Modeling Drought Intensity in California

Introduction

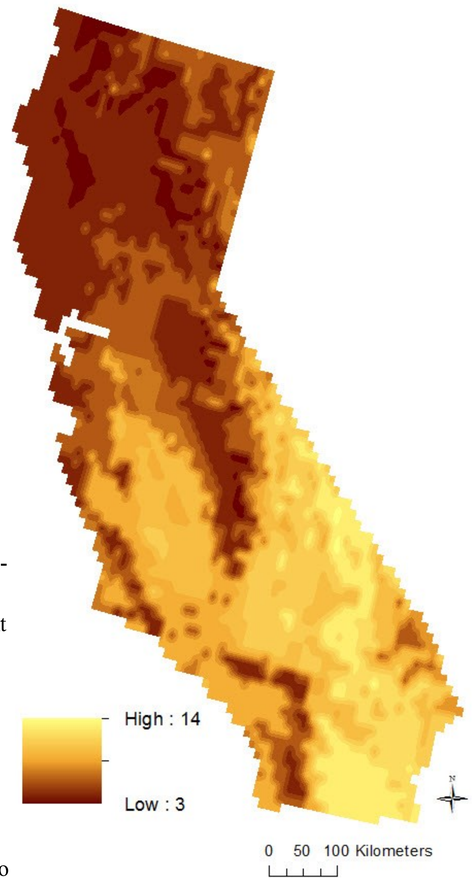
California is facing one of the worst droughts in its history. The current drought has lasted for the last four years. Low precipitation and snowfall rates have resulted in land subsidence, dried out water bodies, and groundwater depletion. The most important factors for drought are decrease in precipitation, streamflow, and snowfall, and an increase in temperature and evapotranspiration. I created three drought intensity models using these weather and environmental factors. I can use these models to identify which regions of California are most affected by drought. These areas face higher water costs, outsourcing water, and more regulations on water use.

Methodology

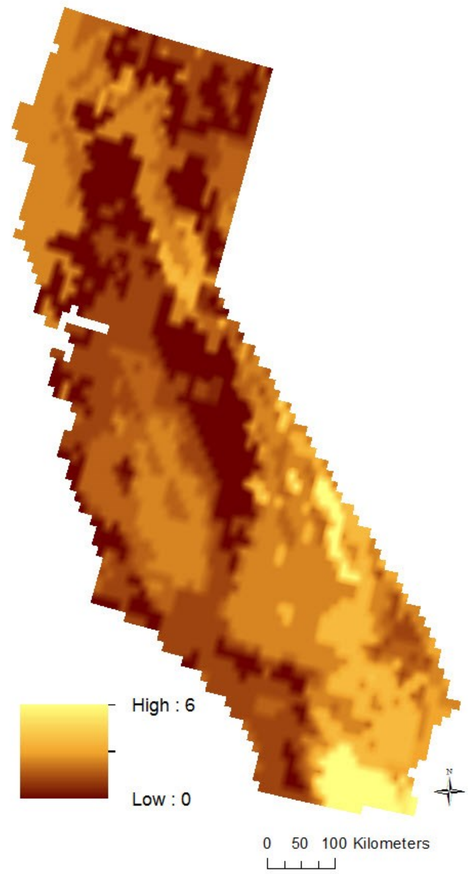
Each of the 9 raster layers have been reclassified into 5 classes, which were manually selected to be evenly-spaced and include the minimum and maximum values. In each drought intensity model, high temperature areas, low precipitation zones, and high evapotranspiration areas have the largest weight. The base flow and streamflow layers have the second highest weight in each model because these layers can impact drought intensity. Soil moisture in the bottom layer, relative humidity, fractional moisture in the entire soil column, and snow water equivalent have the lowest weight in each model because these factors are relevant, not crucial, to drought intensity. All of the weighted rasters were calculated in a raster calculator. A query of the United States for California was used to extract the state of California from the sum of raster calculations.

A low value on the drought intensity map indicates that the weighted parameters such as precipitation, base flow, and snow water equivalent have low values at this point. A low score indicates a high drought intensity.

Drought Intensity Model 1



Drought Intensity Model 2



Drought Intensity Model 3

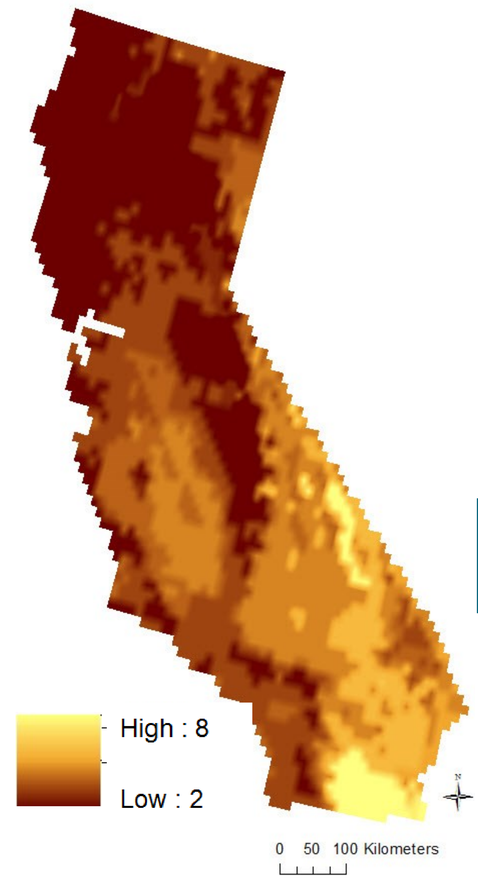


Table 1: Weights of raster layers for each model

Model	Evapotranspiration	Precipitation	Temperature	Base flow	Streamflow	Relative Humidity	Fractional Moisture in Water Column	Snow Water Equivalent	Soil Moisture in the Top Layer
Drought Intensity 1	3	3	3	2	2	1	1	1	1
Drought Intensity 2	2	2	2	1	1	.5	.5	.5	.5
Drought Intensity 3	3	3	3	2.5	2.5	.75	.75	.75	.75

Limitations

All of the raster layers except for Precipitation and Temperature were collected from CAL-Adapt, a California Climate change prediction tool. The rasters layers from this site are projected values for base flow, evapotranspiration, stream flow, snow water equivalent, soil moisture in the bottom layer, fractional moisture in the water column, relative humidity from 2013-2014. The precipitation and temperature layers are actual data from 2014. Another limitation of the models is that Relative Humidity, Fractional Moisture in the Water Column, Snow Water Equivalent, and Soil Moisture in the Top Layer. Another limitation of the data set is that all of the data were environmental factor of drought. None of the layers were due to human involvement, which is a substantial factor in the California drought.

Conclusions

All three drought intensity models have high drought intensity in central California. Models 1 and 2 have a high drought intensity in northern California. The results from the three drought intensity models indicates that the environmental factors causing drought are impacting the regions of northern and central California.

This map can be used as a basis for regulating water usage. Further research should be done to determine the exact weights of each raster necessary to model drought intensity. Also, further research should be done to indicate how water usage in California would impact the model. Excess water usage in the southern or northern regions of California would greatly impact all three models. Understanding the causes of the drought in California is crucial to learning how to minimize the drought's impact on civilization.

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CEE 187

Projection: Equidistant_Conic
Sources: Cal-Adapt, PRISM, USGS, NOA

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Drought Modeling Raster Layers