San Joaquin Valley Water Level Depth Changes for 1980-1990 and 1990-2000



Travis Davis GEO 327G 12/7/2017



Ν

Travis Davis Dr. Helper GEO 327G 7 December, 2017

San Joaquin Valley Water Level Differences between 1980-1990 and 1990-2000

Introduction

The San Joaquin Valley in California has undergone extensive groundwater withdrawal over the 20th century to present. The amount of pumping decreased in the 1960's due to programs implemented to import surface water from other areas. From this point on, the amount of groundwater extraction was influenced by several drought periods from 1976-77, 1986-92, and 2007-09, which increased pumping to meet the agricultural needs of the valley.

Depth to water level data was collected for the years 1980, 1990, and 2000. The drought period in the late 80's is one of the main focuses of this project, and observing how the water levels changed as a result of the drought, and how much the water levels were able to recover by the year 2000.

Data Collection

The data used was collected from the USGS website shown in Figure 1.



Figure 1. USGS website.

This was the first step in the data collecting. Extensioneter data for groundwater gathered through this link, which was the data collecting options page, shown in Figure 2.

Station of the state of the sta	Θ -	a ×
🔄 🕑 🕻 🕯 Secure https://mik.watahidatu.ugg.gge/col/mik/juli/vol/branch_obtes/a/a_long_bounding_boulde.com/_rubioubmitted_form-introduction		\$ i
Kumber of observations enter value for minimum number of observations		
Choose Output Format Display Summary of Selected Sites Choose one of the following options for displaying descriptions of the sites meeting the criteria above:		
I Show sites on a map exe		
B Table of sites grouped by		
Iscroll list of sites allows selection of data for multiple sites		
Brief descriptions allows selection of data for multiple sites		
Site-description intormation displayed in eased to the		
Collect Falled to include in the select/ptim exp(r) Allenge Management State of the select of the		
O Save file of selected sites to local disk for future upload A selected sites to local disk for future upload A selected site of the selected site of the selected sel		
Retrieve Groundwater level data for Selected Sites Choose one of the following options for displaying data for the sites meeting the criteria above		_
Retrieve data from: 1590-41-31 los: 1590-43-31 (YYYY-MM-DD Dlank = all data)		
Image: State of the state of		
Itable of data		
® Tab separated data (YYYYAMAD *) (Sava te file *)		
* Save compressed files with a .gz file extension.		
Submit Asset [160]		
Questions about stevidea?	ips	
Ceculars or una receivant Ceculars of the set of the se	ibe for system ch	anges
Accessibility Plug-ten POTA Privacy Prolificie and Nodican	-	
1.5. Dispetition of the pulse o	US	1.00v
	A 101 44 10	1:00 PM

Figure 2. Data collection in the forms of water table depth and latitude and longitude.

Figure 2 shows where the data for the groundwater levels and locations of the wells (in latitude and longitude) was gathered. To attempt to get consistent data for different decades, I selected an interval of months for 1960, 70, 80, 90, 2000, 2010, and 2016. The data was downloaded in a non-ideal way. The first search yielded the wells used in the extent of the valley and their location in latitude and longitude. The second search yielded each groundwater level measurement for a span of 3 months in each decade. For some reason, the wells that were listed as being used did not all have water level data. Each well had to be gone through to find and delete the ones that didn't have water level data. After compiling all the needed data into one excel file for each year, (shown in Figure 3 is the excel file for 1990) the file was converted to a CSV file and exported to ArcMap.



Figure 3. Final excel file with water depth data and location for one 1990.

This was the final product for the year of 1990. The file was converted to a CSV file to export into ArcMap.

Data Preprocessing

Once the data was in ArcMap, it was exported in the form of a text file. After that, the X,Y data was added for the file, which put the wells on the map with their water level values. From there, the text file was converted into a shapefile. This process was done for each year. The end product is shown in Figure 4.



Figure 4. Shapefile for 1980 measurements.

Attempts to match up data for the same wells in the different years is shown in Figure 5. After deleting all the wells that weren't repeated over the years, there ended up being only 10 wells that were there for every year, and none of them were actually located in the San Joaquin Valley. So this method was abandoned and the decision was made to just take all the well data for each year and work from there, which would provide more data, but also result in some problems with showing the differences between water level data over the years for areas that one year didn't have measurements for, but the other year did.

H No.											-	-	O fine													1			ж
-																													
A. A.M.	free all	22 Hall 1	the Distance	1.000		F) []	2 Inner	100	_	Contra 1		-	1000	-	1. 55-	- "Par 1	5 X	Calificat 1	0-	0							_		_
Relay-		(C)			-	00	_	_		_	_				- 61	10.1	P. 2	181	2.1.2										
· Fiendfann			and manhaces		A Date	eteg- Se							-		2 5	1000	1	Ger-	Abr- M	62									
Concert.	a		110	to there						-						1981		t a	141										
44 *	a 2. A																												
4 4		1 1			100			1.1									1.	1.1	1.4	ý.		12	 - 10	AL	10	AL			
1 210	1000	2000	3012	3014	_																								
T M4134112017068	545125125184(#1	Average and Treasure	145100120282508	Hallweitz (4) 16 Mit.																									1
1 34110104498	345457125019888	SHITESUCONOPE	34045/02/03/03/09/04	545Y2142M3M3M1																									
+ MARTINISTRE	MERIDIAN	3434(7)33080381	MAND-COLUMNEROR	MACHENNEN																									1
1 96411223TH	· Destinitioneres	BORI FLIDLINK	- MORECRETEDOR	(where the first																									44
•	aniater believen	and a local division of the	100401/08/01103	And Distances of the																									н.
A SALAL PLANES	Part and the second second	HOURS INCOME.	. Resources	Separation and the state																									
A DEMONSTRATION OF	Manual Annual State	NORTH COLUMN	14-10111-0-5001	MORE AND ADDRESS OF																									
The Real Property lies	A DESIGNATION OF THE OWNER	here is to be	AND DESCRIPTION OF	MANUTART																									
operant Name Inc.	DEMONSTRATING	Committee Committee	JANDINI PUTTANA	MADELCHICKNE																									
TO MULTIPLE CONTRACTOR	MN01120HURL	INCOME.	M000007070	Million and																									
11 December 2008/201	MINAALINGSHURE	INCOME AND ADDRESS OF	141205-070446	MADINGHISTORY																									
M MINISTRATION	MANAGE PERMIT	DED-METOMORY (Description of the local division of the loc	MANAGEMENT																									
TO BERRY BURNING	INCOME AND	INCOME DI CRUZER	MUSICOURSES	MONITORIDA AND																									
- Annual Contraction	NUMBER	NUMBER	MERECONCERN	MACHINE																									
tr instrument	SOOTALITISING	NOTIFICATION	14UARCEUMPR	MUTERINE																									
10 BOHALL RUDOW	200047120053088	NORCEDENTS.	MONORCHUSE	MODIFICHEMITE																									
· PERSONAL PROPERTY IN CONTRACTOR OF CONTRAC	20041411000418	POHOLISUIT	1461030201172902	NUMBER																									
00 . HAT 1421 20 / 10 / 10	DER ARTSMEREN	NONDRUDDRUDDRUDDRU	34532000010406	MANHTER DRIVE																									
- MONTRONING	Allowed Daringson	Second	- Mercentering	SOSCEROIPSE																									
The second second second	Indiate Independent	particular in the	MONTH AND A	MORECEPTER																									
10 Medical Contractor	SPECIEL SPECIEL	PROPERTY OF A	Perspectation	Manager																									
Contraction in the local division of the loc	Contract of the local	and the second se	And and a local division of	And other Designation																									
THE REAL PROPERTY AND	Vialan Lines her	WOMPONT MODIFIER	Landsaland Table	141000000000000																									
27 INCOMENTAL	Statistics and the	Initial Strength	SALIMATING PROF	SALLEND VALUE 202																									
IN INCOMPANY	2012111120001010	Jacomet Statement	and a substanting	JAGONY LINE AL																									
THE REPORT NUMBER	254834123xCharts	-MODULOURNERS	34535502233334	MONITING																									
SE TEMATING	254217115474481	10001423053008	LOUIS CONTRACTOR	MSHICKSM70																									
21 33054613N21048	334536119479488	MOLETS SHOLOWS	340101010932708	MARGINEERS																									
31 140601204214	30404001947NDH	10021753834981	340300031942702	MACHINER																									
B BCOCLANA	SHORE TO A CONTRACT OF A CONTR	BUDM LAKENDOWINE	HEARING	MARCHINE																									
IN REPRESENTED	KHM101H00H02	SUDARDRENOR.	MANAGE MALTON	MMINICART																									
B UNICLICATION	224611111620811	PUTHELITIKE.	345400031421205	MARKED CHEVEL																									
Contraction of the local division of the loc	THE PARTY OF THE P	. noneditrayer	MONTO COUNTY	MICHORITIKE																									
art statilities as	Contraction of the	Statistics and the	14 COLORADO	HIGHLIGHT HIGHLIGHT																									
The Distance in the	Sardia in prise	The Party of the P	And a local division of the local division o	Article Tallant																									
Beel	4 (1-18)																												
dance.																									THE .				122
and the second second																											the second s	100	100
			61 M																								- U et	• 0.2	08/7

Figure 5. Attempt to gather same well measurements over the years.

Due to the lack of data for the years 2010 and 2016, the data was left off the map. Instead the years 1980, 1990, and 2000 were the main focus, which had the best data as far as amount and similar locations for wells. This is shown in Figure 6.



Figure 6. 2010 and 2016 total wells measured.

Kriging			<
nput point features 1980_A		Semivariogram properties	
value field			
lev_va	~	The Semivariogram model	
utput surface raster		to be used. There are two	
\\austin.utexas.edu\disk\@	eoprofiles\default\tjd876\My Documents\ArcGIS\Default.gdb\Kriging_shp4 🛛 📂	Ordinary and Universal	
emivariogram properties		oraniary and oniversal.	
Kriging method:	Ordinary O Universal	Ordinary kriging can use the following semivariogram models:	
Semivariogram model:	Soberical ×		
	Advanced Parameters	 Spherical— Spherical semivariogram 	
utput cell size (optional)		default	
9.03379519999999E-03		Circular— Circular	
earch radius (optional)		semivariogram	ľ
	OK Cancel Environments << Hide Help	Tool Help	
		. contrap	

Figure 7. Kriging tool.

After testing the different interpolation methods, Kriging proved to be the most effective. This tool was used to convert each of the measurements in the form of point features into a surface raster.

~~~~}	Karact by Mask	- 🗆 X
	Input raster Kriging_shp5 Input raster or feature mask data sanjoaquinbasin Utput raster Utput raster Usustin.utexas.edu\disk\geoprofiles\default\tjd876\My Documents\ArcGIS\Default.gdb\Extract_Krig4	Input raster or feature mask data Input mask data defining areas to extract. It can be a raster or feature dataset. When the input mask data is a raster. NoData cells on
	~	the mask will be assigned NoData values on the output raster.
	OK Cancel Environments << Hide Help	Tool Help

Figure 8. Extract by mask tool.

After the raster surface was created, the extent of it was limited to the San Joaquin Basin with the Extract by mask tool. This process is shown in Figure 8.

The next step was to define the intervals to most effectively show the distribution of water depth data. This process is shown in Figure 9.

General Source Key	Metadata Extent Display Symbology Time	Fast 🗸 🗸
Show: Vector Field Unique Values Classified Stretched Discrete Color	Draw raster grouping values into classes       Image: Classification         Fields       Value <value>       Normalization          Classification       Manual       Classes       Z8       Classify</value>	
	Symbol         Range         Label           0.600000024         0           0.600000024 - 15         0 - 15           15 - 30         15 - 30           30 - 45         30 - 45           45 - 60         45 - 60           60 - 75         60 - 75           60 - 75         60 - 75	
About symbology	Show dass breaks using cell values Use hillshade effect Z: 1	• •

Figure 9. Defining intervals for water depth.

This was the process for defining the depth to water level intervals for a certain year. After classes were formed with intervals of 15 feet, the organizing for each of the raster surface properties was done, yielding the end product for the particular year. One of the three end products is shown in Figure 10.



Figure 10. End result of raster surface for water depth.

The next step was to create a raster of the difference between water levels for the years 1980-90 and 1990-2000. This was done with the raster calculator shown in Figure 11.



Figure 11. Raster calculator for different decades.

This was the process was showing the difference between water levels between decades.

The next step was to define the intervals which most effectively showed the actual differences between measurements, and an attempt to limit the influence of the outlying calculations. This step is shown in Figure 12.



Figure 12. Raster interval manipulation.

Figure 12 shows the process of manipulating the intervals of the water level difference between decades. Due to outliers that didn't have close enough data to a measurement for one year, the "difference" between years were inaccurate for some measurements, yielding much bigger rises in water level due to the absence of data for one year having a default value of 0 feet to water level depth. To offset these outliers and focus more on the distribution for realistic comparisons, the intervals were separated into small intervals for the lower values, since these are the most accurate. These small values are the most accurate because it shows the difference for water levels for an area between decades as close to 0, which means that there were close wells nearby for both decade.



After formatting the data, the end product was produced and is shown in Figure 13.

Figure 13. End product for "difference" raster surface.

#### **ArcGIS Processing**

The raster surface data for each of the three years was gathered from the classification of each layer. This data is shown in Figures 14, 15, and 16.



Figure 14. Classification of data for 1980 raster surface.



Figure 15. Classification of data for 1990 raster surface.



Figure 16. Classification of data for 2000 raster surface.

To easily see the differences between the data, Table 1 is shown below.

Year	Mean Water Table Depth (ft)
1980	134.06
1990	114.74
2000	102.87

Table 1. Mean water table depth for 1980, 1990, and 2000.

As shown from Table 1, the depth to the water table has decreased between each of the years. Further confirmation of this data is shown with the difference between decades classification layers, in Figures 17 and 18.





Figure 17. Classification of data for 1980-1990 difference raster surface.



Figure 18. Classification of data for 1990-2000 difference raster surface.

A table comparing values for the two difference in year's data is shown below.

Years	Mean Change of Water Table Depth (ft)
1980-1990	Rise of 23.60
1990-2000	Rise of 11.33

Table 2. Mean water table depth difference between 1980-1990 and 1990-2000.

As Table 2 shows, the water table relative to the surface has been rising from 1980 to 2000.

#### Conclusion

As the data has shown, the depth to the water table has decreased in the years from 1980 to 2000. This does not reflect completely represent the water table fluctuations with time because water levels rise and fall constantly. There was not enough data to get a very accurate assessment of the regional water levels, which resulted in misrepresentations of areas that had no data, and was purely raster interpolation method. Obviously, the best way to represent water levels on the regional scale in the San Joaquin Valley is to get more data. All of the possible data from USGS was gathered for each year shown.

#### References

USGS. "Measuring Land Subsidence" https://ca.water.usgs.gov/land_subsidence/california-subsidence-measuring.html