Analysis of Water Usage and Economic Output in California

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Abstract

In order to understand the factors that would influence decision makers in the allocation of water in the state of California, this study focuses on the relationship between gross domestic product (GDP) and water consumption. This study utilizes water withdrawal, population, and GDP data from the Santa Clara, Sacramento, and Los Angeles counties of California. These three regions were chosen for analysis because they are representative of the Northern, Central, and Southern regions. These three counties exemplify the diversity in population and economy that is characteristic of California and form the issues decision makers have to consider when adopting policies for water allocation. By comparing GDP and water use per capita in these three regions, GDP was found to be inversely proportional to the amount of water withdrawal. Although Sacramento County has the lowest population and GDP of the three counties, it has the highest per capita water withdrawal. While the conclusions from this study suggest that there is a correlation between GDP and water withdrawal, it does not provide a comprehensive understanding of the actual relationship between the two variables. In addition to GDP and water withdrawal data, the study also looks at the breakdown of the economic sectors for each of the three counties to provide a potential explanation for the trends seen in the results of this study.

Introduction

The distribution and demand of water resources varies widely across California, thus it is common to partition the state into the northern, central, and southern regions. Water supply is greatest in the north, and demand is greatest in the heavily populated and drier regions of the south. To ascertain what is best for California from a water management perspective–and to decide on how to apportion water throughout the State–one must develop an effective way to compare these regions in a meaningful way. The two indicators that can be utilized to complete a simple inter-regional analysis are GDP and Water Use Per Capita (WUPC), or in the case of this study, water withdrawal.

Objective

The objective of this project is to quantify, differentiate, and draw correlations between the WUPC and GDP for the northern, central, and southern regions of California. These factors all affect the best allocation of water resources from a state water management perspective. Drawing from the United States Geological Survey (USGS), the WUPC is calculated from water withdrawal rates by county then divided by the population and placed into graphs with best fit lines to be made more conducive to future analysis. GDP is a standard indicator of economic growth and it is assumed that a greater GDP in each region is indicative of a greater benefit to the state as a whole. In order to compare this GDP with WUPC, data from the United States Department of Commerce's Bureau of Economic Analysis is converted into GDP per capita and placed over an axis of years on a scatter plot.

To further facilitate the connection between GDP and WUPC, the breakdown of employment based on economic sectors is displayed for each state. Using data from the State of

California's Employment Development Department (EDD), data about metropolitan statistical areas (MSA) were placed into pie charts so that the employment by sector of each of the three counties could be compared to one another. The overarching product of this project is an analysis of the trends and correlations found between WUPC and GDP within the several graphs and pie charts displayed throughout the report. A thorough discussion of underlying limitations developed in this project will then explain any shortcomings and provide a basis for further discussion, analysis, and research.

Data Sources

For this project, the population and water withdrawal data were drawn from the website of the United States Geological Survey (USGS), http://waterdata.usgs.gov/nwis/. Similarly, the data for gross domestic product (GDP) were taken from the United States Department of Commerce's Bureau of Economic Analysis (BEA) website, http://www.bea.gov/, and the Metropolitan Statistical Area (MSA) data from the State of California's Employment Development Department (EDD), http://www.calmis.ca.gov/.

Methods and Assumption

Population data and water withdrawal data of the three counties were obtained from the USGS for the period of 1985-2005. Assuming that population growth is stable and follows a particular trend, regression analysis was performed on the population data from each county in order to determine the regression equation that best models population growth. The regression equations were then used to project future population until 2020. Using the projected population data and the water withdrawal, we were able to calculate the water withdrawal per capita. In

addition to this, the obtained GDP data was also converted into GDP per capita using the population data in order to standardize the two variables for comparison. Because this project is analyzing the WUPC and GDP under the assumptions above for three very specific counties, there is an inherent assumption that these counties are, in fact, representative of the larger regions in which they are located.

In conjunction with the GDP data, the study also examines the proportion of contribution to GDP from different economic sectors. By incorporating this information with the GDP data, we can begin inferring patterns of regional water consumption based on the predominant type of economic activity, under the assumption that some types of economic activity, e.g. agriculture, are more water consumptive than others, such as government positions. The simplest approach to make these partitions is to utilize representative Metropolitan Statistical Areas (MSA) in and around Santa Clara, Sacramento, and Los Angeles counties. These counties were picked as representative areas for northern, central, and southern California because they are major population centers and, thus, are assumed to house significant economic activity. Conveniently, they are the same cities that were used as representatives for WUPC and GDP per capita, making comparisons easier assuming that the link between WUPC and GDP has some relation to the types of economic activity that are predominant in each region. It is assumed that measuring employment across sectors will sufficient as a way to quantify the types of economic activity in each county.

Results

The various graphs and charts developed in this report are presented on the following pages. A discussion of the results is presented in the conclusions section of this report.

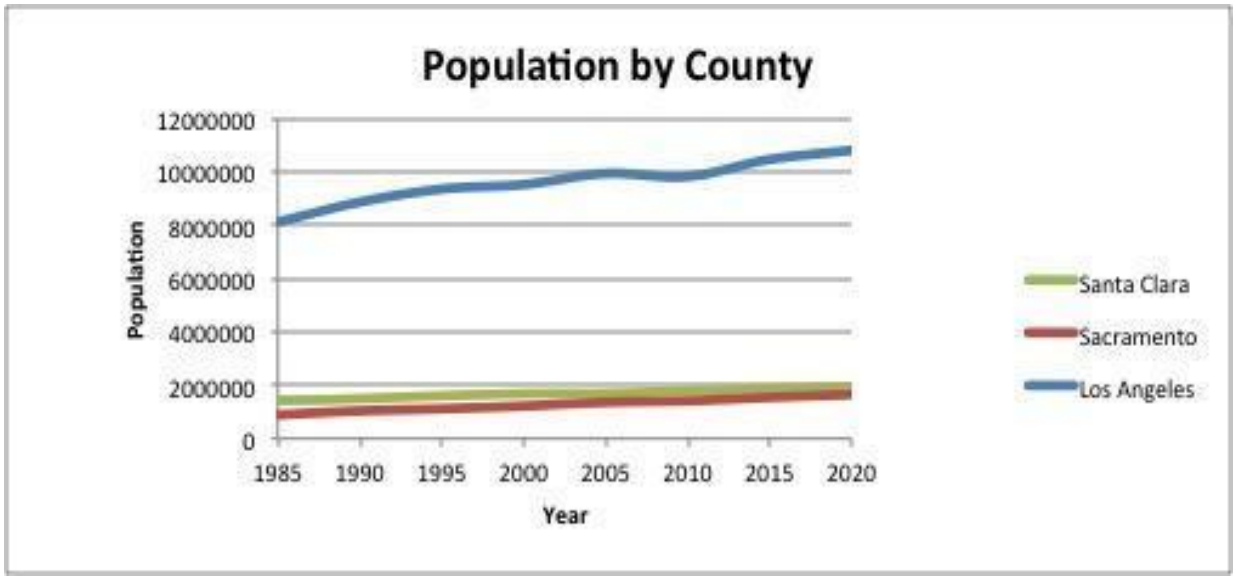

Figure 1: *Smooth lined scatter plot comparing the population of Santa Clara, Sacramento, and Los Angeles counties between 1985-2020. Raw data (from 1985-2005) are from the United States Geological Survey. Estimated data between 2010-2020 calculated using regression analysis.*

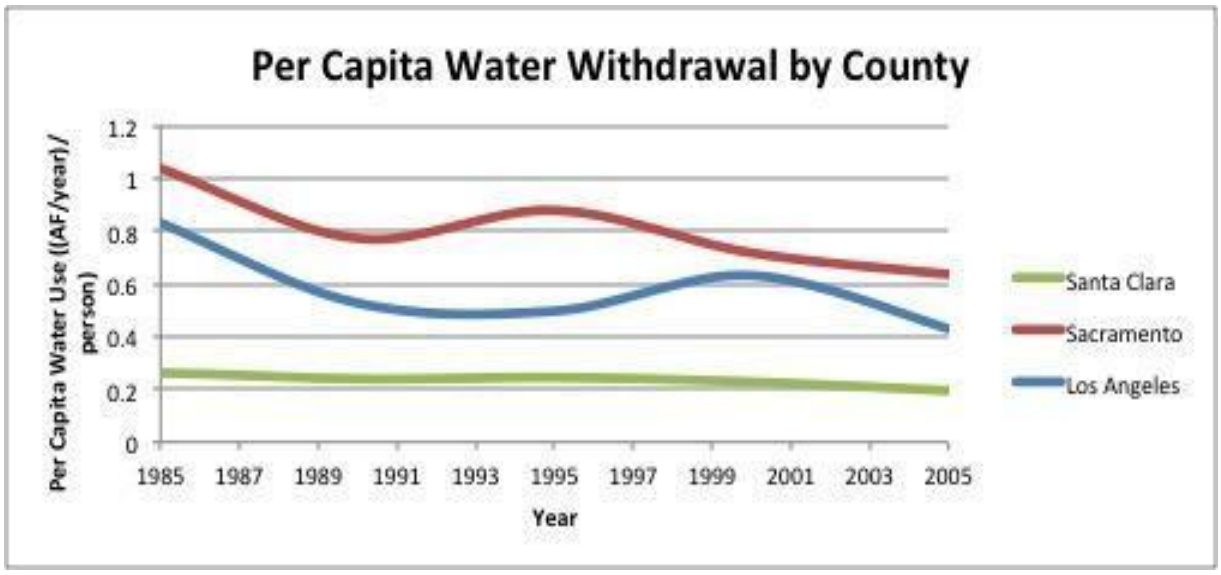

Figure 2: *Smooth lined scatter plot comparing the per capita water withdrawal of Santa Clara, Sacramento, and Los Angeles counties between 1985-2005. Raw data are from the United States Geological Survey.*

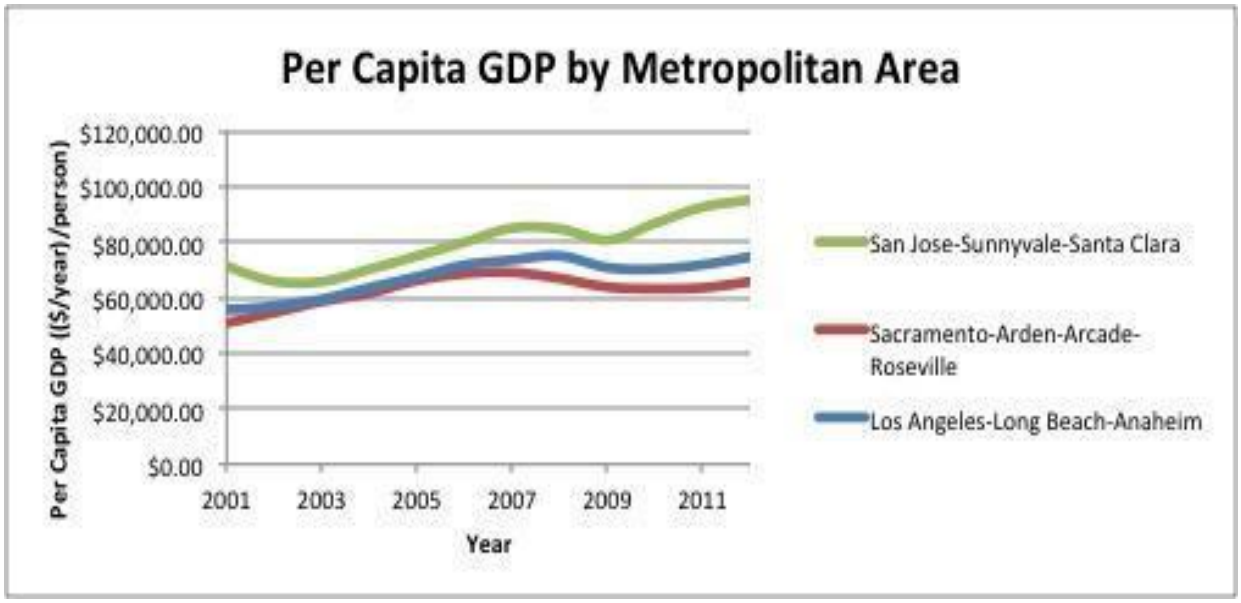

Figure 3*: Smooth lined scatter plot comparing the per capita gross domestic product of San Jose-Sunnyvale-Santa Clara, Sacramento-Arden-Arcade-Roseville, and Los Angeles-Long Beach-Anaheim metropolitan areas between 2001-2012. Data are from the Bureau of Economic Analysis. Per capita data calculated using population data obtained from the USGS.*

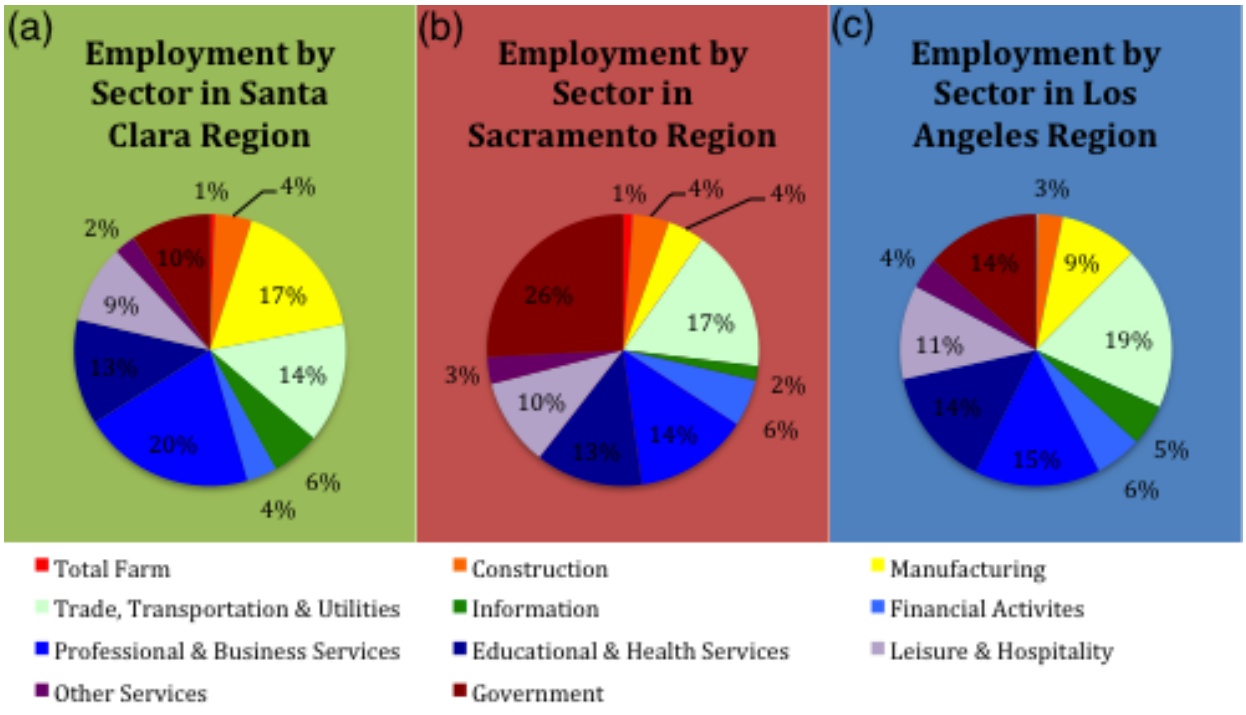

Figure 4 (Previous Page): *Pie charts displaying the percent employment by sector of (a) San Jose-Sunnyvale-Santa Clara, (b) Sacramento-Arden-Arcade-Roseville, and (c) Los Angeles-Long Beach-Anaheim metropolitan areas in September 2013. Data are from the California Employment Development Department.*

Conclusions

As California faces fluctuating levels of precipitation and the drought-triggering effects of climate change, it is imperative that decision makers have clear information to better justify water allocation across different regions of the state. The results obtained from this study can be used to provide information for water management purposes. Since GDP is shown to be inversely proportional to water withdrawal from the data of the three counties, it is possible to make an argument for water conservation if economic output is not hampered by a lower consumption of water. Both Santa Clara and Sacramento County have similar population sizes and fairly similar economies, and yet the GDP of Santa Clara County has increased at a much faster rate despite a significantly lower water withdrawal per capita. Therefore, the State could justify better water conservation practices in Sacramento County. A brief analysis of the breakdown of economic activity by sector is not helpful in explaining the inverse proportionality between GDP and WUPC. Besides a relative larger government sector in Sacramento and manufacturing sector in Los Angeles, employment across the counties is fairly consistent. It could be argued that the presumably office-based government sector does not consume water in the way that water-intensive manufacturing practices could. This muddies understanding the relationship between GDP and WUPC further, however, because Los Angeles clearly has a

lower WUPC than Sacramento does. Overall, the conclusions of this report are not clear cut as the mechanisms behind the inverse relationship between WUPC and GDP are relatively unknown.

Recommendations and Limitations

While the results from this study show that GDP and water use per capita are inversely proportional, there are several factors that limit the validity of the results in applying them on larger scale. Since this study intentionally focuses on urban counties with large economies that are relatively similar, it is difficult to apply any trends to rural, agriculturally-based counties. In addition to this, the GDP of an area can be affected by a multitude of factors that are independent from water consumption. For the purposes of this report, the general use of GDP as an indicator of economic growth is why it is helpful. Breaking down GDP into its constituents of net exports and spending by government, commercial, and public consumers, however, shows that it may not be the best indicator to inform good water management. The lower water rates achieved by Santa Clara and Los Angeles, for instance, could only have been achieved with high capital expenditures by government and commercial sources in water conservation, which would actually serve to increase the GDP. Because of this, any generalization that decreasing WUPC does not negatively affect the economy is flawed.

The scope of this report is severely limited and requires significantly more research in finding appropriate data which will necessitate a more thorough analysis. To best understand the relationship between water use and economic activity, it is necessary to utilize data measuring direct water usages by each economic sector and to quantify public and private spending on water infrastructure. In addition, it would be best to incorporate other parts of California,

particularly rural areas on the Central Coast and in the Central Valley that have high agricultural production.

References

"California Size of Business – Number of Businesses by Employment Size, Industry, and County." *State of California Employment Development Department: Size of Business Data*, <http://www.labormarketinfo.edd.ca.gov/Content.asp?pageid=138> (2003-2012).

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"State Water Data." *United States Geological Survey*, *<http://waterdata.usgs.gov/ca/nwis/wu>* (1985-2005)