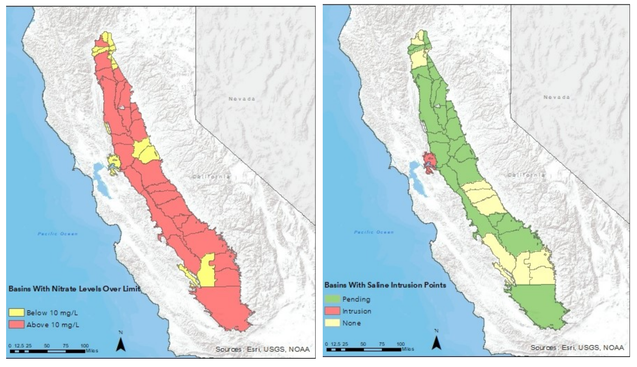
Beyond the Drought:

Assessing Agricultural Risk to the Groundwater Basins of California's Central Valley

Background

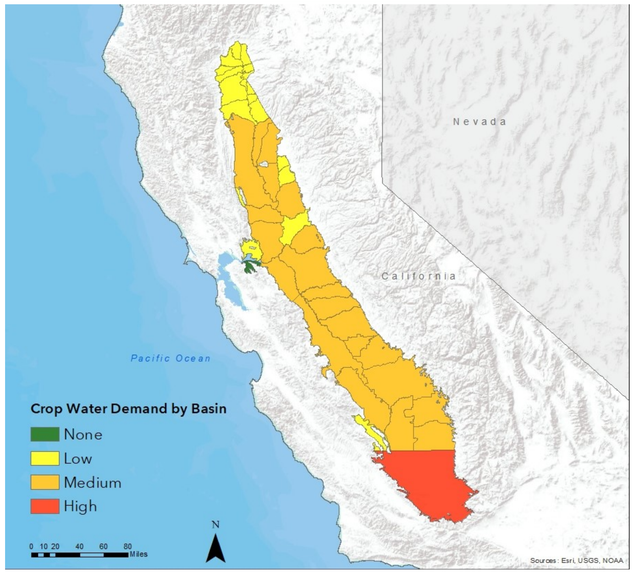
The Central Valley of California is one of the most agriculturally productive regions in the United States. The 20,000-square mile region accounts for one-sixth of irrigated land and one-fifth of groundwater use in the nation. Recent periods of drought, exacerbated by climate change, have drawn attention to the sustainability of California's water supply, between 40 and 60 percent of which is used for irrigation (Johnson, 2015). When normal snowmelt and rainfall levels are not enough to meet demands, groundwater serves as a replacement. However, the increasing use of groundwater has both decreased the quantity and the quality of this vital resource, and has even led to the lowering of the land surface in places of extreme overdraft ("Groundwater", 2009).

Three main risk factors were considered for the analysis: water quality degradation, water demand, and land subsidence. I used data on saline intrusion and nitrate levels to assess water quality, and the number of production wells and net water demand of the crops grown above the basin to estimate total water demand. My results may be compared to the California Department of Water Resources (DWR) Basin Prioritization Report ("Sustainable", 2019).



Water Quality Degradation: Basins with Saline Intrusion (left) and Basins with Nitrate Levels Above 10 mg/L (right)

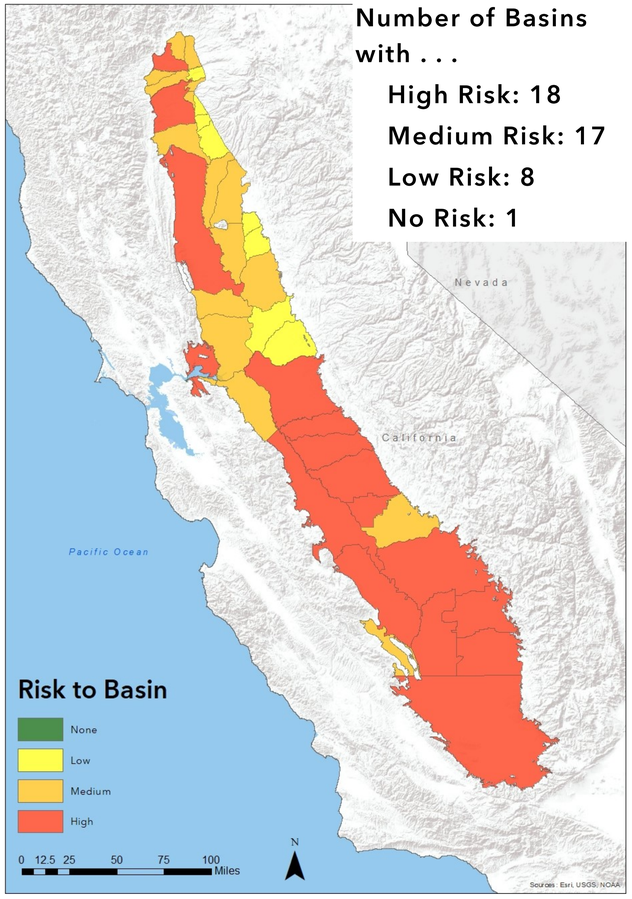
Water Demand of Crops Grown



Top Crops Grown:
1. Almonds
2. Alfalfa
3. Vineyards
4. Corn
5. Deciduous

Most Water Intensive:
1. Alfalfa
2. Almonds
3. Irrigated Pasture
4. Rice
5. Deciduous

Risk to Groundwater Basins

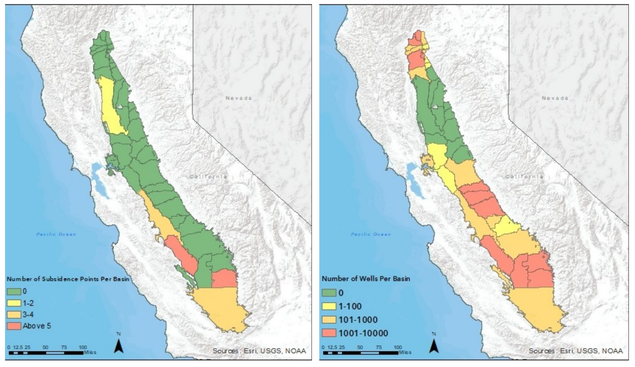


Methodology

I spatially joined point data for nitrate measurements, saline intrusion points, production well locations, and land subsidence locations to the groundwater basin polygon layer to assess each risk indicator by basin. Then, I converted this vector data to raster data, and reclassified each to have levels between 0 to 1 for saline and nitrate level or 0 to 3 for subsidence and wells. I changed the vector crop data to raster data and reclassified the type of crop by its water demand ranking based on irrigated water use information, as shown above. Finally, I determined combined risk with the raster calculator. Since some of the inputs are indicators of a groundwater basin at risk (subsidence, saline intrusion, and high nitrate levels) while others are causes of risk (large number of production wells and crops with high water demand), I applied weights the reclassified raster data in order of significance: subsidence, the greatest indicator, had a factor of 4; saline, 3; nitrate and production wells, 2; while crop data was given no factor, assuming crop water demand to be the least significant metric of groundwater risk in comparison.

Results & Conclusions

My assessment found a total of 18 basins in the Central Valley with high risk, 17 with medium risk, 8 with low risk, and 1 with no risk. This data can be used to inform the state of California how to properly allocate groundwater resources, especially in terms of irrigation. The analysis on crop water demand throughout the valley may suggest reconsideration of the types of crops grown on top of at-risk basins. Comparison of the water demand of crops and the groundwater basins at-risk shows that even with crop water demand counted as the least significant contributor to the risk, crop water demand and risk align: currently, the most water intensive crops are being grown on the most at-risk basins. My results differ slightly from the DWR report, which identified a greater number of basins in the Central Valley as at high risk than my model. The DWR report considered a much more comprehensive definition of water demand, taking into account population above the basin and the amount of water pumped per well than merely the number of wells as per my model. My analysis was further limited by inconsistencies in data collection. I relied on counts of data points for my analysis, which may differ across basins due to a lack of measurement and not necessarily a lack of the existence of the risk factor.



Overdraft: Number of Land Subsidence Locations per Basin (left) and Number of Production Wells per Basin (right)

Abby Raymond, Cartographer

CEE187- Geographic Information Systems
Presented May 3, 2019
Projection: California Teale Albers
Data Sources: CA Open Data Portal, USGS, GAMA

Sources

Groundwater Availability of the Central Valley Aquifer, California. (2009). *USGS. Retrieved from https://pubs.usgs.gov/pp/1766/PP_1766.pdf*

Johnson, R., Cody, B. A. (2015). California Agricultural Production and Irrigated Water Use. *Congressional Research Service. https://fas.org/sgp/crs/misc/R44093.pdf*

Sustainable Groundwater Management Act 2019 Basin Prioritization. (2019). *California Department of Water Resources. Retrieved from https://water.ca.gov/Programs/Groundwater-Management/Basin-Prioritization*

[Image] "Sunset Nature Fields Valley Wheat California Harvest Fresh HD Wallpaper", Lauri Brandeberry, UC Davis (2014)