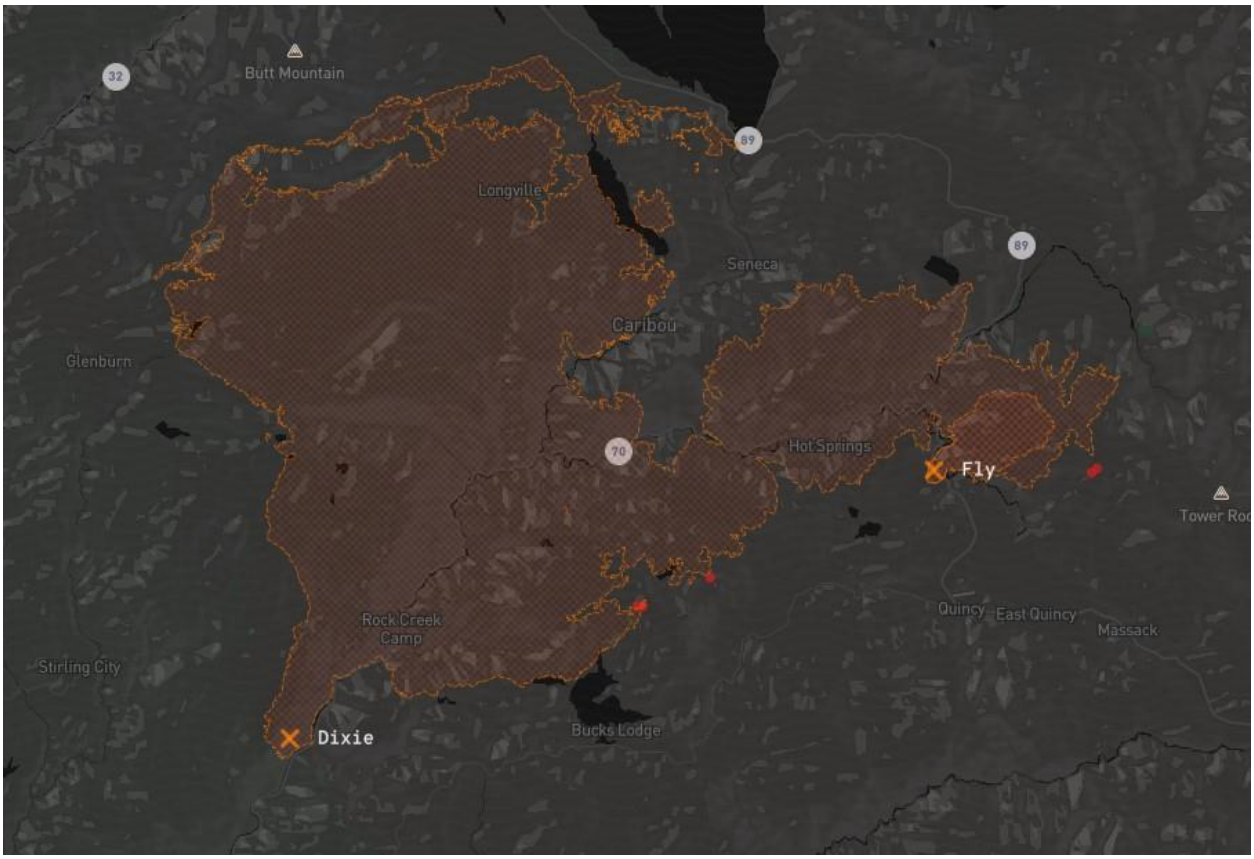


Image 3: *This image shows the Dixie and Fly fires in California July 2021.*

By using SQL query ST_Touches we can see where two fire zones connect and how fire crews will need to work together in battling these blazes. In the fire service, departments use Mutual Aid agreements to allow multiple agencies to work together. They normally share radio frequencies, equipment and manpower. In fires of this magnitude, crews from all over the nation respond for Mutual Aid. I have a friend that is a Wildland firefighter that works for the US Forest Service in Nebraska, and he is currently detached to California fighting these blazes. Mutual Aid agreements are necessary in these areas because no one agency can fight a fire of this size.

Conclusion:

Using SQL in PostGIS to query geospatial data seems easy at face value. However, there are situations that the program creates difficulties. One example of this is using multiple datasets and establishing one coordinate system. PostGIS requires the user to set each coordinate system for each dataset when loading it into the database. However, each dataset already has its own coordinate system that the program doesn't recognize during the loading process. It would seem more functionally plausible that the program would recognize and set the coordinate system when loading and return a notice, such as is with ArcGIS, when a subsequent dataset has a conflicting coordinate system. Additionally, if the user is not familiar with SQL, it becomes confusing and stressful continually receiving syntax error messages during queries. Querying spatial data is confusing at times and most of the tutorials on SQL do not cover this area as well as they could or do not cover it in enough detail. This report contained significant issues with this very issue because the datasets that were utilized were not set up the same way and had to be altered so that the columns and rows aligned, and the attributes could be queried correctly. The process was very labor intensive and time consuming. Overall, the project results returned what was expected and covered the topic carefully. The queries returned the expected results once the SQL statements were understood and properly utilized.

References:

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