Orange County Wildfire Wildland-Urban Risk Assessment

By Chase VanSchoonhoven
SSCI 581
Dr. Bernstein

Introduction

With all the recent fires in California, especially the fires currently going on up in Napa and the Canyon Fire 2 in Orange County, I believe it is wise to look at the wild fire risk for Orange County California. The Canyon Fire 2 was especially important for me since I was very near the evacuation zone for that fire, and a good friends home was nearly burned down; the fire crossed over onto their property line. And although there is a downward trend with the number of wildfires occurring, they wildfires that are happening are increasing in area burned (Tedford 2017).

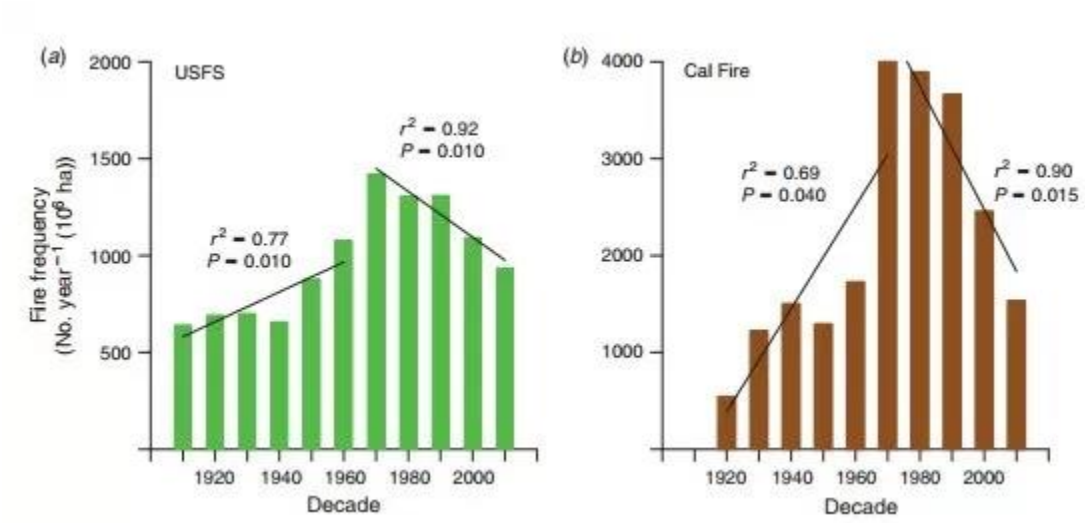


Figure 1 Decline of Wildfires in Both Calfire and USFS jurisdictions (Keeley 2017)

In 2017, although it may be an outlier year, for example as of September 11, Calfire has reported 5,102 wildfires with around 230,000 acres burned. Compared to 2016 where in the same time period there was 3,803 wildfires and 204,000 acres burned (Tedford 2017).

Because of this I believe it is important to understand areas that are higher risk. Currently there are many codes in place for fire safety inside of buildings and construction of buildings but there is little policy for outside and around buildings. Currently wildland-urban interface building codes dictate that home owner's clear flammable vegetation within 30ft of buildings and modify vegetation within 100ft to create a more defensible space (California 2007). The rest of these building codes deal with ignition resistant standards that make homes and businesses less susceptible to wildfire (California 2007). There is no regulation on manmade fuel sources, such as large propane tanks or gas pipelines around homes. And even the listing for many

building materials under Wildland Urban Interface Building Codes are not required by law to be listed and is voluntary (California 2012).

The goal of this study was to create a model for wildland-urban interfaces that gives local fire safety officials the knowledge necessary to update local fire code that could lower the risk of wildfire at these interfaces.

This research will look at controllable factors in wildfire, man-made fuel and vegetation density around urban areas. As well as analyzing several factors that are not able to be controlled such as population density and for the most part slope. According to Reams et.al. designation of high-risk areas can be accomplished by examining several individual risk factors in conjunction with one another. Such as fuel loading, topography, housing density and infrastructure for firefighting (Reams et. al. 2005). Calkin, Ager, and Gilbertson-Day also provided me with some of the criteria I used to preform my risk assessment. They mapped out more energy structure such as power transmission lines, oil and gas pipelines, powerplant locations, and cellular tower point locations. From their data, I chose to focus on just oil and natural gas pipelines, as I am focusing this study on orange counties wildland-urban interface there are less of those other variables in this area (Calkin et. al. 2010). Another source I used in determining what data sets to consider was the article "Human-caused wildfire risk rating for prevention planning in Spain." By Martínez, Jesús, Cristina Vega-Garcia, and Emilio Chuvieco. They looked at the human factors most associated with high forest fire risk, they used over 108 variables to model factors related to fire ignition. Factors I considered from them were on-going vegetation management, reduction of hazardous fuels, and transportation access. From looking at this research and more I chose these factors to consider when I preformed my risk assessment: DEM, USGS GAP Data, Crude Oil Pipelines, Natural Gas Pipelines, Population Density and Transporation Infrastructure.

Study Area

The study area for this project is Orange County California; it is surrounded by Los Angeles County to the north, San Diego County to the south, Riverside County to the east, and San Bernardino County to the northeast. Orange County has an area of 791 square miles of land (Wikipedia). The population is 3,010,232 as of the 2010 United Stats Census. The county is densely populated especially on the western portion of the county, but is less densely population in the east/southeast portions of the county around unincorporated areas. These are the areas that this study is focused on. The unincorporated area includes several regional parks, Santiago Oaks, Irvine, O'Neill and Limestone Regional Parks, and contains portions of the Santa Ana mountains. The weather is temperate with low precipitation, with lows in the month of January averaging 40.5 and highs in August averaging 84.1, and average annual rainfall of only 12.82 inches (OC Almanac). With high temperatures and low precipitation in the summer Orange County and especially the unincorporated areas, and cities surrounding that area, are especially at

risk for wildfire.

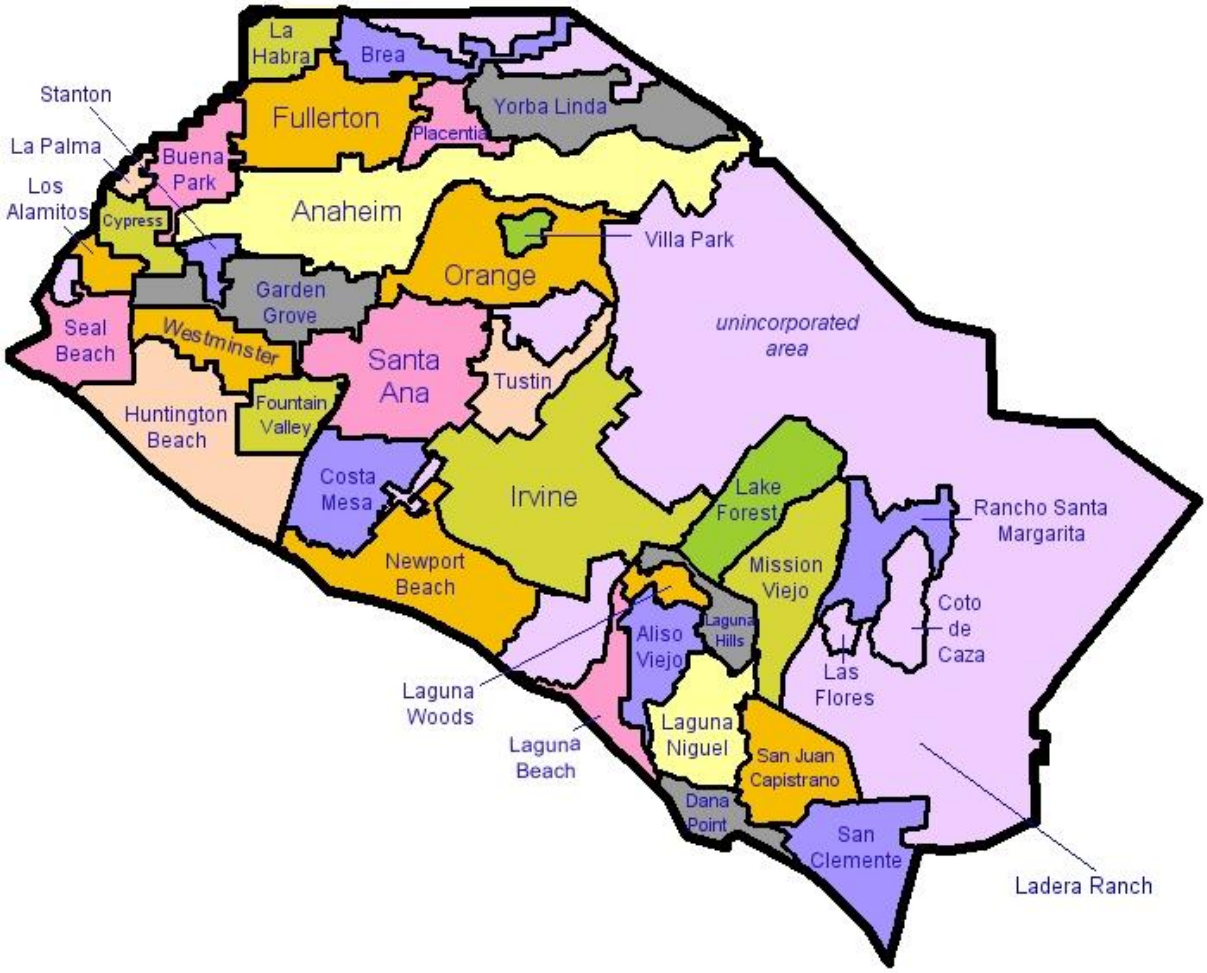


Figure 1 (CDC Technology Inc. 2007)

Data

For this project, I collected data from four sources: United States Census Bureau, United States Geological Survey, United States Energy Information Administration, and the Orange County Cloud GIS Cloud Data Application (see Table 1, Appendix).

From the U.S. Census Bureau, I acquired the boundary data for Orange County this vector shapefile contains polygon data for all the United States counties. I used this shapefile to define my study area, and restrict my data sets to only show within the study area. The biggest issue with this shapefile is the initial size of the data before removing all of the areas I did not need to use. After that it became much more manageable. The second dataset I used from the U.S. Census Bureau was the Population Density within Census Tracts. The census tract data set is a polygon vector shapefile. For this data, I also had to acquire the population data in a separate table. The issue with this data set is having to properly format the table so that it can be spatially joined to the census tracts.

For looking at plant communities and density the best freely available data set I could find was the USGS GAP data. Although its resolution is not the best at 30 meters it is a source that I reclassified to show density and different plant communities. I think it is a good start for creating a risk assessment model and long term I would attempt to acquire better resolution, and more specific plant data for the area. The GAP data is a raster image from 2011. From USGS I also acquired the DEM data that I used to determine the slope of the area.

I acquired natural gas and crude oil pipeline data from the Energy Information Administration (EIA). In looking through the data I found that the crude oil pipelines do not run through orange county, but there are several natural gas pipelines that do. The pipeline data files are vector line shapefiles that were created in March 2017.

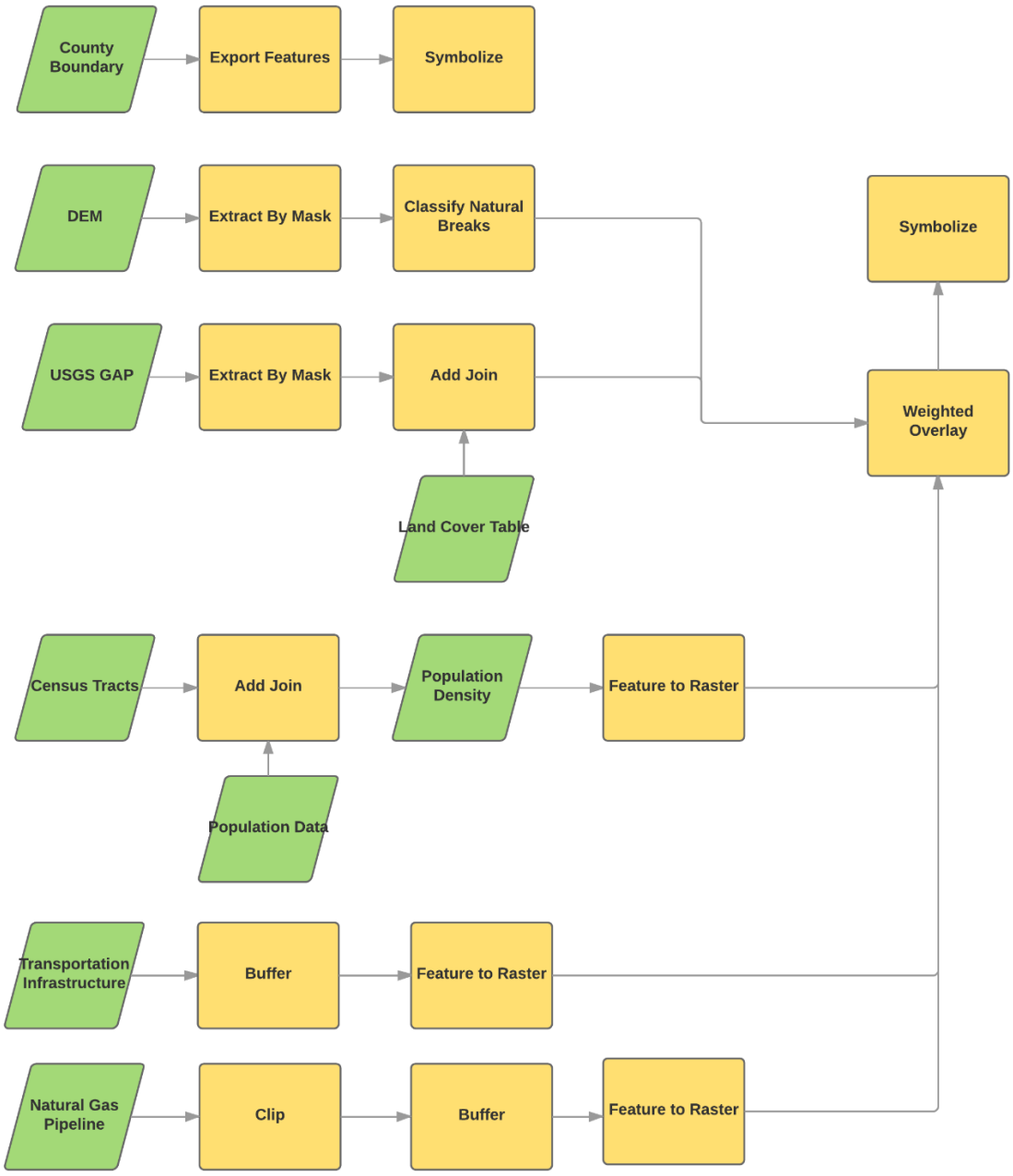
For transportation infrastructure, I acquired the data from the Orange County Data GIS Cloud. This resource has data for arterial, street, freeway, and railroad center lines for Orange County. These are all vector line shapefiles, and were produced in 2017.

Methodology

My methodology begins with preparing the Orange County border as that shapefile was used to extract and clip several other data layers. For this data layer, I opened the attribute table and selected only Orange County, CA. I then used the export features function to create a new layer that was only the Orange County polygon. After that I symbolized the polygon as empty with a black border. Next, I prepared the DEM. I did this by using Extract by Mask using the country boundary polygon I created before. After that I reclassified using Natural Breaks and created five breaks. After that I prepared the USGS GAP data for my weighted overlay. I first used the Extract by mask tool again. I then joined the supporting land cover table that came with the dataset. This table added values, names, and types for all the vegetation. This allowed me to choose values for the types of vegetation when doing the weighted overlay. After that I prepared the census tracts to become population density. With the Census Tracts, I also downloaded population data. I edited this data in excel to be the correct format in ArcGIS Pro. I then did an Add Join which allowed me to calculate the population density. I then converted the feature set to a raster using Feature to Raster. After that I prepared the four transportation infrastructure layers. These layers were: Arterial, Street, Freeway, and Railroad lines. Because I got this data from the Orange County GIS Portal it was already clipped to size. So, for each of these layers I created a buffer of 30m, because the supposed buffer code for Orange County is 100ft, I wanted to be near that distance assuming the city is following its own codes. After I did the Buffer I converted the features to rasters. Lastly, I prepared the natural gas pipeline layer. This was done similarly to the transportation infrastructure as they were both vector line files. But unlike the infrastructure I needed to clip the layer within the Orange County boundary using the Orange County Border I created earlier. Then I converted this feature to raster. After all that was said and done I attempted to do a weighted overlay using the rasters I created but ArcGIS consistently crashed on me and I was unable to.

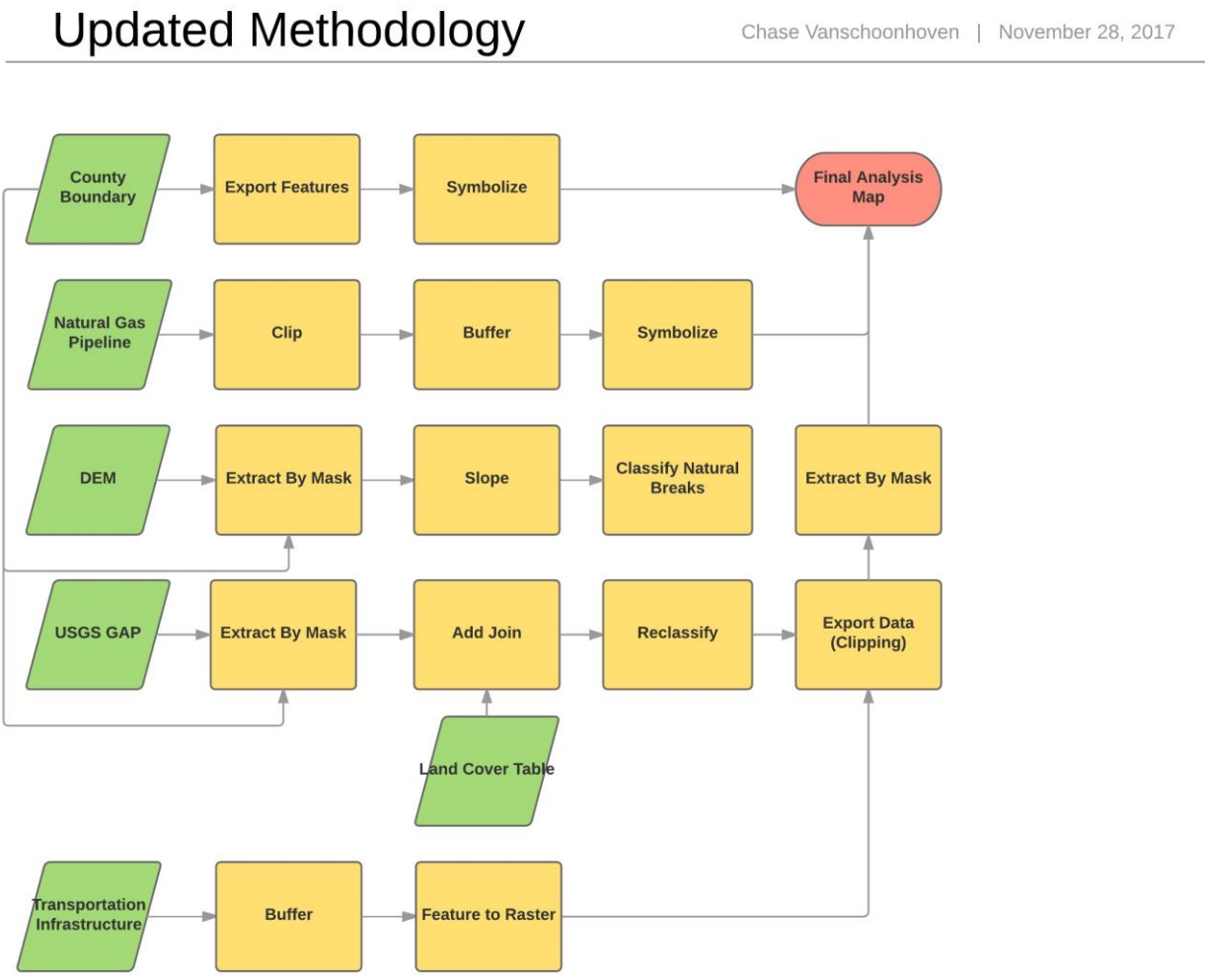
Methodology

Chase Vanschoonhoven | November 28, 2017



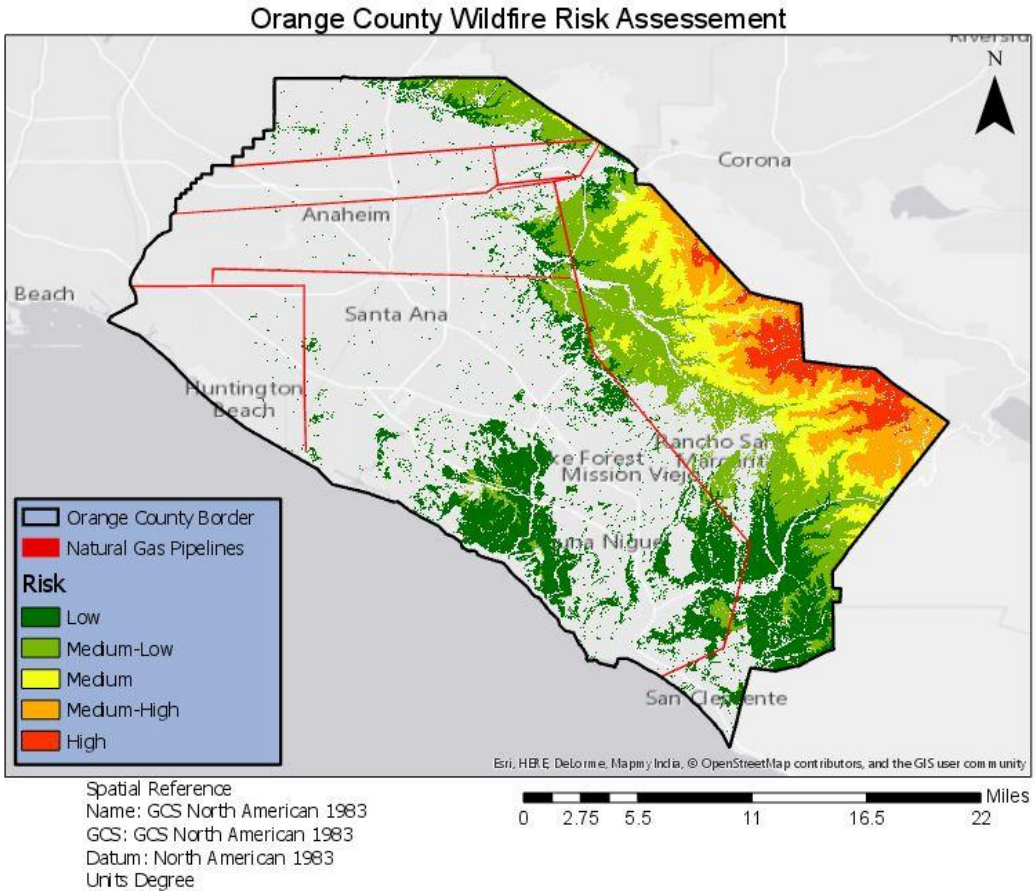
So instead of doing a weighted overlay, I went back and changed my methodology some to do a similar analysis but rather than having the overlay be weighted I created an overlay through masks. While what I did for the county boundary was the same, all the other data sets I processed at least slightly differently. For the DEM, I still used Extract by Mask to only display the cells that fell within the county border. Then I used the Slope tool to calculate the slope. After that I reclassified the slope into five natural breaks. Next, I prepared the USGS GAP data.

For this data, I did Extract by Mask using the Orange County Border; then I did a Join to the Land Cover table so that it would have all of values, names, and types for the vegetation. After that I reclassified the raster so that only Forest & Woodland, Shrub & Herb Vegetation, Desert & Semi-Desert, and Open Rock Vegetation were displayed and all other values were NODATA (See NVC _Class Column Table 2, Appendix). Next, I prepared the Transportation Infrastructure layers by doing a buffer on those layers of 100ft because the California Fire Code (California 2012). Then I used Feature to Raster to convert the layer to a raster layer. Next with the USGS GAP data and the Transportation Infrastructure I used Export Data and used the Selected Graphic (Clipping) option to remove the area of the Transportation Infrastructure from the USGS raster. Next, I used Extract by Mask on the DEM Slope layer and the GAP layer. I chose settings so that the Slope layer would be the one remaining but it would be the area of the GAP raster. And finally, I symbolized the County Boundary, Natural Gas Pipeline, and Slope and created the final map based off of those three layers.



Results

During my analysis, I was able to generate six symbolized maps based upon the datasets I acquired (See Appendix Maps 1 – 6). I was not able to create a weighted overlay for the final risk analysis because ArcGIS Pro continually crashed on me when trying to do the weighted overlay. I was able to prepare all of the data layers to be inputted into weighted overlay, but could not complete that portion. I spent many hours trying to complete the weighted overlay but it continually crashed on me. I tried trouble shooting the problem and tried different methods of input. So instead of doing a weighted overlay I created a manual overlay. The only factor I did not consider for the manual overlay was population density. But as I expected the data shows that the areas that are not yet developed, with a high slope and the natural gas pipeline are at higher risk for wildfire. While I think that a weighted overlay would have given a better understanding of the risk this overlay still shows areas at the most risk. Even areas that are next to developed areas are still at risk, though those areas are mostly low risk on my assessment because they are the areas closest to people in many other ways they are still at high risk for wildfire.



Conclusion

I would say much of this project went right, but also, I hit I major problem at the end as I stated in pervious sections. For what went right, the gathering of my data and research about the subjects went very well. I was able to find significant research on the topic that lead me in the proper direction. I was also able to acquire the data needed with relative ease. The websites and portals hosting the data were all free to use and I did not have to go through the effort of contacting anyone personally to ask for permission. As for what went wrong, during the final geoprocessing task, weighted overlay, I kept experiencing crashed in ArcGIS Pro whenever I tried to run the tool. This caused me to not be able to create the final product that I wanted, but instead I had to take a different route to complete my analysis. For this project, there are several things I would change and improve on. First, I still need to become more familiar with ArcGIS, I still had to look up how to perform several tasks. Second, I would give myself more time to do the geoprocessing needed. Because I waited a bit too long I ran into the crashes and I was unable to complete the project in the manner I was hoping to, and instead had to do the overlay in a different manner. I hope to do better in the future and give myself extremely ample time to complete geoprocessing my data. And personally, I want to do better prioritizing and completing tasks in a set timeline to help prevent things like this in the future.

References

California, State Of. 2007. "Fire Prevention." CAL FIRE - Fire Prevention. http://www.fire.ca.gov/fire_prevention/.

California, State Of. 2012. "California's Wildland-Urban Interface Code Information." CAL FIRE - California's Wildland-Urban Interface Code Information. http://www.fire.ca.gov/fire_prevention/fire_prevention_wildland_codes.

Calkin, David E., Alan A. Ager, and Julie Gilbertson-Day. "Wildfire risk and hazard: procedures for the first approximation." (2010).

CDC Technology, Inc. Coto de Caza, CA. n.d. 2007. “OCMap.jpg.” Ron Denhaan, Orange County, CA real estate specialist. http://www.ronforhomes.com/.

Donovan, Geoffrey H., Patricia A. Champ, and David T. Butry. "Wildfire risk and housing prices: a case study from Colorado Springs." *Land Economics* 83, no. 2 (2007): 217-233.

Martínez, Jesús, Cristina Vega-Garcia, and Emilio Chuvieco. "Human-caused wildfire risk rating for prevention planning in Spain." *Journal of environmental management* 90, no. 2 (2009): 1241-1252.

OC Almanac. *Temperature & Rainfall Ranges - Selected Orange County Locations.* http://www.ocalmanac.com/Weather/we02.htm.

Preisler, Haiganoush K., David R. Brillinger, Robert E. Burgan, and J. W. Benoit. "Probability based models for estimation of wildfire risk." *International Journal of wildland fire* 13, no. 2 (2004): 133-142.

Tedford, Daniel. 2017. "Over the last 40 years, there is a surprising trend with California wildfires." *Orange County Register*. Orange County Register. September 18. http://www.ocregister.com/2017/09/14/you-may-not-believe-it-but-the-number-of-california-wildfires-has-been-going-down/.

Wikipedia contributors, "Orange County, California," *Wikipedia, The Free Encyclopedia,* https://en.wikipedia.org/w/index.php?title=Orange_County,_California&oldid=812097004 (accessed November, 2017).

Appendix

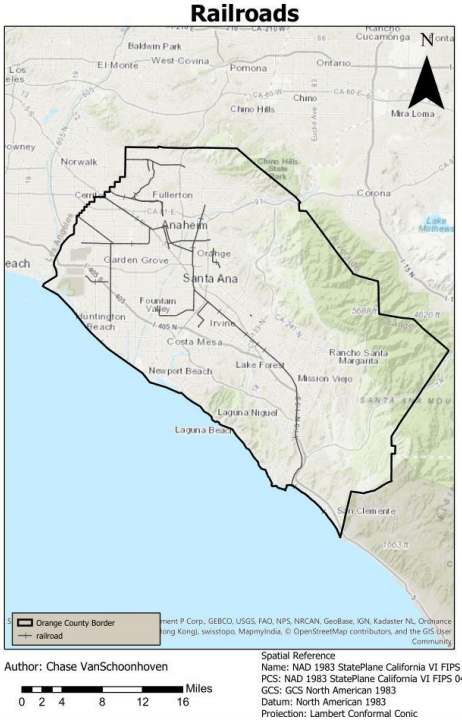
Data Acquired					
Name	**Source**	**Format**	**Date of compilation**	**Attributes**	**Description**
County Boundary	U.S. Census Bureau https://www.census.gov/geo/mapsdata/data/cbf/cbf_counties.html	Vector (Line) Shapefile	10/19/2017	Area	Orange County Boundary which covers the area of the study
DEM	USGS 3DEP product https://viewer.nationalmap.gov/basic/#productS earch	Raster Image	08/2017	1 meter resolution elevation data	Elevation data that will be used to find the slop and aspect.
USGS GAP Data	USGS https://gapanalysis.usgs.gov/gaplandcover/	Raster Image	2011	30 meter resolution land cover data.	Plant communities and density.
Crude Oil Pipelines	EIA https://www.eia.gov/maps/layer_info-m.php	Vector (Line) Shapefile	03/2017	Location and distance of pipeline	Line data of the location of crude oil pipelines. Does not go through orange county
Natural Gas Pipelines	EIA https://www.eia.gov/maps/layer_info-m.php	Vector (Line) Shapefile	03/2017	Location and distance of pipeline	Line data of natural gas pipelines.
Population Density	U.S. Census Bureau https://www.census.gov/geo/maps-data/data/tiger-data.html	Vector (Polygon) Shapefile	12/05/2016	Population	Shows the population density within Census Bureau tracts.

Transportation Infrastructure	https://ocdata.gisclou d.com/	Vector (Line) Shapefile	2017		Arterial, Street, Freeway, and Railroad Center Lines for Orange County

Table 1

OBJECTID	VALUE	COUNT	Value	Count	RED	GREEN	BLUE	CL	NVC_CLASS	SC	NVC_SUBCL	FRM	NVC_FORM	DIV
2	39	16775	39	12519035	0	0.61176	0.36078	1	Forest & Woodland	1.B	Temperate & Boreal...	1.B.1	Warm Temperate For...	1.B.1.Nc
3	40	472	40	390651	0	0.61176	0.36078	1	Forest & Woodland	1.B	Temperate & Boreal...	1.B.1	Warm Temperate For...	1.B.1.Nc
4	41	12177	41	4967451	0	0.61176	0.36078	1	Forest & Woodland	1.B	Temperate & Boreal...	1.B.1	Warm Temperate For...	1.B.1.Nc
5	42	1769	42	18956371	0	0.61176	0.36078	1	Forest & Woodland	1.B	Temperate & Boreal...	1.B.1	Warm Temperate For...	1.B.1.Nc
6	43	1776	43	283933	0	0.61176	0.36078	1	Forest & Woodland	1.B	Temperate & Boreal...	1.B.1	Warm Temperate For...	1.B.1.Nc
8	45	3747	45	362595	0	0.61176	0.36078	1	Forest & Woodland	1.B	Temperate & Boreal...	1.B.1	Warm Temperate For...	1.B.1.Nc
10	55	349	55	10379400	0	0.47059	0.36078	1	Forest & Woodland	1.B	Temperate & Boreal...	1.B.1	Warm Temperate For...	1.B.1.Nc
28	162	6588	162	29293449	0	0.27059	0.19608	1	Forest & Woodland	1.B	Temperate & Boreal...	1.B.2	Cool Temperate Fore...	1.B.2.Nd
31	165	318	165	7523779	0	0.32941	0.27059	1	Forest & Woodland	1.B	Temperate & Boreal...	1.B.2	Cool Temperate Fore...	1.B.2.Nd
45	183	1395	183	71643541	0	0.4902	0.08627	1	Forest & Woodland	1.B	Temperate & Boreal...	1.B.2	Cool Temperate Fore...	1.B.2.Nc
60	277	157	277	526092	0	0.57647	0.63922	1	Forest & Woodland	1.B	Temperate & Boreal...	1.B.3	Temperate Flooded...	1.B.3.Nd
61	278	15329	278	5529510	0	0.57647	0.63922	1	Forest & Woodland	1.B	Temperate & Boreal...	1.B.3	Temperate Flooded...	1.B.3.Nd
66	296	159	296	16866	1	0.46275	0.07059	2	Shrub & Herb Vegeta...	2.B	Temperate & Boreal...	2.B.1	Mediterranean Scrub...	2.B.1.Na
67	297	22652	297	1014827	1	0.46275	0.07059	2	Shrub & Herb Vegeta...	2.B	Temperate & Boreal...	2.B.1	Mediterranean Scrub...	2.B.1.Na
70	300	1166	300	6574742	1	0.46275	0.07059	1	Forest & Woodland	1.B	Temperate & Boreal...	1.B.2	Cool Temperate Fore...	1.B.2.Nd
72	302	223319	302	9603359	1	0.46275	0.07059	2	Shrub & Herb Vegeta...	2.B	Temperate & Boreal...	2.B.1	Mediterranean Scrub...	2.B.1.Na
73	303	386751	303	9295471	1	0.46275	0.07059	2	Shrub & Herb Vegeta...	2.B	Temperate & Boreal...	2.B.1	Mediterranean Scrub...	2.B.1.Na
74	304	133652	304	38765299	1	0.84314	0.55294	2	Shrub & Herb Vegeta...	2.B	Temperate & Boreal...	2.B.1	Mediterranean Scrub...	2.B.1.Nb
75	305	6	305	78349	1	0.84314	0.55294	2	Shrub & Herb Vegeta...	2.B	Temperate & Boreal...	2.B.1	Mediterranean Scrub...	2.B.1.Nb
88	359	11	359	120771	1	0.78824	0.44314	2	Shrub & Herb Vegeta...	2.B	Temperate & Boreal...	2.B.2	Temperate Grassland...	2.B.2.Nd
92	383	3	383	32030	1	0.52941	0.35294	2	Shrub & Herb Vegeta...	2.B	Temperate & Boreal...	2.B.1	Mediterranean Scrub...	2.B.1.Na
94	385	1193	385	27858	1	0.52941	0.35294	2	Shrub & Herb Vegeta...	2.B	Temperate & Boreal...	2.B.4	Temperate to Polar S...	2.B.4.Nb
97	432	1962	432	1645000	0	0.76078	0.76863	2	Shrub & Herb Vegeta...	2.C	Shrub & Herb Wetland	2.C.4	Temperate to Polar F...	2.C.4.Nb
105	455	1699	455	730099	1	0.74118	1	2	Shrub & Herb Vegeta...	2.C	Shrub & Herb Wetland	2.C.5	Salt Marsh	2.C.5.Nc
111	470	172	470	38757752	1	0.76863	0.72157	3	Desert & Semi-Desert	3.B	Cool Semi-Desert Scr...	3.B.1	Cool Semi-Desert Scr...	3.B.1.Ne
113	472	1788	472	124893552	1	0.76863	0.72157	3	Desert & Semi-Desert	3.A	Warm Desert & Semi...	3.A.2	Warm Desert & Semi...	3.A.2.Na
119	485	1	485	18365816	1	0.58824	0.4902	3	Desert & Semi-Desert	3.B	Cool Semi-Desert Scr...	3.B.1	Cool Semi-Desert Scr...	3.B.1.Ne
123	489	1	489	187305620	1	0.81961	0.65882	3	Desert & Semi-Desert	3.B	Cool Semi-Desert Scr...	3.B.1	Cool Semi-Desert Scr...	3.B.1.Ne
136	516	14	516	156596	1	0.83922	0.83922	6	Open Rock Vegetation	6.B	Temperate & Boreal...	6.B.1	Temperate & Boreal...	6.B.1.Nb
141	539	895	539	3550284	0	0.34902	0.34118	6	Open Rock Vegetation	3.A	Warm Desert & Semi...	3.A.2	Warm Desert & Semi...	3.A.2.Na
142	540	14	540	4051579	0	0.34902	0.34118	6	Open Rock Vegetation	3.A	Warm Desert & Semi...	3.A.2	Warm Desert & Semi...	3.A.2.Na
147	547	251	547	6774927	0	0.4549	0.44706	6	Open Rock Vegetation	3.B	Cool Semi-Desert Scr...	3.B.1	Cool Semi-Desert Scr...	3.B.1.Ne
150	552	279	552	1727859	1	0.56078	0.56863	8	Nonvascular & Spars...	8.E	Barren	8.E.	Barren	8.E.
151	553	44	553	6900933	1	0.56078	0.56863	8	Nonvascular & Spars...	8.E	Barren	8.E.	Barren	8.E.
153	556	12122	556	1532431380	1	0.99608	0.75686	7	Agricultural & Devel...	7.B	Herbaceous Agricult...	7.B.1	Row & Close Grain C...	7.B.1
154	557	1756	557	655777154	1	0.99608	0.75686	7	Agricultural & Devel...	7.B	Herbaceous Agricult...	7.B.2	Pasture & Hay Field...	7.B.2
155	558	2665	558	32962164	1	0.27059	0.61176	9	Introduced & Semi N...	9.A	Introduced & Semi N...	9.A	Introduced & Semi N...	9.A
161	567	36	567	63110161	1	0.18039	0.14902	10	Recently Disturbed o...	10.A	Recently Disturbed o...	10.A	Recently Disturbed o...	10.A
162	568	77	568	77899738	1	0.18039	0.14902	10	Recently Disturbed o...	10.A	Recently Disturbed o...	10.A	Recently Disturbed o...	10.A
170	578	6790	578	181461386	0	0.17647	0.76078	11	Open Water	11.A	Open Water	11.A	Open Water	11.A
171	579	8438	579	324263510	0	0.17647	0.76078	11	Open Water	11.A	Open Water	11.A	Open Water	11.A
173	581	242544	581	228044833	1	0.30196	0.25882	8	Developed & Other...	8.A	Developed & Urban	8.A	Developed & Urban	8.A
174	582	341980	582	115308969	1	0.30196	0.25882	8	Developed & Other...	8.A	Developed & Urban	8.A	Developed & Urban	8.A
175	583	670634	583	52655029	1	0.30196	0.25882	8	Developed & Other...	8.A	Developed & Urban	8.A	Developed & Urban	8.A
176	584	175513	584	108122987	1	0.30196	0.25882	8	Developed & Other...	8.A	Developed & Urban	8.A	Developed & Urban	8.A

Table 2

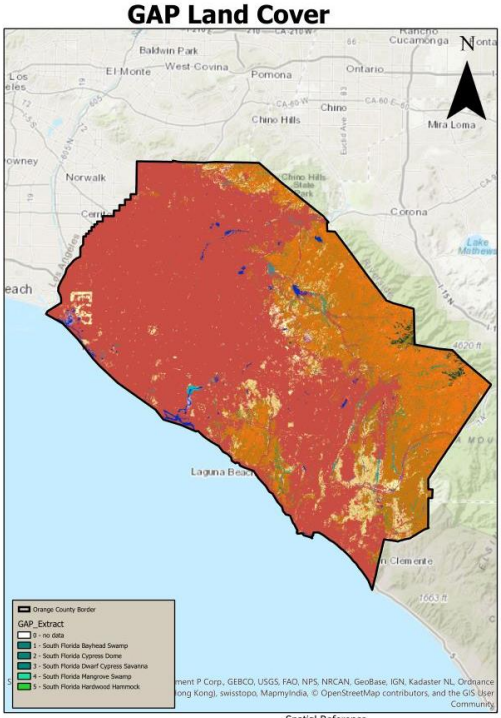


Map 1

Natural Gas Pipelines

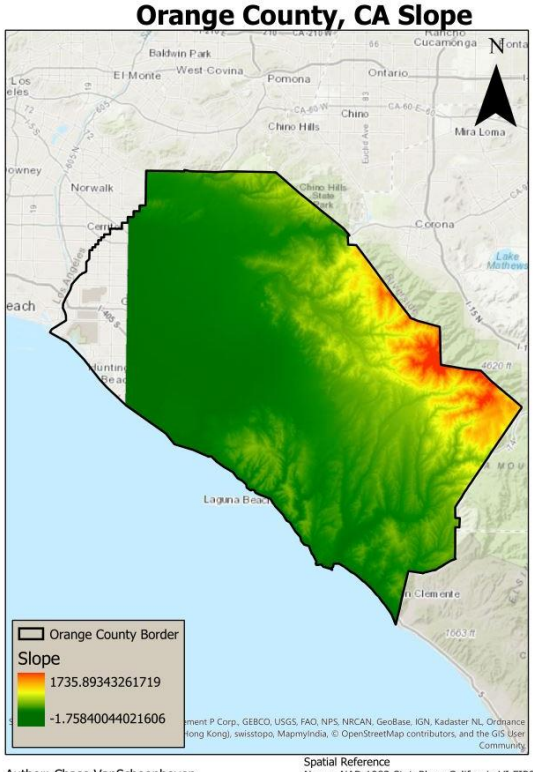
Map 2

GAP Land Cover



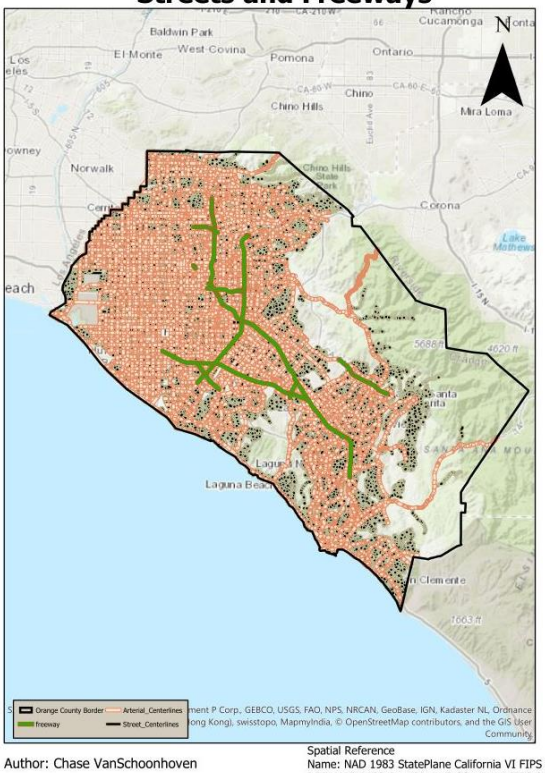
Map 3

Orange County, CA Slope



Map 4

Streets and Freeways



Map 5