EMPOWERING THE ENGINES OF TOMORROW

Optimal Locations For Electric vehicle (EV) Charging Stations in The Boston Region

INTRODUCTION

The transportation sector's substantial contribution to greenhouse gas (GHG) emissions in the United States, primarily driven by fossil fuel-powered private vehicles, has prompted various states, including Massachusetts, to prioritize the promotion of electric vehicles (EVs) as a key strategy for emission reduction. Despite the acknowledged importance of private vehicle usage, challenges such as the high initial costs of EVs, limited driving range, and insufficient EV charging infrastructure have hindered widespread EV adoption across different U.S. states. Consequently, the identification of strategic locations for EV charging stations becomes pivotal in encouraging EV usage. This project endeavors to pinpoint optimal sites within the Boston region for the deployment of EV charging stations, employing two distinct multi-criteria suitability analysis methods. These methods take into account essential variables associated with both EV ownership and the existing EV charging infrastructure.

RESEARCH QUESTION

Taking into account EV ownership, commuting times, accessibility to EV charging stations, socioeconomic considerations, parking facilities, and availability, where in Boston City are good places to install electric vehicle (EV) charging stations?

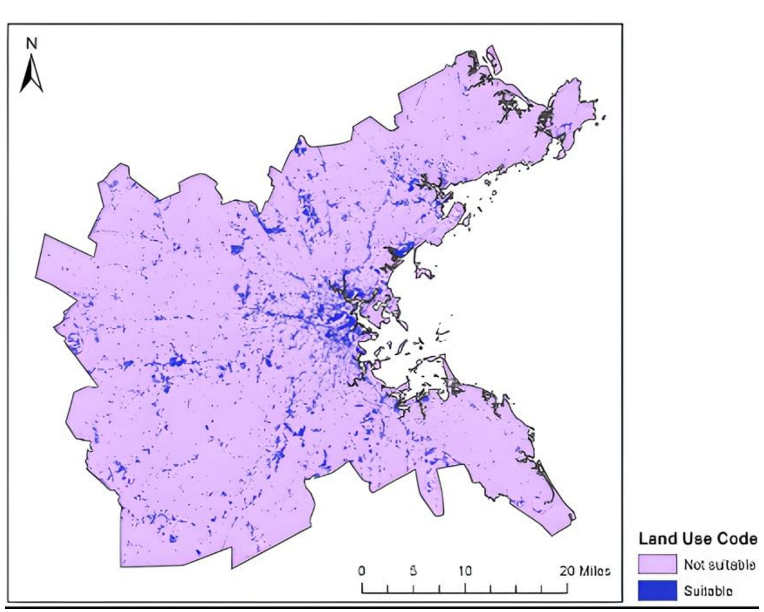
DATA

Boston region, census block groups were designated as neighbourhood's. The assessment of suitability for electric vehicle (EV) charging stations considered factors such as the presence of EV owners, proximity to existing charging stations, population density, land use classification, commute distances, and income. Data spanning from 2009 to 2014 from Massachusetts Vehicle Summary Statistics identified block groups with at least one EV owner. Information on population density, income, and commute distances was sourced from the American Community Survey and linked to the Massachusetts census block group layer. Current EV charging station locations were obtained from the Alternative Fuels Data Center and integrated with layers for land use codes, elevation, and shopping mall data for parking facilities in a file geodatabase.

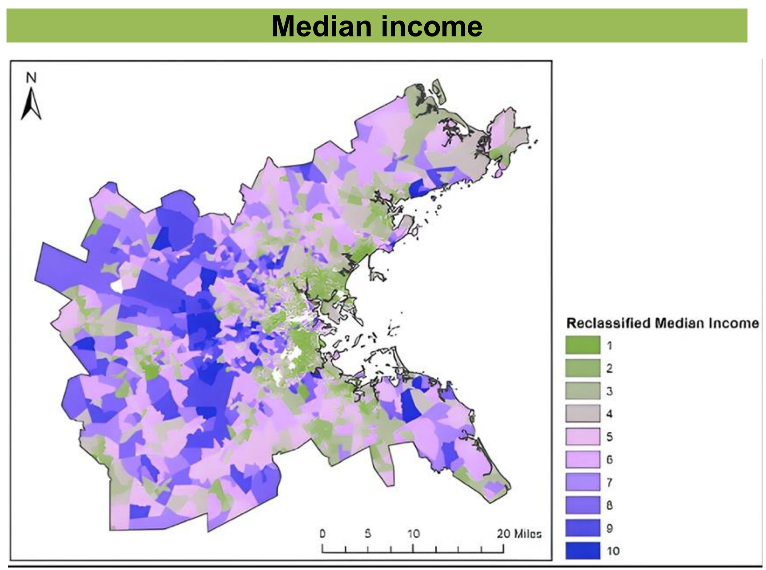
Description of Data

Layers of data	Variables of Focus:	Structure:
MassGIS Data: Digital Elevation Model	-Surface elevation	-Raster dataset
Survey of the American Community	-Median income -Density of residents -Average travel distance	-Polygon feature class
MassGIS Data: Land Use	-Land use code	-Polygon feature class
Summary Statistics for Massachusetts Vehicles	- Cluster residents with or without electric vehicle ownership	- Polygon feature class
Alternative Fuels Data Center	- EV charging station locations	-Point feature class

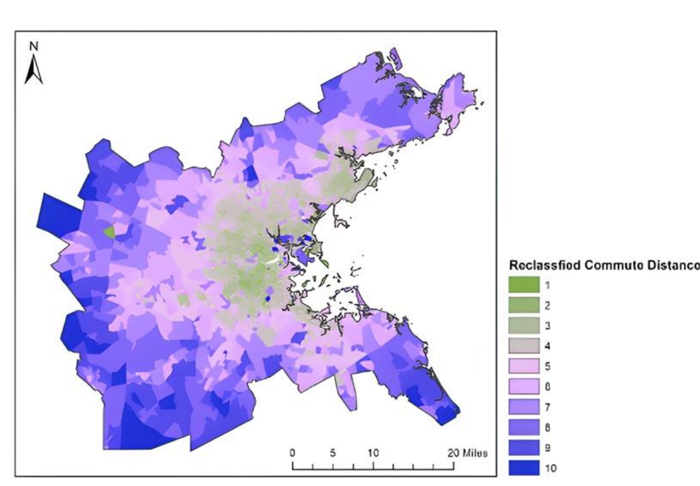
Land use classification



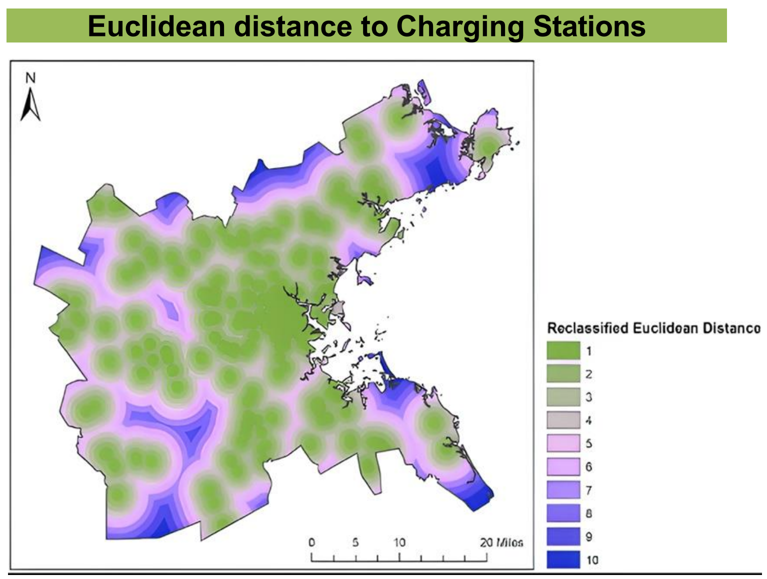
Median income



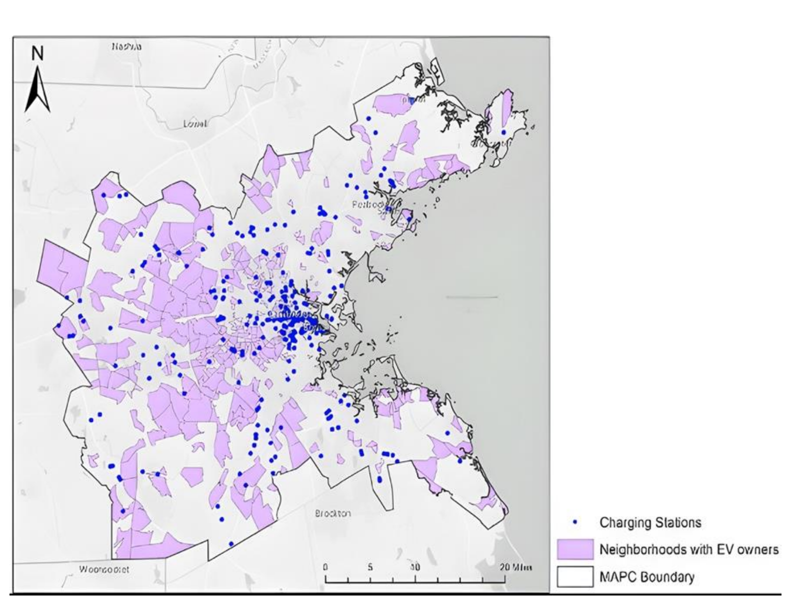
Median Commute Distance



Euclidean distance to Charging Stations



Existence of electric vehicle Owners



Data Sources and Map Information

- Metropolitan Area Planning Council (MAPC), Alternative Fuels Data Center (AFDC), American Community Survey, MassGIS
- Base map Layer Credit: Esri, HERE, Garmin, (c) OpenStreetMap contributors
- Projected Coordinate System: NAD_1983_StatePlane_Massachusetts_Mainland_FIPS_2001

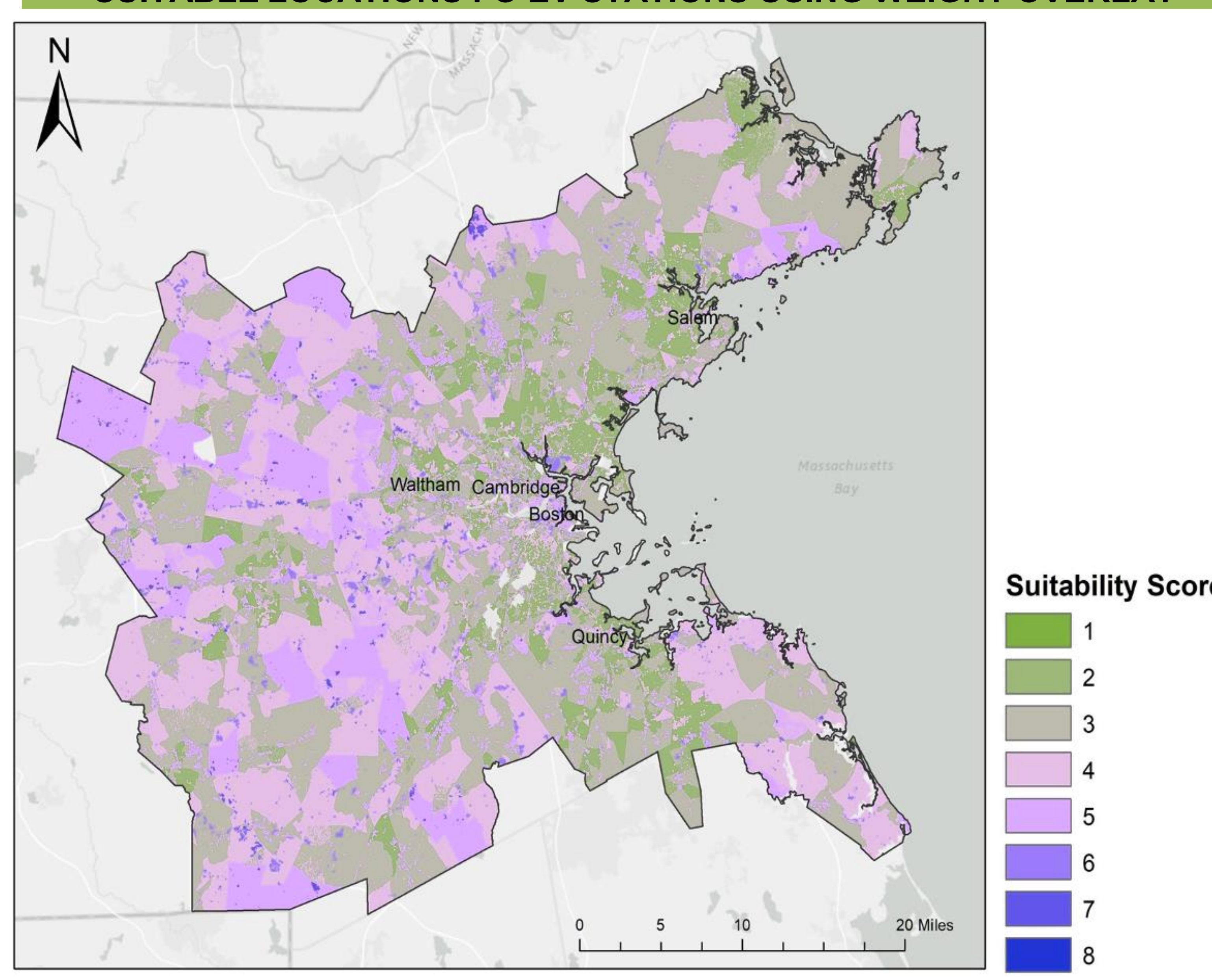
METHODOLOGY

The conversion of all polygon feature classes into raster datasets was accomplished through the application of the feature to raster tool. The determination of proximity to existing charging stations was achieved by employing the Euclidean distance tool, while the elevation raster underwent conversion into a slope raster using the slope tool. Subsequently, these input layers were clipped based on the Boston region boundary and utilized in the creation of a conclusive suitability map via the weighted overlay tools.

In generating the weighted overlay suitability map, the reclassify tool was employed to assign scores on a 1-10 scale to all quantifiable layers, with higher scores designated for values deemed suitable. For categorical layers, such as land use codes, a score of 10 was assigned to appropriate codes, while inappropriate codes received a score of 0. Similarly, raster cells within a block group containing at least one electric vehicle (EV) owner were allocated a score of 10, whereas cells in block groups lacking any EV owners were assigned a score of 0. The weighted overlay technique facilitated the assignment of weights to each input factor based on their significance in determining the suitability of an area for an EV charging station. The weighting scheme for the final weighted overlay map is outlined below.

Land use classification.	**25%**
Median income	**20%**
Closeness to accessible charging points	**15%**
Median Commuting distance	**15%**
Existence of electric vehicle Owners.	**10%**
Population density	**10%**
Incline	**5%**
Total	**100%**

SUITABLE LOCATIONS FO EV STATIONS USING WEIGHT OVERLAY



RESULTS

The final map delineates prospective regions for the future deployment of EV charging stations, utilizing the input factors outlined in the study and determined through a weighted overlay analysis. In the eastern sectors of Waltham and Newton, neighborhoods garnered suitability scores spanning from 0.8 to 1. Similarly, areas encompassing Franklin and Foxborough to the southeast of the Boston region, alongside neighborhoods including Manchester and those situated east of Quincy, exhibited elevated suitability scores ranging from 0.7 to 1. The weighted overlay method strategically prioritized input factors based on their anticipated impact, yielding specific zones within the identified suitable neighborhoods. Notably, segments of neighborhoods east of Waltham and Newton received weighted suitability scores within the range of 4 to 7, mirroring a comparable pattern in areas around Franklin, Foxborough, Manchester, and Quincy. The resulting weighted overlay map further classified suitable areas with scores ranging from 5 to 7 in neighborhoods proximate to Boston, such as Roxbury, Somerville, and Chelsea.

CONCLUSIONS

In conclusion, the final map identifies areas suitable for EV charging stations based on factors such as the presence of EV owners, appropriate land use codes, low proximity to existing charging stations, higher population density, higher incomes, and longer commute distances. The analysis, however, focuses on a limited set of criteria, emphasizing the significance of a weighted overlay approach. To enhance suitability results, it is essential to consider additional factors such as commute directions, proximity to major roads and amenities, and development costs. Furthermore, evaluating different weighting, reclassifying, and overlay schemes, while taking into account vehicle use patterns and local socioeconomic and spatial factors, is crucial for refining the selection of streets or addresses for optimal EV charging station deployment.

References:

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