Electricity and Water Consumption in Los Angeles

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INTRODUCTION

Who consumes more Electricity and Water? What led to drought and how did measures taken so far help reduce consumption?

This question needs to be addressed since energy is not free even if it occurs naturally. As the most populous state in the U.S. and a major agricultural producer, drought in California can have a severe economic as well as environmental impact. Part of a study investigates consumption of electricity and water by area or zip-code based on integration of energy consumption and water consumption data from utility companies and data.gov.

Drought may be due solely or in combination to weather conditions; economic or political actions; or population and farming. For this project, I have decided to target city of Los Angeles which is second largest city in U.S and largest city in California. My analysis will cover trends, insights related to number of electricity units consumed, number of water units consumed from 2005- 2013. With this analysis I plan to find underlying reasons or causes that led to this problem and how measures taken so far have helped solve this problem.

About dataset

There are 125 areas represented by Zip-code with 8 years of electricity and water units consumed from Year 2005- 2013.

FY 05/06, FY 06/07, FY 07/08, FY 08/09, FY 09/10, FY 10/11, FY 11/12, FY 12/13, Location

SCENARIO

The scenario for this project is aimed at **identifying energy and water consumption patterns and support in evaluation of policies for energy efficiency.** The big question here is which area consumes most units and how is unit related to population of area. I plan to unearth reasons, causes and measures by performing this analysis.

LIST OF QUESTIONS TO BE ADDRESSED

1. Identification of energy consumption patterns and support in evaluation of policies for energy efficiency
2. How did total units consumed for electricity and water varied over the year?
3. What were the reasons behind change in number of units consumed and how did change in government and policies affect it?
4. Which area or county consumes more units of water and electricity and Why?
5. How does population affect number of units consumed?

LITERATURE REVIEW

California has been suffering with water problems since draught in 2011 [5]. While doing this study I have explored all the sources of water in Los Angeles [2] and policies and restrictions that were taken as measures to preserve water [3]. I also explored Energy usage in California and Los Angeles [1] and sources of electricity [6] and energy distribution by county [7] and referred to articles that highlighted problems and consumption[10] in the city of Los Angeles[4] and later used regression (both linear and polynomial) [8] to predict consumption in future. I verified my results with actual consumption [9].

REFERENCES

1. http://www.energy.ca.gov/2013publications/CEC-500-2013-023/CEC-500-2013-023.pdf
2. http://www.environment.ucla.edu/perch/resources/report-card-2015-water.pdf
3. http://www.mercurynews.com/2015/03/17/california-new-mandatory-water-conservation-rules-for-lawns-hotels-restaurants/
4. http://beccconference.org/wp-content/uploads/2013/12/Circella-BECC-Energy-Analysis-Los-Angeles-2013_circella.pdf
5. https://en.wikipedia.org/wiki/Droughts_in_California#2011.E2.80.932016
6. http://www.energyatlas.ucla.edu/analysis/
7. http://ecdms.energy.ca.gov/elecbycounty.aspx
8. https://www.r-bloggers.com/polynomial-regression-techniques/
9. https://www.eia.gov/consumption/residential/reports/2009/state_briefs/pdf/ca.pdf
10. http://articles.latimes.com/2013/mar/29/science/la-sci-sn-ucla-electricity-los-angeles-20130329

Data Analysis

Datasets

1. **Average_monthly_residential_energy_usage_By_zip_code**
2. **Water_Use_Average_By_Zipcode**

The following datasets were obtained from **data.gov**, U.S. government website which contains large number of datasets or information made available to public. The two datasets which I have used for this project come from **City of Los Angeles** (data.lacity.org). The datasets were intended for public access and use and were collected by city of Los Angeles.

Electricity Dataset

Dataset was collected by City of Los Angeles by calculating average units of electricity consumed in each area by Zip code. For example:- every house under Zip code 90210 was measured for number of units it consumed during each year from 2005- 2013 then sum of all houses were added corresponding to that Zip code and year. Number of units consumed by each area will help in knowing which area consumes more units and which area consumes less and help uncover reasons behind any anomalies.

There are 9 columns or features in electricity dataset and 125 rows or examples.

Variables in Dataset

1. **FY 05/06 :-** Average number of Units consumed in kWh for Year 2005-2006
2. **FY 06/07 :-** Average number of Units consumed in kWh for Year 2006-2007
3. **FY 07/08 :-** Average number of Units consumed in kWh for Year 2007-2008
4. **FY 08/09 :-** Average number of Units consumed in kWh for Year 2008-2009
5. **FY 09/10 :-** Average number of Units consumed in kWh for Year 2009-2010
6. **FY 10/11 :-** Average number of Units consumed in kWh for Year 2010-2011
7. **FY 11/12 :-** Average number of Units consumed in kWh for Year 2011-2012
8. **FY 12/13 :-** Average number of Units consumed in kWh for Year 2012-2013
9. **Location :-** Contains Zip-code of every area in Los Angeles along with Latitude and Longitude

Snapshot of Electricity Dataset:-

FY 05/06	FY 06/07	FY 07/08	FY 08/09	FY 09/10	FY 10/11	FY 11/12	FY 12/13	Location
273	280	276	273	275	264	262	265	90058 (34.00184426500044, -118.22112680399971)
399	413	419	413	400	394	390	411	90065 (34.10881395500047, -118.22766603799971)
847	853	858	826	790	763	757	796	91311 (34.25282047300044, -118.5950275619997)

Water Dataset

Dataset was collected by City of Los Angeles by calculating average units of water consumed in each area by Zip code. For example:- every house under Zip code 90210 was measured for average units of water it consumed during every year from 2005- 2013 then sum of all houses were added corresponding to that Zip code and year. Number of units consumed by each area will help in knowing which area consumes more water and which area consumes less and help uncover reasons behind any anomalies and help us dig deeper into water problem and drought in state of California.

There are 9 columns or features in electricity dataset and 125 rows or examples.

Variables in Dataset

1. **FY 05/06 :-** Number of Units consumed in Hundred cubic feet for Year 2005-2006
2. **FY 06/07 :-** Number of Units consumed in Hundred cubic feet for Year 2006-2007
3. **FY 07/08 :-** Number of Units consumed in Hundred cubic feet for Year 2007-2008

4. **FY 08/09 :-** Number of Units consumed in Hundred cubic feet for Year 2008-2009
5. **FY 09/10 :-** Number of Units consumed in Hundred cubic feet for Year 2009-2010
6. **FY 10/11 :-** Number of Units consumed in Hundred cubic feet for Year 2010-2011
7. **FY 11/12 :-** Number of Units consumed in Hundred cubic feet for Year 2011-2012
8. **FY 12/13 :-** Number of Units consumed in Hundred cubic feet for Year 2012-2013
9. **Location :-** Contains Zip-code of every area in Los Angeles along with Latitude and Longitude

Snapshot of Water Dataset:-

FY 05/06	FY 06/07	FY 07/08	FY 08/09	FY 09/10	FY 10/11	FY 11/12	FY 12/13	Location
32	36	34	32	27	26	36	16	91342 (34.30514302800049, -118.43521825999971)
18	19	17	14	13	13	13	12	91309 (34.21867307400049, -118.59758676999968)
62	66	58	65	55	52	44	36	91302 (34.14327419400047, -118.6628270279997)

Number of Units consumed by Area

Electricity and Water consumption in Year 2005-2006

Electricity Consumed in FY 2005-2006 By Area
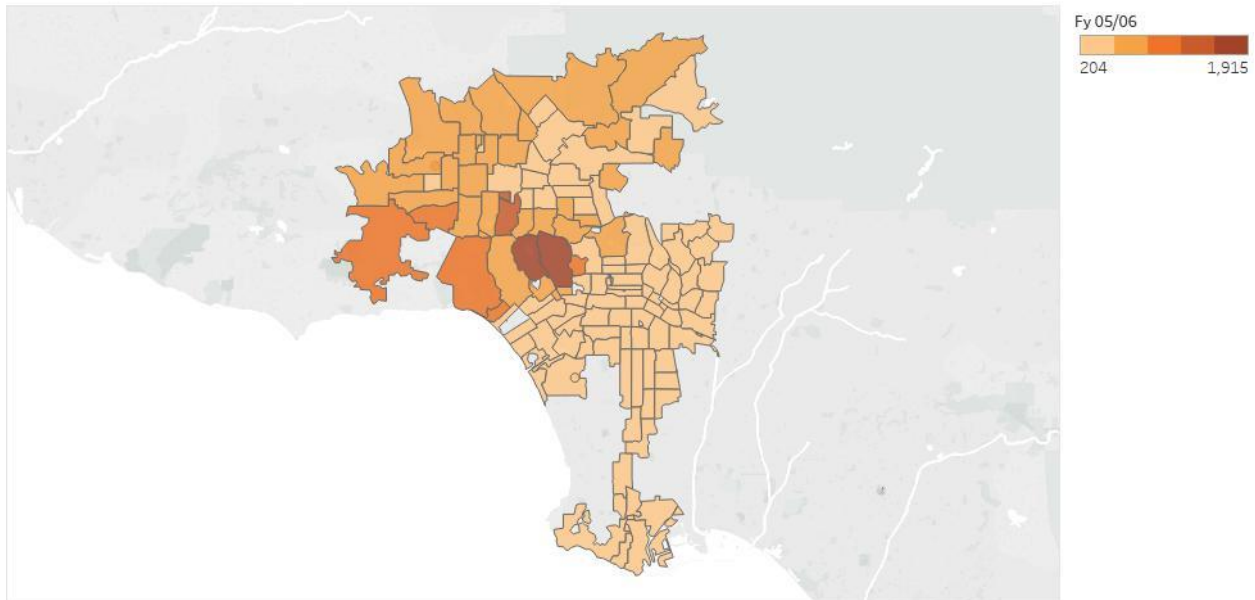
Fy 05/06
204   1,915

Map based on Longitude (generated) and Latitude (generated). Color shows sum of Fy 05/06. Details are shown for Zip code.

As seen from the Heat map, 204 is the least number of electricity units consumed by area and 1915 is the maximum units consumed. Beverly Hills has consumed most number of units whereas Rancho Palos Verdes has consumed least number of units. Interesting thing observed from heat map is that there are areas which may be small in terms of size but consumes a lot of units. Example: Santa Monica, West Hollywood , Encino are very small in terms of size but consume more units compared to Sun valley, Panorama city which are pretty big in terms of area. Another way of comparing units consumed by area would be through population and by calculating number of units per person but it is difficult to acquire accurate population across all the areas in the city for all 8 years plus people often move to new area or new people come in from different state which makes it difficult to get accurate results.
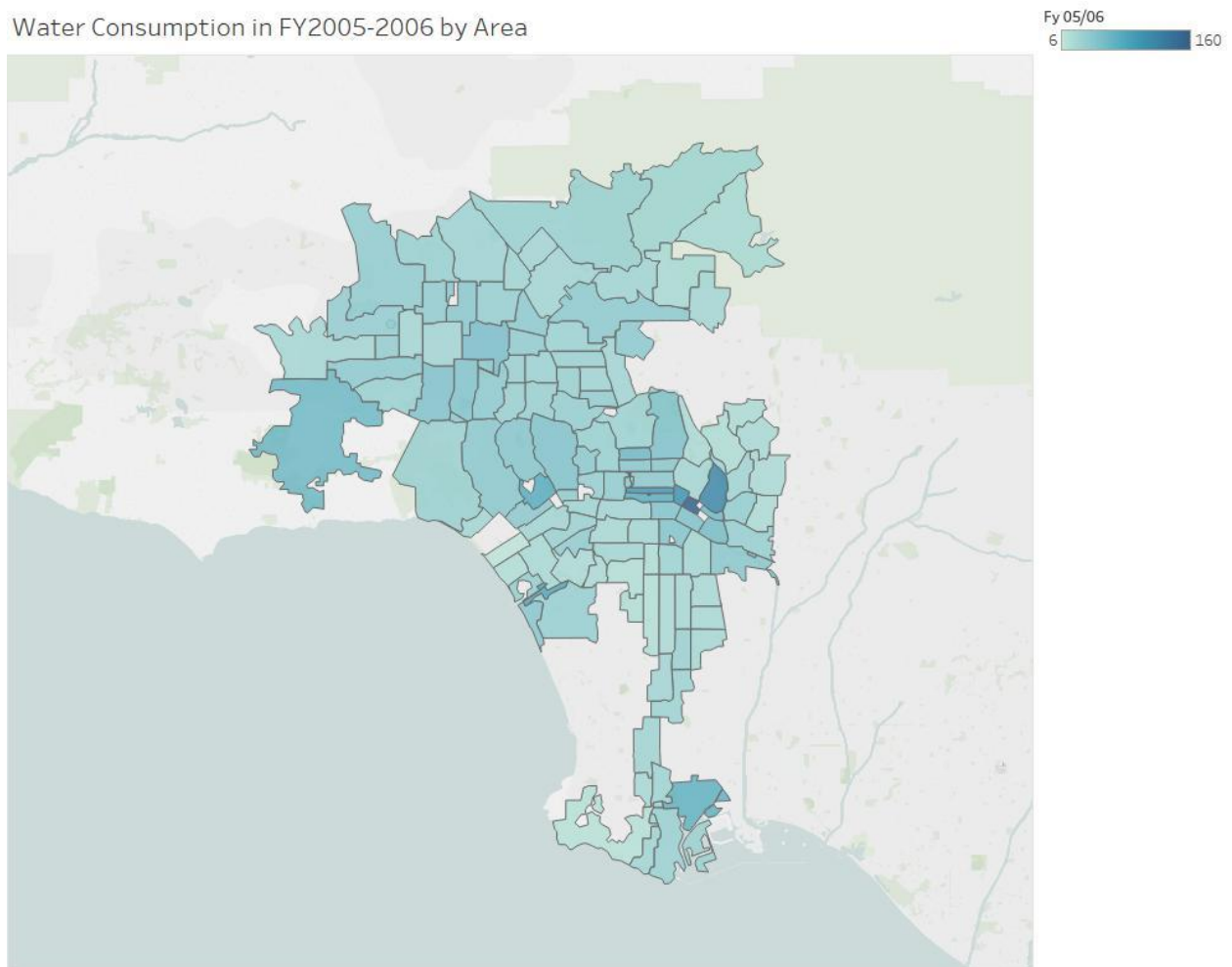

As seen from the Heat map, least number of units consumed is 6 and maximum units consumed is 160. Zip code 90017 which is in South California consumes most units of water even though it is very small in area or size. Santa Monica consumes least units of water even though it consumed more electricity in same year and is larger than 90017. Sylmar, Sunland-Tujunga are pretty big in terms of area but

consume less units whereas smaller areas such as University of California ,LA , Playa Vista consume more water. Again these areas can be compared to one another by bringing population in picture. Another good indicator for water and electricity consumption would be commercial buildings, universities, offices and residential and non-residential buildings which require more water and electricity. University of California would end up consuming more water and electricity when compared with large neighborhoods.

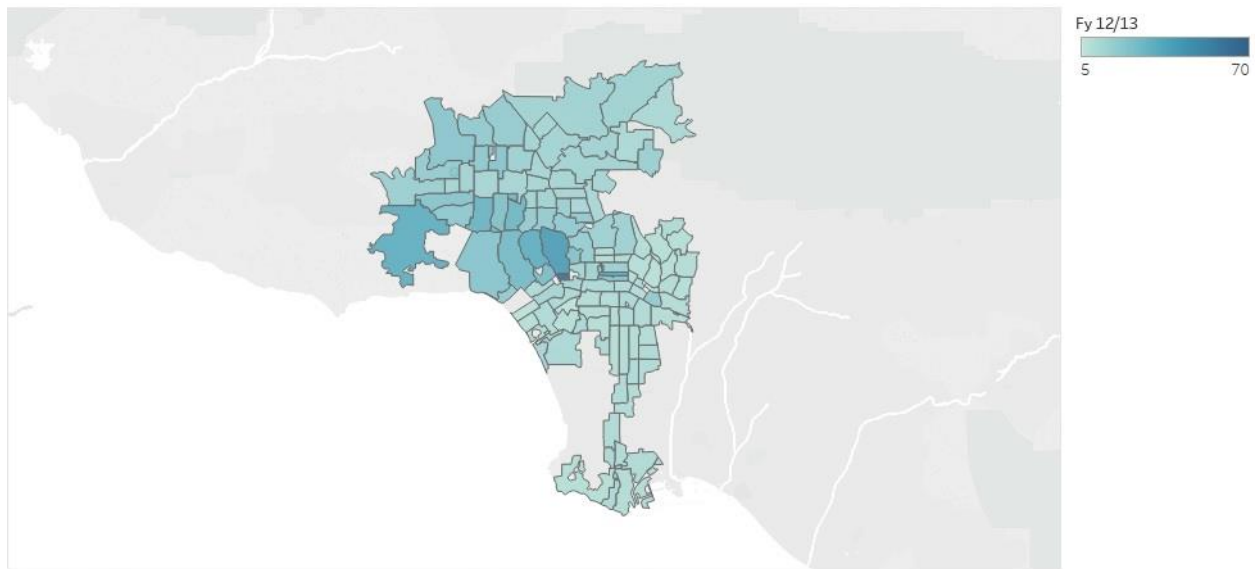**Electricity and Water consumption in Year 2012-2013**

Electricity Consumed in FY 2012-2013 By Area
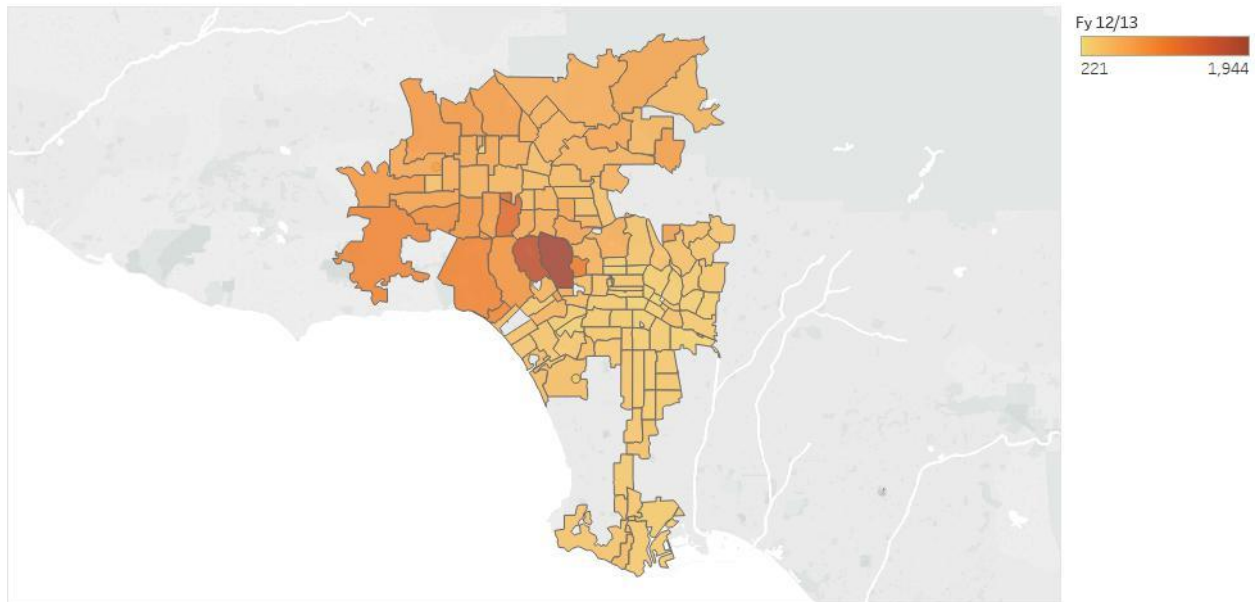
Map based on Longitude (generated) and Latitude (generated). Color shows sum of Fy 12/13. Details are shown for Zip code.

Even though total units consumed in 2012-2013 is less than 2005-2006. Beverly Hills ended up consuming more units than in 2005-2006 which is 1944 and even minimum unit in 2012-2013 is larger than in 2005-2006 around 221 for which Northridge. When compared with 2005-2006, electricity consumption looks more balanced in 2012-2013 with most of the areas close to mean.

Average Water Consumption in FY2012-2013 by Area

Map based on Longitude (generated) and Latitude (generated). Color shows sum of Fy 12/13. Details are shown for Zip code.

There has been a huge turn-around in water consumption, it dropped more than 50% from previous year and more than 60% when compared with 2005-2006. Maximum units of water consumed in 2012-2013 was 70 and minimum being 5. Area which consumed 160 units (90017) in 2005 consumed only 11 units in 2012-2013. Beverly Hills consumed 70 units which is highest in 2012-2013 whereas it consumed 37 in 2005-2006. After drought in 2011, average unit consumption decreased all across LA since

Governor Brown declared emergency and stricter laws related to water. Some of them were irrigation restrictions in cities and increased water prices for farmers. Water consumption is supposed to decrease further by 20% by 2020.

Total Units Consumed Over the Years

Total Units of Electricity Consumed each year

Fy 05/06	62,914
Fy 06/07	64,421
Fy 07/08	65,944
Fy 08/09	65,210
Fy 09/10	62,551
Fy 10/11	61,081
Fy 11/12	61,478
Fy 12/13	63,299

As seen from above, Electricity consumption increased from 2005-2008 but decreased from 2009-2012 and again increased slightly in 2013. Until 2012, California's two nuclear power plants with four reactors provided about one-sixth of the state's total net electricity generation. However, the two reactors at the San Onofre nuclear plant, initially shut down because of equipment problems in 2012, were permanently shut down in mid-2013, cutting the amount of electricity generation from nuclear power in California in half which resulted in increase in number of units in 2013. Electricity consumption was comparatively high during republican years (2005-2008) and dropped in 2009 when democrats took over.

Total Units of Water Consumed each year

Fy 05/06	4,316
Fy 06/07	4,533
Fy 07/08	4,278
Fy 08/09	4,146
Fy 09/10	3,722
Fy 10/11	3,659
Fy 11/12	3,739
Fy 12/13	1,840

Water consumption was really high in 2006-2007 and started decreasing from 2007 and was reduced by more than 50 % in 2013. There are multiple reasons for decrease in water consumption

1. Emergency declared in 2011.
2. Stricter laws related to water like irrigation restriction and higher charges for farmers.
3. Surface water regulated by the state.
4. Percolating groundwater regulated by local/judicial management

Recent laws that were implemented includes:

- Ban all restaurants, bars and hotels from serving water unless customers ask for it.
- Require all hotels and motels to provide signs in rooms telling guests that they have the option of choosing not to have towels and linens washed daily.
- Ban Californians from watering lawns and landscaping with potable water within 48 hours after measurable rainfall.
- Require cities, counties, water districts and private companies to limit lawn watering to two days a week if they aren't already limiting lawn and landscape watering to a certain number of days a week. The rule applies to all 411 water providers with more than 3,000 customers in California, covering more than 95 percent of the state's population

Outliers

Outliers in 2005-2006 for Electricity Consumption

Zip code	Units of Electricity Consumed in kWh
West Hollywood (90069)	1026
Bel Air (90077)	1674
Beverly Hills (90210)	1915
Encino (91436)	1318
Pacific Palisades(90272)	980

Outliers in 2012-2013 for Electricity Consumption

Zip code	Units of Electricity Consumed in kWh
West Hollywood (90069)	1102
Bel Air (90077)	1678
Beverly Hills (90210)	1944
Encino (91436)	1279
Pacific Palisades (90272)	1002

All the 5 areas mentioned above consume most units of electricity and have been constant over the years. Beverly Hills consume most units of electricity because lot of celebrities live there and have huge houses or mansions which require more units.

Outliers in 2005-2006 for Water Consumption

Zip code	Units of Water Consumed in CCF
Koreatown (90010)	138
Chinatown (90012)	117
Financial District (90017)	160
Central LA (90020)	98
Mac Arthur Park (90057)	102

Outliers in 2012-2013 for Water Consumption

Zip code	Units of Water Consumed in CCF
Central LA (90020)	37
Bel Air (90077)	36
Beverly Hills (90210)	45
Beverly Hills (90212)	70
Calabasas (91302)	36

There is drastic change in number of units consumed by outliers in both years. Highest units consumed by outliers was 160 in 2005-06 but it was only 70 in 2012-13. Moreover , areas that consumed most units are not same over the years.

Predicting Future Electricity Unit Consumption using Regression

Total Units Consumed Every Year in Los Angeles
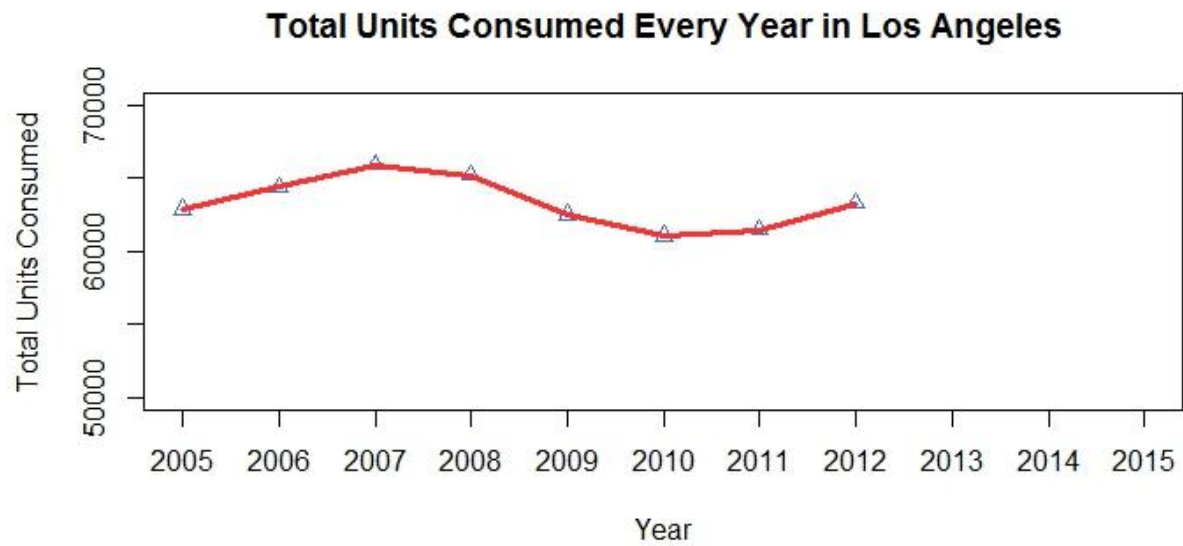
Data points follow curve which is non-linear and total units consumed decreases after 2007 till 2010 and starts increasing again from 2011. As per regression curve it is supposed to increase again in 2013 and 2014 and then again decrease from 2015 onwards.

Total Units of Water Consumed Every Year in Los Angeles
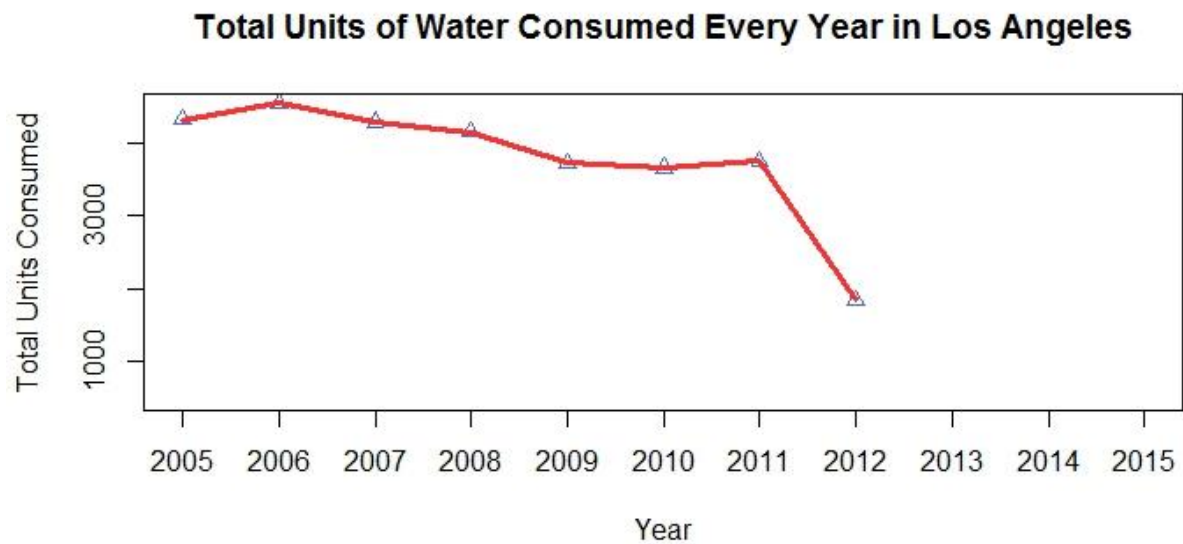
Water consumption started decreasing slowly from 2007 but steep fall came in year 2012 after drought, restrictions and policy changes mentioned earlier which reduced consumption more than half. Looking at the trend, consumption should decrease further in coming years.

Results

1. After Implementing Linear Regression, I observed that data doesn't follow linear trend and doesn't predict accurate values hence polynomial function works better for both electricity and water data.
2. Area that consumes more energy need not necessarily consume more water also.
3. Regression fails when there are restrictions or policy changes imposed by government as seen in case of water which dropped more than 50 % in year.

Note: - I have made all the changes that were suggested during Initial draft and data analysis. Mostly grammatical mistakes.

Conclusion

Even though with data analysis we got basic idea of distribution of units across different areas but we can still dig deeper by including more attributes to this data set like who consumes more units Residential or Non-residential? What impact do commercial buildings like markets, malls, sport complex have on consumption of energy and water. How does population or demographic effect consumption? How elections affect consumption?