Development of an Interactive Web Map for Visualizing Long Beach Water Department Data

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Introduction

Water use data and water rebate data is important for conservation efforts. Local government agencies like the Long Beach Water Department can benefit from improved methods of interacting with this data to better market rebate programs to customers and identify high water users. Through the use of geospatial and web-based technologies, government agencies can produce locally hosted web maps to better process water and rebate data. This project is a proof of concept for the process of agencies hosting and interacting with geospatial data.

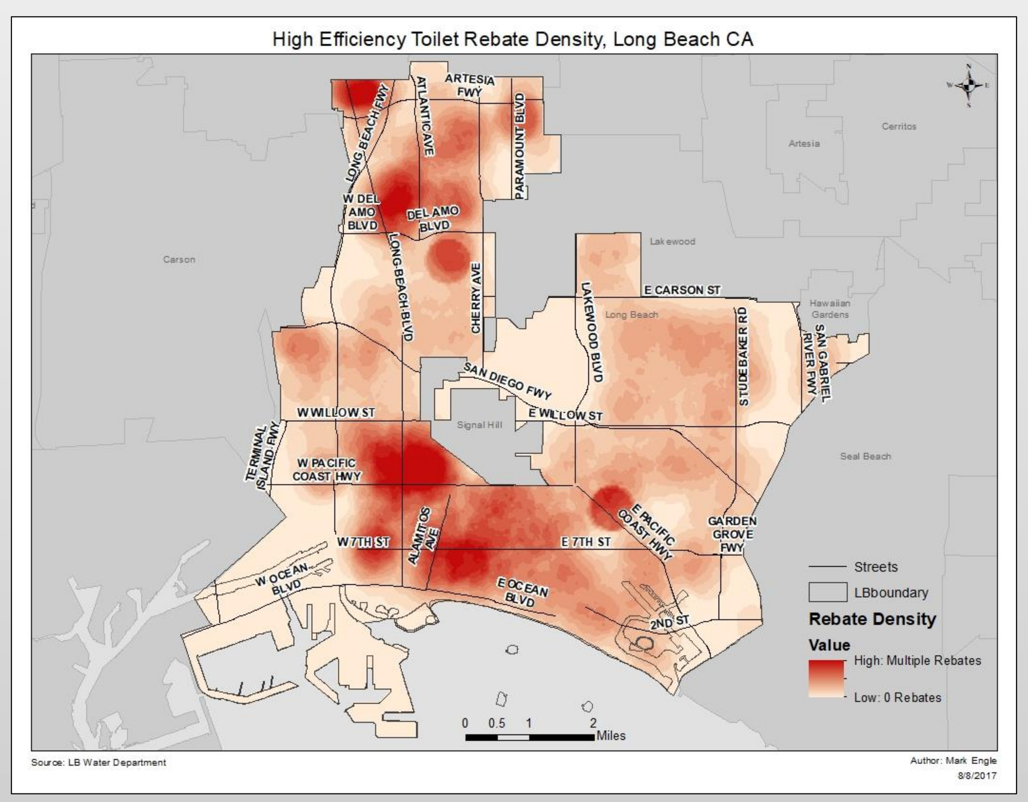

Figure 1. *High Efficiency Toilet Rebate Density Map, shows a spatial analysis of the locations of issued water rebates.*

Data and Data Sources

The data used to produce the spatial analysis and the data presented as the focus of the web map were both provided by the Long Beach Water Department. This included water rebate data and water service data. Both data sets had to have information redacted from them for use in this project. The LA GIS Portal provided the LA County CAMS data for use in geocoding location for tabular rebate and water service data. The US Census Bureau provided US census data that included a census block polygon shapefile and accompanying income data for census blocks in Long Beach, CA.

Table 1. *List of data and data sources used in the project*

Dataset	Source
Rebate Data	Long Beach Water Department
Water Service Data	Long Beach Water Department
LA County CAMS	LA County GIS Portal
US Census Data	US Census Bureau
US Census Block Groups	US Census Bureau

Methodology

To carry out the rebate density analysis, it was necessary to geocode address points from the water service and rebate data layers using the LA County CAMS address locator. I then developed a Python script that was used to segment the rebate data by rebate type. The same script ran a point density analysis on each rebate type producing maps similar to the High Efficiency Toilet Rebate Density Map (Figure 1). This process was also used to segment the rebate data by year to produce a time-lapse map video in Windows Movie Maker.

I next set my personal laptop up as a local testing server by installing Server JRE Java, Apache Tomcat, and GeoServer. This local server was designed to emulate a locally configured server common in government agencies that does not connect to the internet but is accessible on the local network.

Once the data was acquired and processed to remove sensitive information, two shapefiles containing the median income by census block and combined water service and water rebate data were hosted on GeoServer in the locally configured server.

A web map was created that incorporated these GeoServer WMS services. OpenLayers was used to create the map, functions within the map, and access the WMS services. Functions included allowing the user to zoom in and out, clicking to see information, viewing mouse coordinates, and panning and moving within the map.

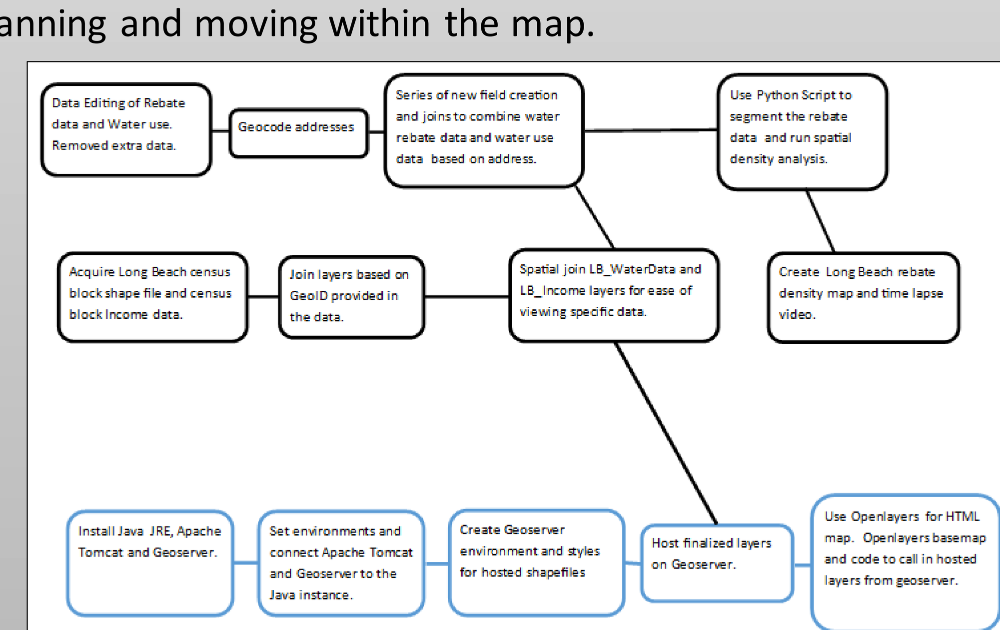

Figure 2. *Methods Flow Chart.*

Timeline

Proposed Time line	Project Time Line
Data Editing & Cleanup – 5/19/2017 New water use data must be integrated into the water rebate data and demographic data must be related to the rebate data. I will need to create some new layers for the eventual data export function.	**Data Editing and Income data– 5/19/2017** New water use data must be integrated into the water rebate data and income data must be produced for census blocks.
Complete heat map Analysis and demographic analysis by neighborhood – 5/26/2017 As the heat maps are complete this step will be finishing any extra analysis I will need to display and decide on how to best display the data.	**Complete heat map Analysis and Time lapse – 5/26/2017** As the heat maps are complete this step will be finishing any extra analysis I will need to display and producing the time-lapse movie.
Python export codes – 6/2/2017 The export to csv code for the web map will need to export address, water use and rebate data into a csv file.	**Java Server, Tomcat Apache and Geoserver setup – 6/2/2017** To host my own data for the webmap I will need to set up the server structure and prepare it for use.
Hosting relevant layers as services – 6/9/2017 Finalize layers to post to ArcGIS online for use in Web map.	**Hosting relevant layers as services – 6/16/2017** Finalize layers to post to Geoserver for use in Web map.
Web Map development 6/16/2017 Develop Web map design and load layer services and code. Finalize map layout and elements.	**Web Map development 7/15/2017** Develop Web map design and code. Finalize map layout and elements.

Figure 3. *Proposed Time Line and Actual Time Line*

Results

This applied research project has produced five products. These include a Long Beach High Efficiency Toilet Rebate Density Map (Figure 1), a time lapse video depicting the change in high efficiency toilet rebate issuance from 2008 to 2017, a Python script for automating point density analysis (Figure 4), a locally configured GIS/web server (Figure 5), and a Water Data Web Map (Figure 6).

```
import arcpy

arcpy.env.workspace = "F:/Geog_605/PROJECT/605PROJECT.gdb"
arcpy.CheckOutExtension("Spatial")


alist = ['%HET%','WBIC%']
alist2 = ['HET','WBIC']
slist = ['ZWU','HECW','Rain Barrel','Flow Regulator','Flow Restrictor','Cooling Tower','Synthetic Turf','Plumbing Flow Control',
         'Rotating Nozzle','RES Cistern','Ice-Making Machine','Soil Moisture Sensor System','ULWU']
slist2 = ['ZWU','HECW','RBARREL','FREG','FRES','CTOWER','STURF','PFCON','RNOZZ','RES_CIS','ICEM','SOILMSS','ULWU','WBIC']

def Tool(CRD):

    for a,b in zip(alist,alist2):
        arcpy.Select_analysis(CRD,"REBATEDATA_" + b, "MEASURE LIKE '" + a +"'")

    for c,d in zip(slist,slist2):
        arcpy.Select_analysis(CRD,"REBATEDATA_" + d,"MEASURE = '" + c +"'")

    density = arcpy.ListFeatureClasses("R*", "Point")
    flist = list(density)


    for f in flist:
        arcpy.gp.PointDensity_sa(f, "NONE", "PointDe" + f[11:], "222.197430932343", "Circle 1851.64525776952 MAP", "SQUARE_MAP_UNITS")


if __name__ == '__main__':

    CRD = arcpy.GetParameterAsText(0)

    Tool(CRD)
    print "Finished"
```

Figure 4. Point Density Python Code, segments the rebate data and runs a point density analysis on each rebate type. This code was altered to segment rebates by year and run the point density analysis to create the images for the time lapse video.

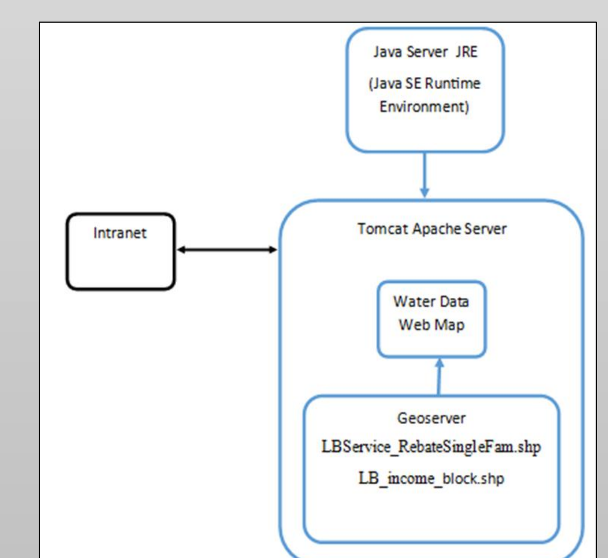

Figure 5. *This figure depicts the locally configured GIS/Web server structure. This set up is designed to only allow users on the local network to access the interactive web map.*

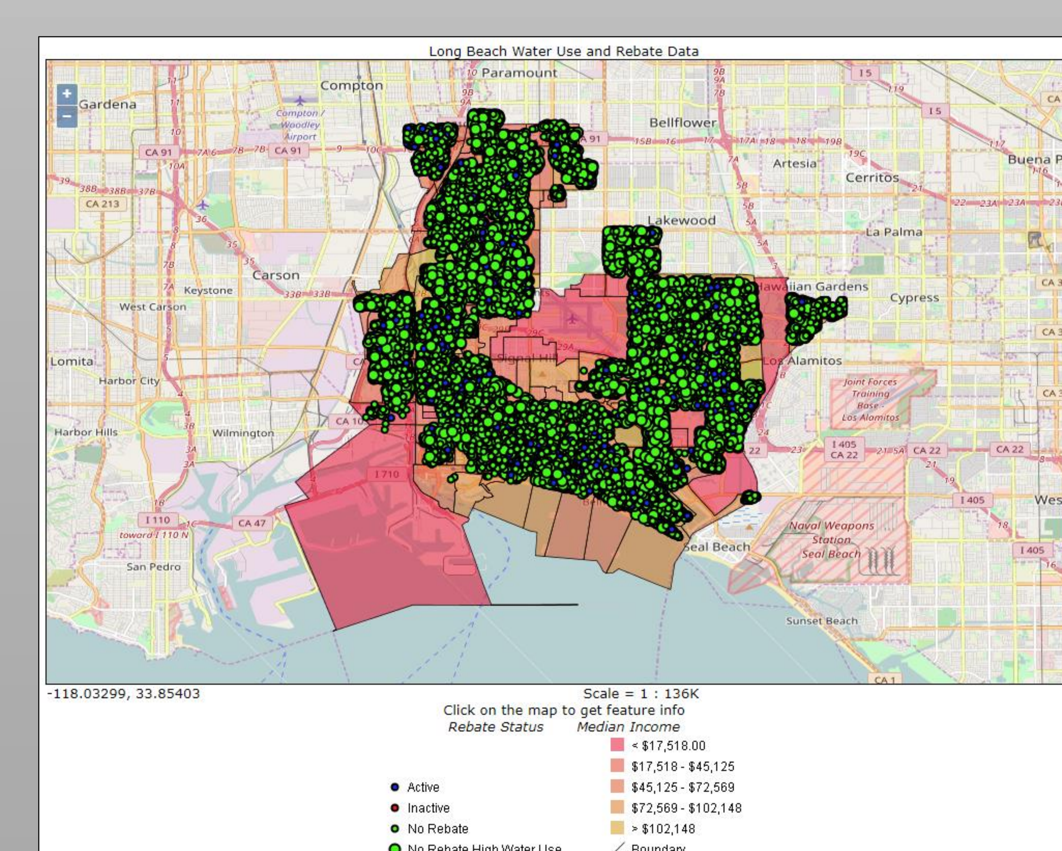

Figure 6. This screenshot of the *Water Data Web Map, shows the view upon opening the web map. The map includes symbology information for rebate status, water use and median income by census block in the legend. This web map also contains a zoom function, an on-click information pop-up, and a latitude and longitude coordinate mouse display.*

Discussion

The methods of this project can be separated into two branches of work. The methods that created the point density analysis of the rebate types and time lapse video of the rebates produced a very vague product because each point had location data but did not have a Z value. Normally, a Z value would be an additional statistic associated with the data but in this case, the location was the only useful data for the point density spatial analysis.

The Water Data Web Map is a working web map but I do not believe it would be ready for use by the target audience, which in this case is employees at the Long Beach Water Department. Due to time constraints, additional functions could not be implemented. Without functions to make the web map more user friendly, I do not believe it would be accepted or used by employees that are not trained and used to using GIS software.

This project utilizes open source and proprietary software programs. The advantage of using open source programs were reduction of costs as these programs are available free of charge. If this project did not utilize ArcMap and instead used QGIS, there would have been zero cost. Since this project was a proof of concept , the cost of using only Esri products would have been unacceptable and would have limited the scope of the project.

Conclusion

In summary, the spatial analysis map did not identify any definitive trends in rebate location. The data was skewed by heavy points and the number of rebates was so low and spread out over the time frame of nine years, that any area that had apartment buildings in it became the highest density area of the analysis.

To expand on this project in the future, I would add more functionality to the Water Data Web Map. I would like to add a select feature tool so that a user could select the data points that they want to contact, an export to Excel function so that the selected features could be exported in an Excel format for use in contacting high water users who would benefit from a rebate, an address locator function that would also be useful for navigating to sections of the city, and an on-click popup that opens in the map as opposed to the current method of a table opening under the map for viewing the data.

If I were to complete this project again, I would filter the data to solely run the spatial analysis for single family dwellings instead of including multi-home or apartment buildings. This adjustment would improve the spatial analysis component of the project.

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