LA County Fuel Stations Analysis Tool

Zedong Li, Kelly Chung, Wanqing Dong, Jared Tadayon

Objective

- **Problem / Current Situation:**
    - Strict emission policy
    - Pressure of high gas prices in LA
    - Revolution of electric cars
  → *Demand for more alternative fuel stations*

- **The Main Objective: Do alternative fuel stations meet public demand or do traditional fuel stations continue to dominate the market?**

    - **Method:** Compare the difference between traditional fossil gas stations and alternative fuel stations using four specific questions:
        1) What is the difference between the coverage of traditional gas stations and alternative fuel stations
        2) Is there a high availability of alternative fuel stations in areas where car ownership is high?
        3) Which type of fuel station is more convenient (closest) to different facilities?
        4) How does the income factor affect traditional gas stations and alternative fuel stations

- **Purpose of developing the tool (functions): Utilize the existing dataset to calculate and produce some relative statistics and maps that help us analyze and find solutions for the specific questions and improve the coverage of certain fuel stations in LA County**

1) Comparison and Overview (in LA County): **What is the total coverage of fuel stations? What is the difference between the coverage of traditional gas stations and alternative fuel stations? How is the distribution of these two kinds of stations look like?**

LabData Inputs: Alternative Stations, Traditional Stations, LA County (Shapefiles)

Expected Results: The total percentage of Covered Area (Alternative Stations or Traditional Gas Stations), The total percentage of Covered Area (Alternative Stations and Traditional Gas Stations), The difference of the coverage between Alternative Fuel Stations and Traditional Fuel Stations
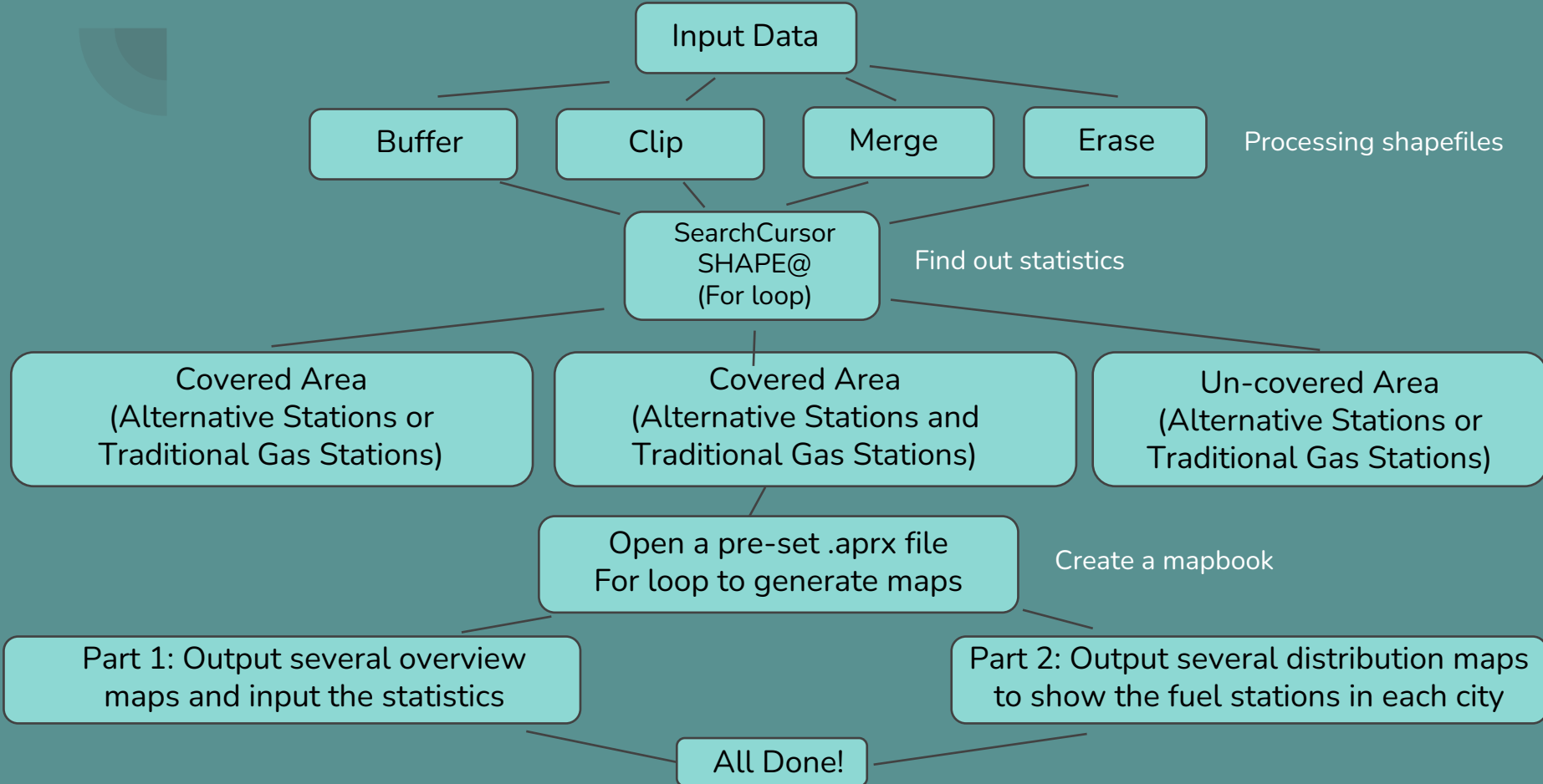
Note -

(Alternative Stations or Traditional Gas Stations): Union Set - the buffer area includes any kind of gas stations (Alternative Fuel Stations and Traditional Fuel Stations)

(Alternative Stations and Traditional Gas Stations): Intersection Set - the buffer area must includes all kinds of gas stations in the same time (Alternative Fuel Stations and Traditional Fuel Stations)
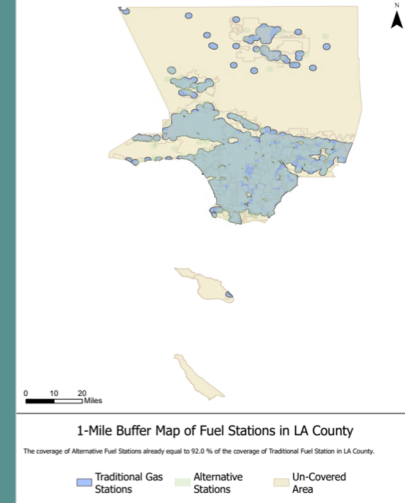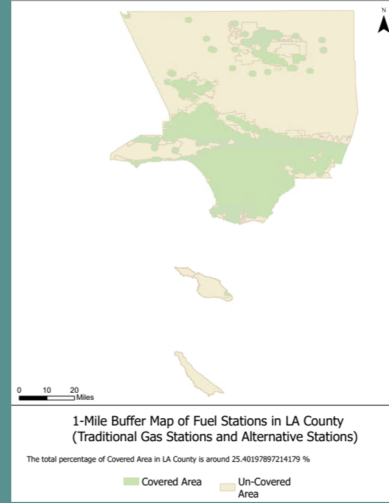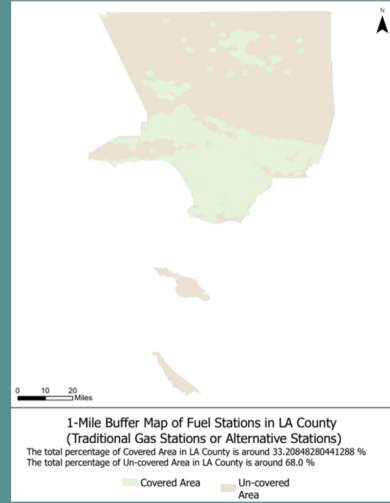
Outputs: A Mapbook includes buffer maps, statistics, and distribution maps (LA county extent and City extent)

Method: Using ArcPy to generate the maps and statistics

Input Data

Buffer   Clip   Merge   Erase   Processing shapefiles

SearchCursor
SHAPE@
(For loop)   Find out statistics

Covered Area
(Alternative Stations or
Traditional Gas Stations)

Covered Area
(Alternative Stations and
Traditional Gas Stations)

Un-covered Area
(Alternative Stations or
Traditional Gas Stations)

Open a pre-set .aprx file
For loop to generate maps   Create a mapbook

Part 1: Output several overview
maps and input the statistics

Part 2: Output several distribution maps
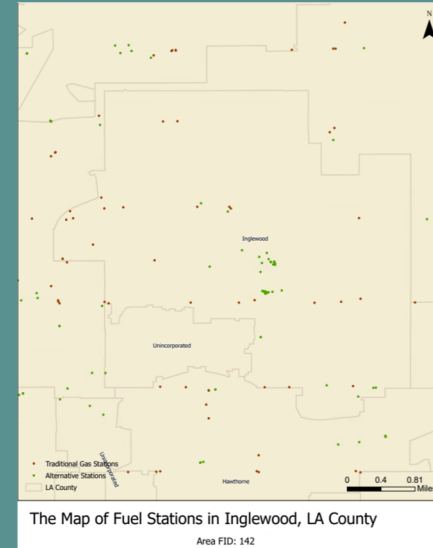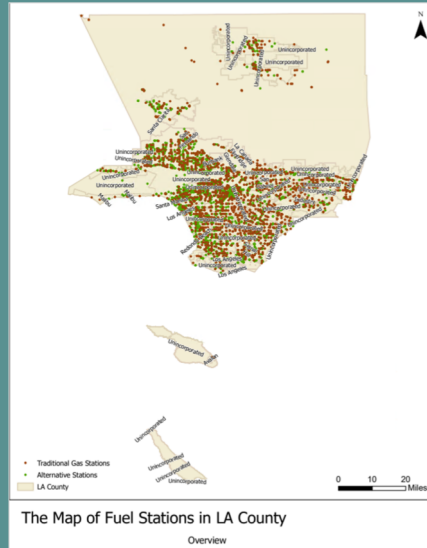to show the fuel stations in each city

All Done!

Results

Here are the buffer maps showing in the LA County extent to show the statistics (the total coverage of fuel stations and the difference of coverage between traditional stations and alternative stations)

1-Mile Buffer Map of Fuel Stations in LA County
(Traditional Gas Stations or Alternative Stations)
The total percentage of Covered Area in LA County is around 33.20848280441288 %
The total percentage of Un-covered Area in LA County is around 68.0 %
Covered Area   Un-covered Area

1-Mile Buffer Map of Fuel Stations in LA County
(Traditional Gas Stations and Alternative Stations)
The total percentage of Covered Area in LA County is around 25.4019789721419 %
Covered Area   Un-Covered Area

1-Mile Buffer Map of Fuel Stations in LA County
The coverage of Alternative Fuel Stations already equal to 92.0 % of the coverage of Traditional Fuel Station in LA County.
Traditional Gas Stations   Alternative Stations   Un-Covered Area

Here are the distribution maps showing in the LA County extent and City extent to show the station points (the distribution of traditional stations and alternative stations)

Traditional Gas Stations
Alternative Stations
LA County

The Map of Fuel Stations in LA County
Overview

Traditional Gas Stations
Alternative Stations
LA County

The Map of Fuel Stations in Inglewood, LA County
Area FID: 142

Results

What is the total coverage of fuel stations?

The total percentage of Covered Area (Alternative Stations or Traditional Gas Stations) in LA County is around 33.20848280441288 %
The total percentage of Covered Area (Alternative Stations and Traditional Gas Stations) in LA County is around 25.40197897214179 %

What is the difference between the coverage of traditional gas stations and alternative fuel stations?

The coverage of Alternative Fuel Stations already equal to 92.0 % of the coverage of Traditional Fuel Station in LA County

How is the distribution of these two kinds of stations look like?

We could see the distribution maps showing in mapbooks. The distribution of traditional stations is more scatter, however, the distribution of alternative stations is concentrated and limited in the metropolitan area.
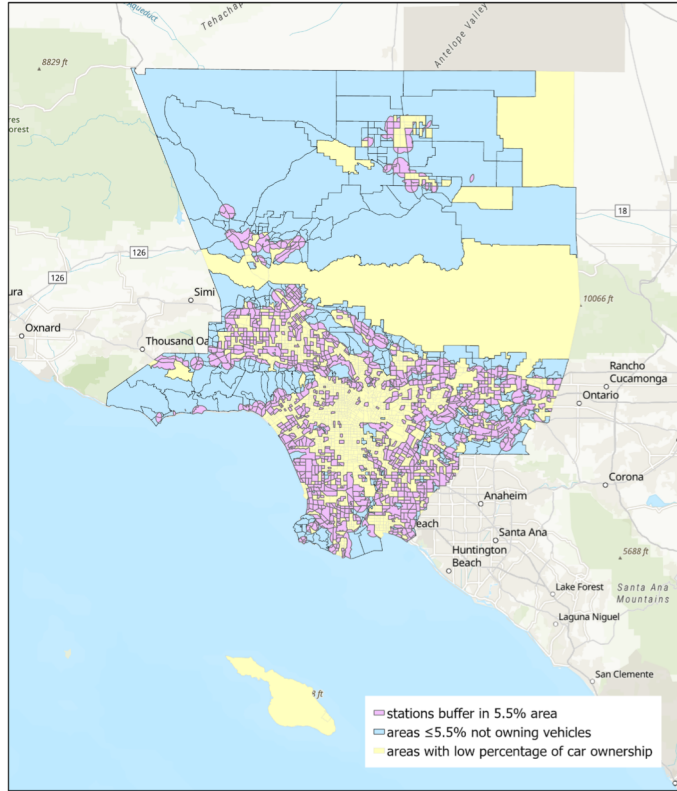
2) Conveniency: Is there a high availability of alternative and traditional stations in areas where car ownership is high?

LabData: Alternative Stations, Traditional Stations, Without Vehicles → High Percentage of Vehicles Ownership, vehicle_coverage.txt

Method:

1) Buffer (1 mile): Traditional and Alternative
2) Clip: **a)** trad_buffer to car_ownership **b)** alt_buffer to car_ownership **c)**alt and trad → combined one to car_ownership
3) SearchCursor to find area for: **a)** traditional **b)** alternative **c)** traditional and alternative **d)**LA areas with high car ownership
4) Store those area values into the lists
5) Mathematical calculation (ex: alternative_area/ ownership_area)
6) Write the results into the vehicle_coverage.txt and move it to the output folder

Is there a high availability of alternative and traditional stations in areas where car ownership is high?

Legend:
- stations buffer in 5.5% area
- areas ≤5.5% not owning vehicles
- areas with low percentage of car ownership

0 4.25 8.5   17 Miles
Map Scale 1:850,000

Output:

vehicle_coverage1 - Notepad

File Edit Format View Help

coverage for alternative stations is 71.86%
coverage for traditional stations is 93.92%
the percent coverage for traditional and alternative is: 62.32%

3) Which Type of Fuel Station is More Convenient (Closest) to Different Facilities?

Input Data: Alternative Stations, Traditional Stations, School Locations, Hospital Locations, Mall Locations

Method:

1) Create SearchCursors for stations and amenities to get their coordinates ("SHAPE@XY")
2) Calculate the shortest Euclidean distance of alternative and traditional stations to each amenity (for-loop)
3) Store those shortest distances to the amenity's shapefiles' distance fields
4) Compare the shortest distance of alternative and traditional stations to each amenity (Is alternative station or traditional station closer to this amenity? SearchCursor)
5) Add up to get the total number of amenities with the closest type of fuel stations (for-loop)

Output:

For schools:

```
Wait for about 30 minutes to get the closest alternative station distance.
Done with alternative stations.
Wait for about 15 minutes to get the closest traditional station distance.
Done with traditional stations.
For 1321 schools, traditional fuel stations are closer
For 879 schools, alternative fuel stations are closer
```

For hospitals:

```
Wait for about 5 minutes to get the closest alternative station distance.
Done with alternative stations.
Wait for about 5 minutes to get the closest traditional station distance.
Done with traditional stations.
For 51 hospitals, traditional fuel stations are closer
For 114 hospitals, alternative fuel stations are closer
```

For shopping malls:

```
Wait for about 5 minutes to get the closest alternative station distance.
Done with alternative stations.
Wait for about 5 minutes to get the closest traditional station distance.
Done with traditional stations.
For 172 malls, traditional fuel stations are closer
For 176 malls, alternative fuel stations are closer
```

4) How does the income factor affect traditional gas stations and alternative fuel stations?

Input Data: Traditional Stations, Alternative Stations, Census Tracts for LA County

1) **Copy** the Census shapefile
2) **Statistical Analysis** on the Census copy to find the median household income for each city
3) **Join** the outputted Statistical Analysis ("MEDIUM_Med") to the Census Copy
4) **Dissolve** the Census tracts to make distinct Cities
5) **Join** fields of the Census Copy to Cities
6) **Copy** the Cities shapefile (to use for #8)
7) **Spatial Join** Traditional Stations to Cities (Join_Count)
8) **Spatial Join** Alternative Stations to the copy of Cities (Join_Count)
9) **Sort** Cities_Traditional_Stations by income descending
10) **Sort** Cities_Alternative_Stations by income descending
11) **Select** Top 10 Income Cities for Traditional Stations
12) **Select** Bottom 10 Income Cities for Traditional Stations
13) **Select** Top 10 Income Cities for Alternative Stations
14) **Select** Bottom 10 Income Cities for Alternative Stations
15) **SearchCursor** to relay three columns for each select: City Name, Median Household Income, and Join_Count

4) Output

Traditional Stations
Alternative Stations

Top 10 Household Income Cities and the number of Traditional Stations

Los Angeles - Mandeville Canyon, $250001.0, 0 Stations
City of Rolling Hills, $250000.0, 0 Stations
Los Angeles - Palisades Highlands, $225547.5, 0 Stations
Los Angeles - Bel Air, $211736.5, 2 Stations
City of Palos Verdes Estates, $204179.0, 1 Stations
City of Rolling Hills Estates, $194236.0, 0 Stations
Los Angeles - Beverly Crest, $190508.0, 0 Stations
Los Angeles - Pacific Palisades, $182042.0, 7 Stations
City of San Marino, $175294.0, 2 Stations
City of Manhattan Beach, $170694.0, 5 Stations

Bottom 10 Household Income Cities and the number of Traditional Stations

Unincorporated - Athens-Westmont, $37443.0, 5 Stations
Los Angeles - Vermont Vista, $37157.0, 4 Stations
Los Angeles - Victoria Park, $36618.5, 0 Stations
Los Angeles - Pico-Union, $35733.0, 7 Stations
Los Angeles - Westlake, $35313.0, 1 Stations
Los Angeles - Baldwin Hills, $33944.0, 3 Stations
Los Angeles - Chinatown, $33487.0, 2 Stations
Los Angeles - Watts, $32366.0, 0 Stations
Los Angeles - Little Tokyo, $25565.0, 0 Stations
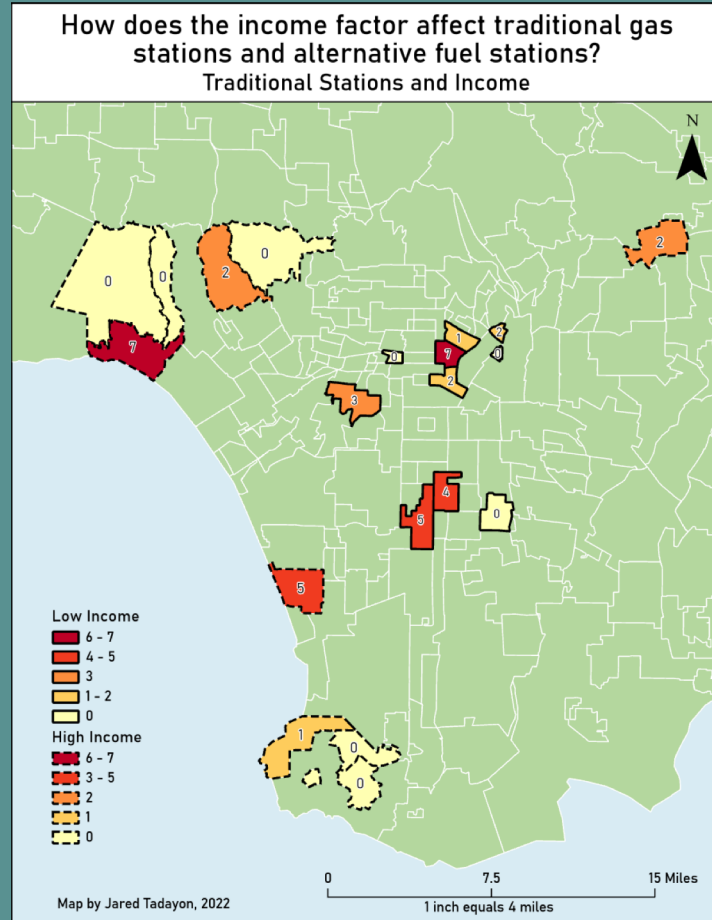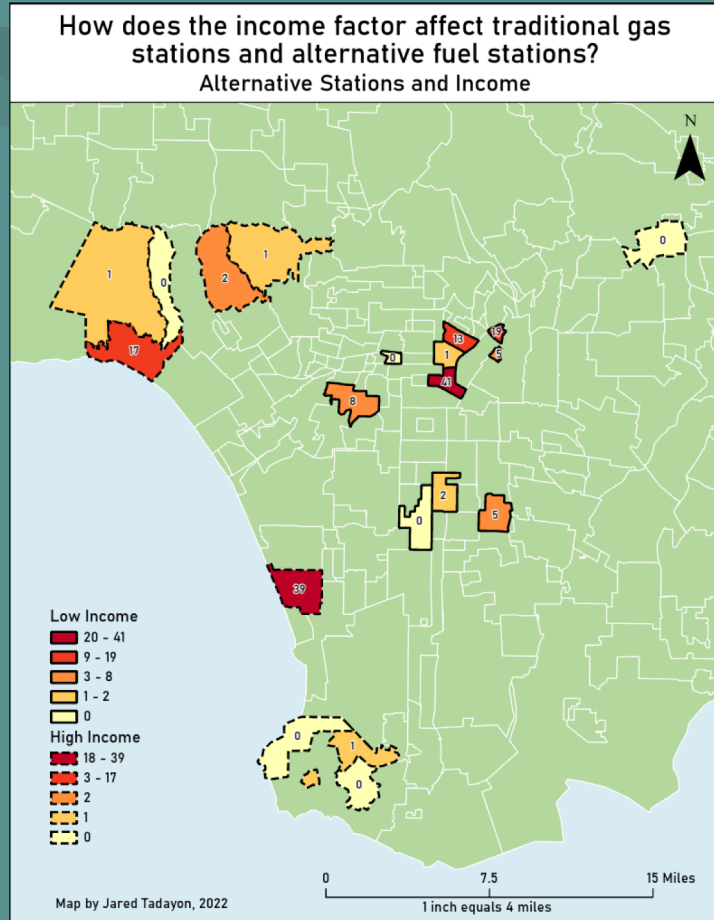Los Angeles - University Park, $24952.0, 2 Stations

Top 10 Household Income Cities and the number of Alternative Stations

Los Angeles - Mandeville Canyon, $250001.0, 0 Stations
City of Rolling Hills, $250000.0, 0 Stations
Los Angeles - Palisades Highlands, $225547.5, 1 Stations
Los Angeles - Bel Air, $211736.5, 2 Stations
City of Palos Verdes Estates, $204179.0, 0 Stations
City of Rolling Hills Estates, $194236.0, 1 Stations
Los Angeles - Beverly Crest, $190508.0, 1 Stations
Los Angeles - Pacific Palisades, $182042.0, 17 Stations
City of San Marino, $175294.0, 0 Stations
City of Manhattan Beach, $170694.0, 39 Stations

Bottom 10 Household Income Cities and the number of Alternative Stations

Unincorporated - Athens-Westmont, $37443.0, 0 Stations
Los Angeles - Vermont Vista, $37157.0, 2 Stations
Los Angeles - Victoria Park, $36618.5, 0 Stations
Los Angeles - Pico-Union, $35733.0, 1 Stations
Los Angeles - Westlake, $35313.0, 13 Stations
Los Angeles - Baldwin Hills, $33944.0, 8 Stations
Los Angeles - Chinatown, $33487.0, 19 Stations
Los Angeles - Watts, $32366.0, 5 Stations
Los Angeles - Little Tokyo, $25565.0, 5 Stations
Los Angeles - University Park, $24952.0, 41 Stations

4) Output

How does the income factor affect traditional gas stations and alternative fuel stations?
Alternative Stations and Income

How does the income factor affect traditional gas stations and alternative fuel stations?
Traditional Stations and Income

Map by Jared Tadayon, 2022

4) Output explained

Traditional Stations

- 4/10 high-income cities had traditional stations (13 total)
- 7/10 low-income cities had traditional stations (24 total)

Alternative Stations

- 6/10 high-income cities had alternative stations (61 total)
- 8/10 low-income cities had alternative stations (94 total)

Conclusion

1) Based on the statistics, the total coverage of fuel stations still need to be improved. The coverage of alternative stations is very close to the coverage of traditional stations. However, when we see the distribution of these fuel stations, the distribution of alternative stations is concentrated and need more scatter.

2) In areas with a high vehicle ownership, traditional fuel stations have greater coverage than alternative stations.

3) For schools, traditional fuel stations are typically closer. For hospitals, alternative fuel stations are closer. For shopping malls, neither traditional fuel stations nor alternative fuel stations are significantly closer.

4) Alternative stations are much more prevalent than traditional stations in both low-income and high-income cities. Low income cities have more traditional stations and alternative stations than low-income cities.

Traditional fuel stations still dominate the market, however, the coverage of alternative fuel stations is getting close to traditional fuel stations.

Discussion

Challenges / Limitation:

- Hard to start from scratch on Arcpy
- Difficult to make mapbooks appear organized and visually appealing with many labels
- Calculating the shortest Euclidean distance of stations to amenities is not that accurate, without considering the actual road networks, terrain, and traffic
- Only three types of amenities (hospitals, schools, and malls) are compared. Relatively limited datasets.
- The output data need to be sorted before analysis

Arcpy Benefits:

- Save time (mapbook, distance calculations, etc)
- Easy to share and work with other people
- Can apply to other similar situations by only changing the data (shapefiles, etc)

Thank you!

Data References:

https://egis-lacounty.hub.arcgis.com/datasets/lacounty::without-vehicle-census-tract/about

https://afdc.energy.gov/stations#/find/nearest

https://arcg.is/0fiqPa0

https://hub.arcgis.com/datasets/7b0998f4e2ea42bda0068afc8eeaf904/explore?location=33.774022%2C-118.302300%2C9.00

etc...