Pick your Poison!

A Comparison of Water Data from CalEnviroScreen 3.0 and UC Davis

INTRODUCTION

According to the World Health Organization, at least two billion people drink contaminated water. In California, there are many organizations looking at a range of contaminants from bacterial such as E. coli, to chemical such as Nitrate. In 2008, the state Legislature enacted SBX2 which required the State Water Board to research nitrate in groundwater through pilot projects across the state. In order to accomplish this goal, the State Water Board teamed up with University of California, Davis' Center for Watershed Sciences to gather nitrate levels from public drinking water wells. The study mainly analyzed data from Tulare Basin and Salinas Valley as Nitrate levels around farming installations are assumed to be higher. I decided to look at Los Angeles County nitrate level data from UCD and found high amounts of Nitrate in southern part of the County where there is no farming.

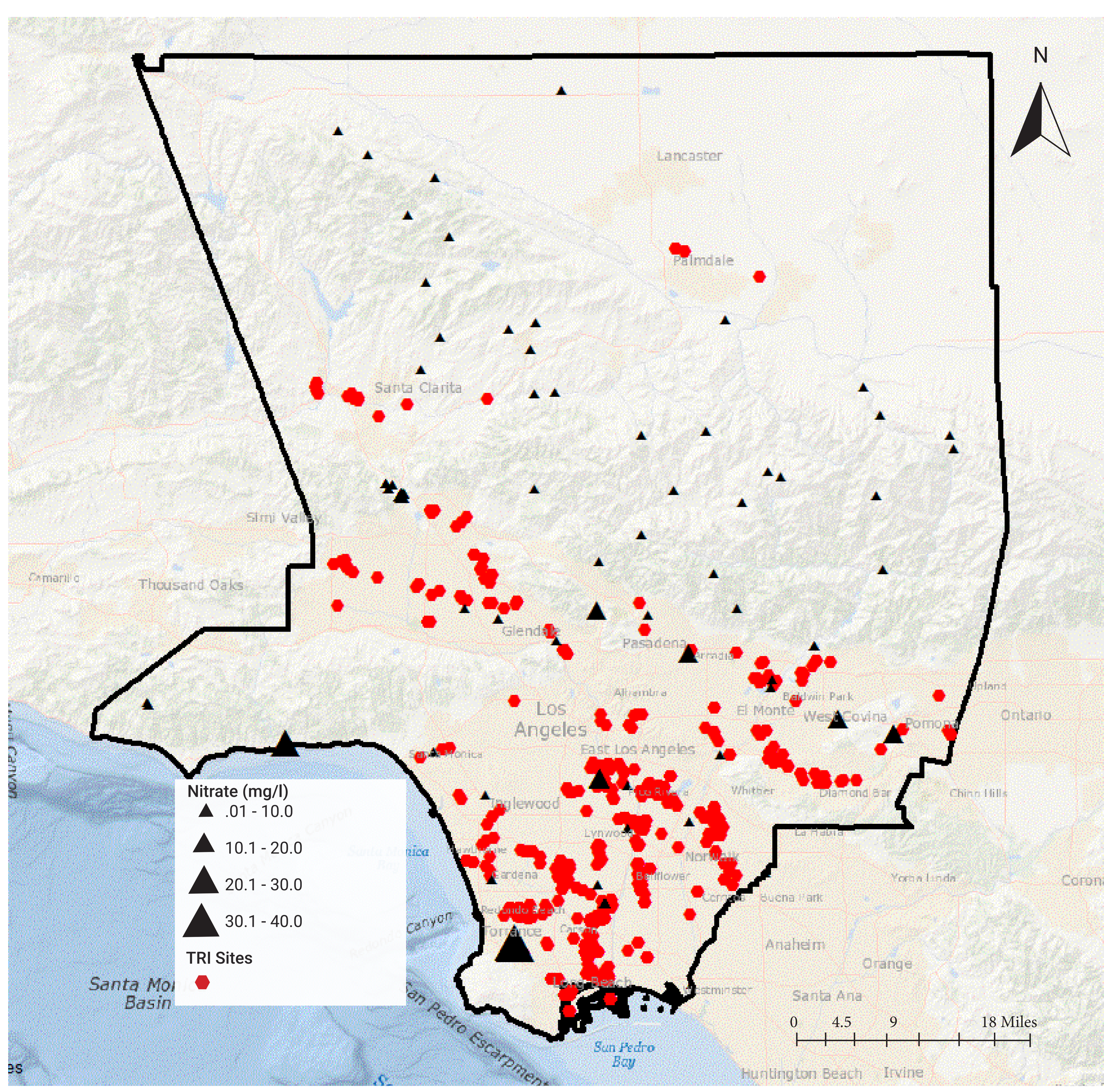
BACKGROUND

The United States Environmental Protection Agency started regulating the nitrate and other chemicals of concern through the Safe Drinking Water Act in 1975 (Fan 1995). The maximum contamination Level (MCL) was first established in 1977 by the state of California as 10 milligrams per liter in the form of Nitrate-nitrogen (NO2) and adopted by the rest of the country in 1991. When the body converts Nitrate to Nitrite and turns the hemoglobin, into methemoglobin a form of hemoglobin that is able to retain oxygen but not able to release it to the tissues. This process in infants under six months of age is called methemoglobinemia also known as blue baby syndrome because the child will begin to turn a bluish tint as they lose oxygen. Other serious complications that nitrate can cause include diuresis, a condition in which the kidneys malfunction and produce large of amounts of urine, bladder cancer and ovarian cancer.

METHODS

Part 1

I used UCD Nitrate data measured in milligrams per liter measuring Nitrate as N. I also used Toxic Release Inventory (TRI) data from the Environmental Protection agency. This data provides the location, type of contaminant and approximate amount of contaminant being released. I refined the data to only show TRI sites releasing Nitrate into groundwater in Los Angeles County. In order to test my hypothesis. I created a buffer of 100 feet, 1000 feet and 1 mile around each well. I then overlayed that buffer on the TRI data to find TRI sites within 100 feet, 1000 feet and 1 mile radius' around each well. The results were inconclusive as I found zero TRI site within 100 feet of a well, 4 TRI sites within 1000 feet of a well and 7 TRI sites within 1 mile of a well.



This map shows the locations of drinking water wells contaminated with Nitrate measured in mg/l. All those over 10 mg/l are violating the EPA's Maximum Contaminant Level (MCL). This also shows the location of Toxic Release Inventory sites which are companies that are releasing nitrate into the groundwater.

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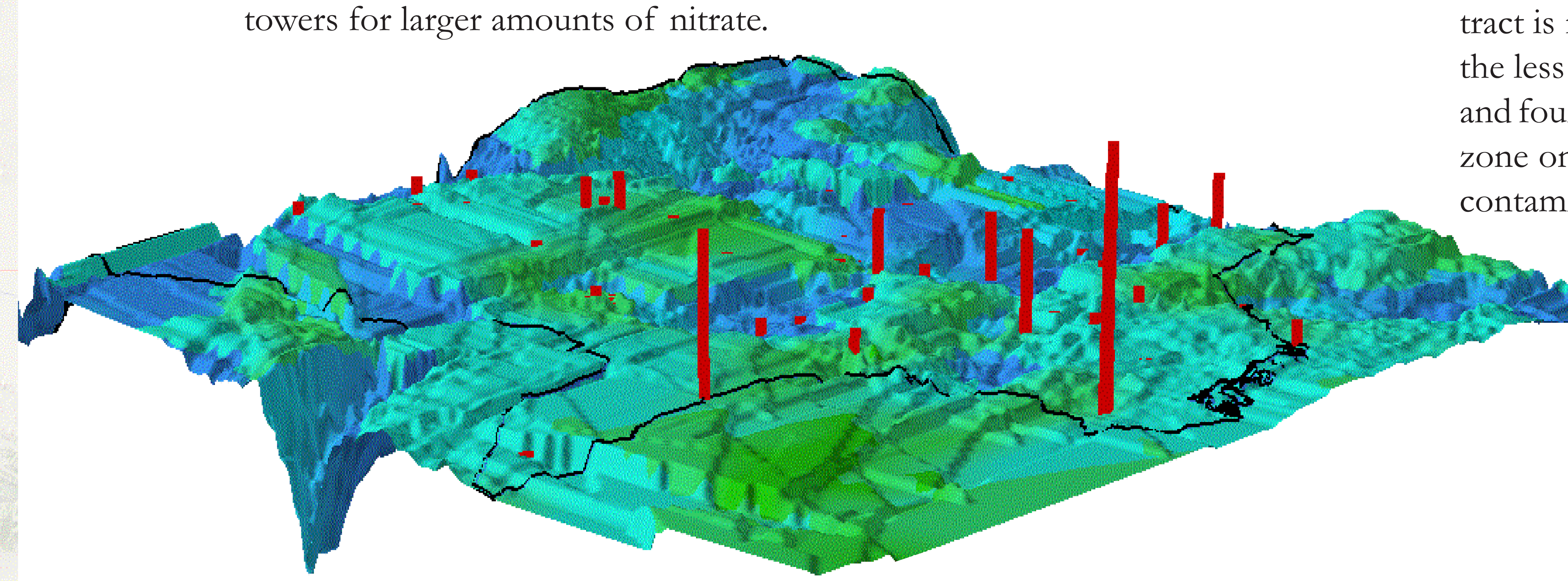
Class: UEP 232 Intro to GIS

Projection System: NAD 1983 State Plane California FIPS 0405 Feet

Part 2

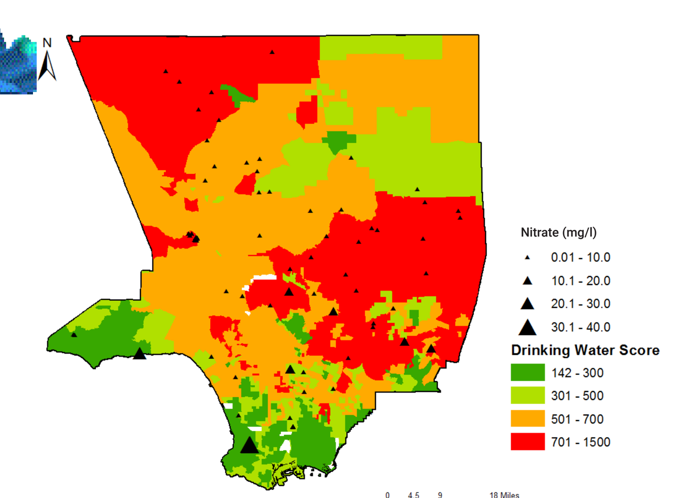
Due to these results, I decided to look at how depth of the wells could have an effect on the results. I hypothesized that the greater contaminant levels would be found in the wells dug on shallow aquifers and the low levels would be found in wells dug on deep aquifers. I used California Water Board well depth data (>3000 data points) as my UCD data did not have depth information. I then krigged these points using the ordinary kriging geospatial anaylst tool. Using the Geostatistial Wizard, I went through the 6 steps as though I was looking at elevation. I then imported the resulting raster into ArcScene and used the well depth data as the base height and multiplied this column by -1 to show the depth data as under the surface of the earth. Lastly, I imported the nitrate data and overlayed this onto the 3D model. I then used the contamination level as the base height resulting in larger towers for larger amounts of nitrate.



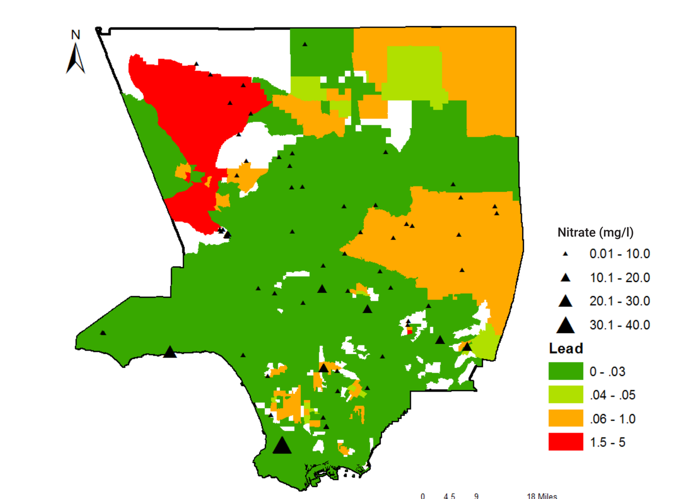
The model below displays the depth of groundwater aquifers beneath Los Angeles County. The green is shallow aquifers and the blue is deep aquifers. This also shows the location of Nitrate contaminated wells and the amount of contamination is illustrated by the height of the bar. The more contamination, the taller the bar.

Part 3

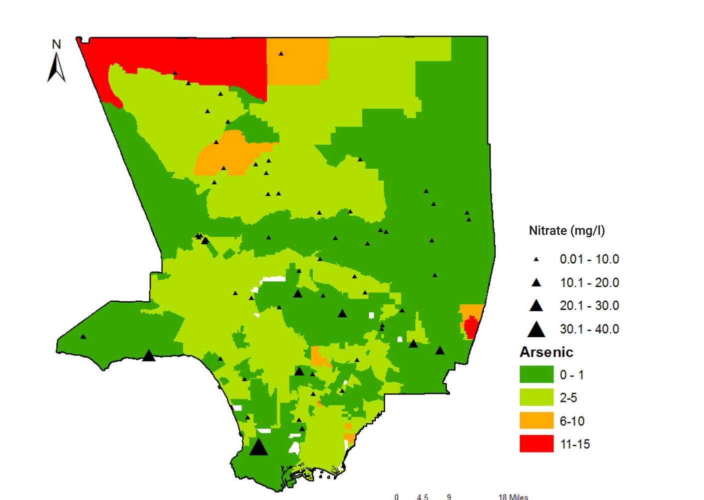
The last part of this analysis was looking at how my data and analysis compared to other similar analyses. I looked an Environmental Health Screening Tool: CaliEnviroscreen 3.0. This tool encompasses various indicators to reflect a population's vulnerability to environmental contaminants. This tool was made by the Office of Environmental Health and Hazard Assessment Agency. The tool creates "indicator scores" for various environmental health risks including water. The overall drinking water score is calculted using average average contaminant concentrations from 2005 to 2013. This number is then looked at on a Census tract by calculating the population-weighted sum of the contaminants for each Census block within the tract. These census tracts were then put into an order by the value of their contaminant concentration number and calulates a percentile for each contaminant. The drinking water contaminant score for one Census tract is found by adding up all the percentiles for all contaminants. The lower the score, the less vulnerable the area is to cotaminants. I also looked at three single contaminants and found that not only does my nitrate contamination data show up in a "less vulnerable" zone on the nitrate score map but also shows up in less vulnerable zones on two other contaminant maps.



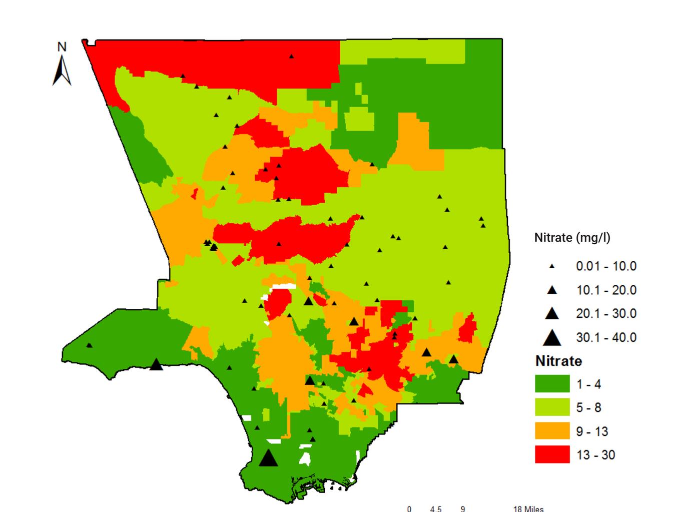
The map above displays the EnviroScreen 3.0 Drinking Water Score data which is a metric used to map vulnerability to environmental contaminants.



The map above displays the EnviroScreen 3.0 Lead Score data which is a metric used to map vulnerability to lead in drinking water.



The map above displays the EnviroScreen 3.0 Arsenic Score data which is a metric used to map vulnerability to Arsenic in drinking water.



The map above displays the EnviroScreen 3.0 Nitrate Score data which is a metric used to map vulnerability to nitrate in drinking water.

CONCLUSION

I found that the CalEnviroScreen 3.0 is misleading by using complicated methods to provide a score that does not nessesarily reflect the reality of how vulnerable a population may be to drinking water contaminants. Vulnerablitiy assessments are extremely difficult to do on drinking water because there are so many contaminants to consider. It would be expensive and difficult to test for all chemical and bacterial contaminants. The scores are supposed to reflect a person vulnerability to environmental hazards but instead they give false idea of clean water. As for my analysis, I conclude that contaminants are more dense in shallow aquifer wells, therefore the deep aquifers will be the best location for "safer" water.

Sources:

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