



LITTLE FREE LIBRARY.ORG  
TAKE A BOOK • RETURN A BOOK

## BACKGROUND

### What is Little Free Library?

A Little Free Library (LFL) is a free book exchange that anyone may take or bring a book to share. The most common set-up is a small wooden box of books.

### How many LFL are in Boston?

Up to December 2017, there are 9 LFLs installed in Boston.



Photo Source: <https://littlefreelibrary.org/>

## AIM

The aim of this project is to generate a LFL index based on a residential model. The index will be used to identify the most suitable locations for establishing the Little Free Libraries (LFLs) and to evaluate the existing locations in Boston City. The definition of high suitability is that the LFLs can reach the largest population and target the population mostly in need of reading materials - the low-income and low-literacy population.

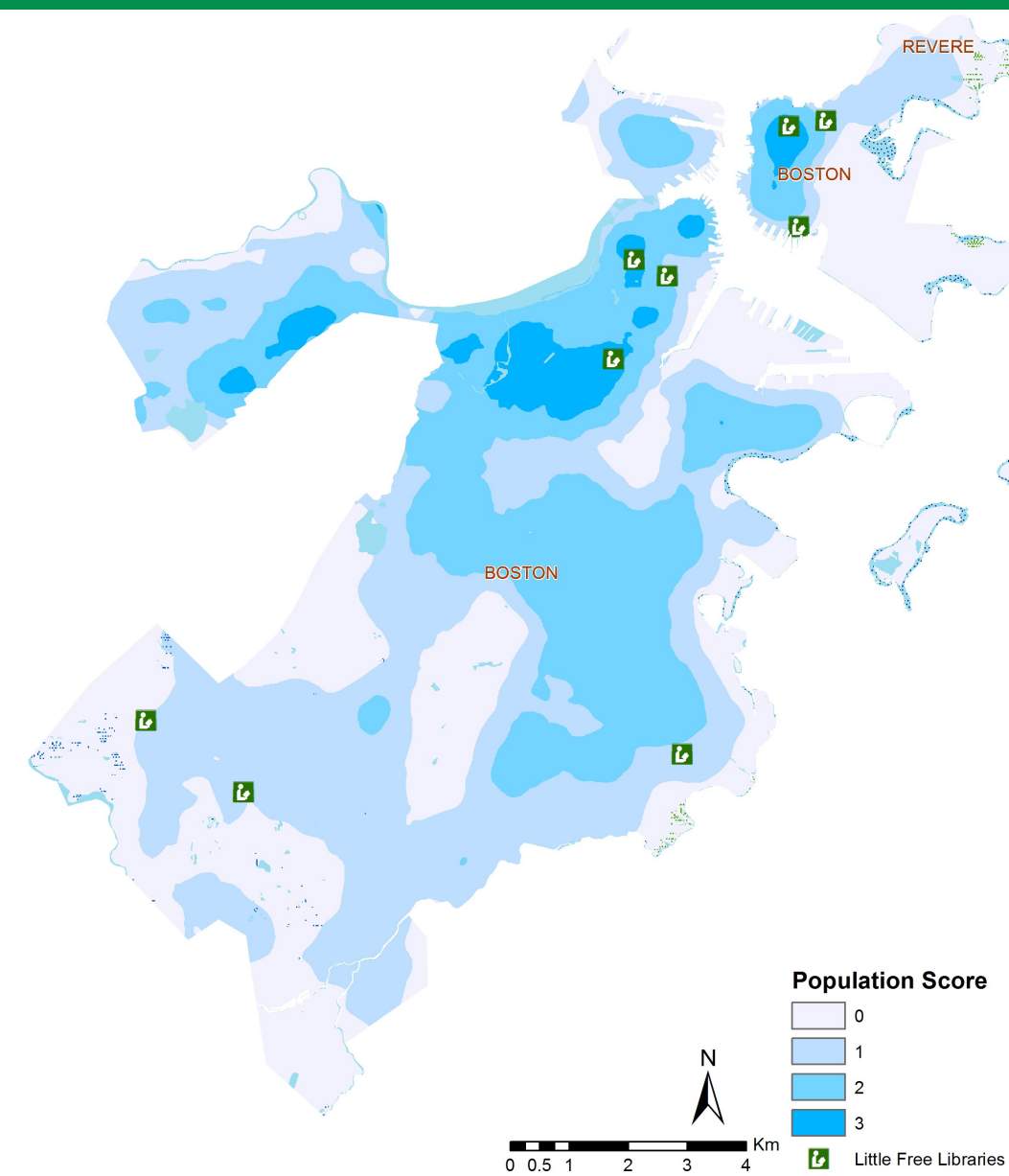
## METHOD

The residential model targets the population by identifying the areas:  
I. that have higher population density,  
II. have higher number of individuals below poverty line,  
III. where population have lower average educational level, and  
IV. that are farther from existing public libraries.

The criteria above are evaluated using four respective scores:

# TAKE A BOOK • RETURN A BOOK

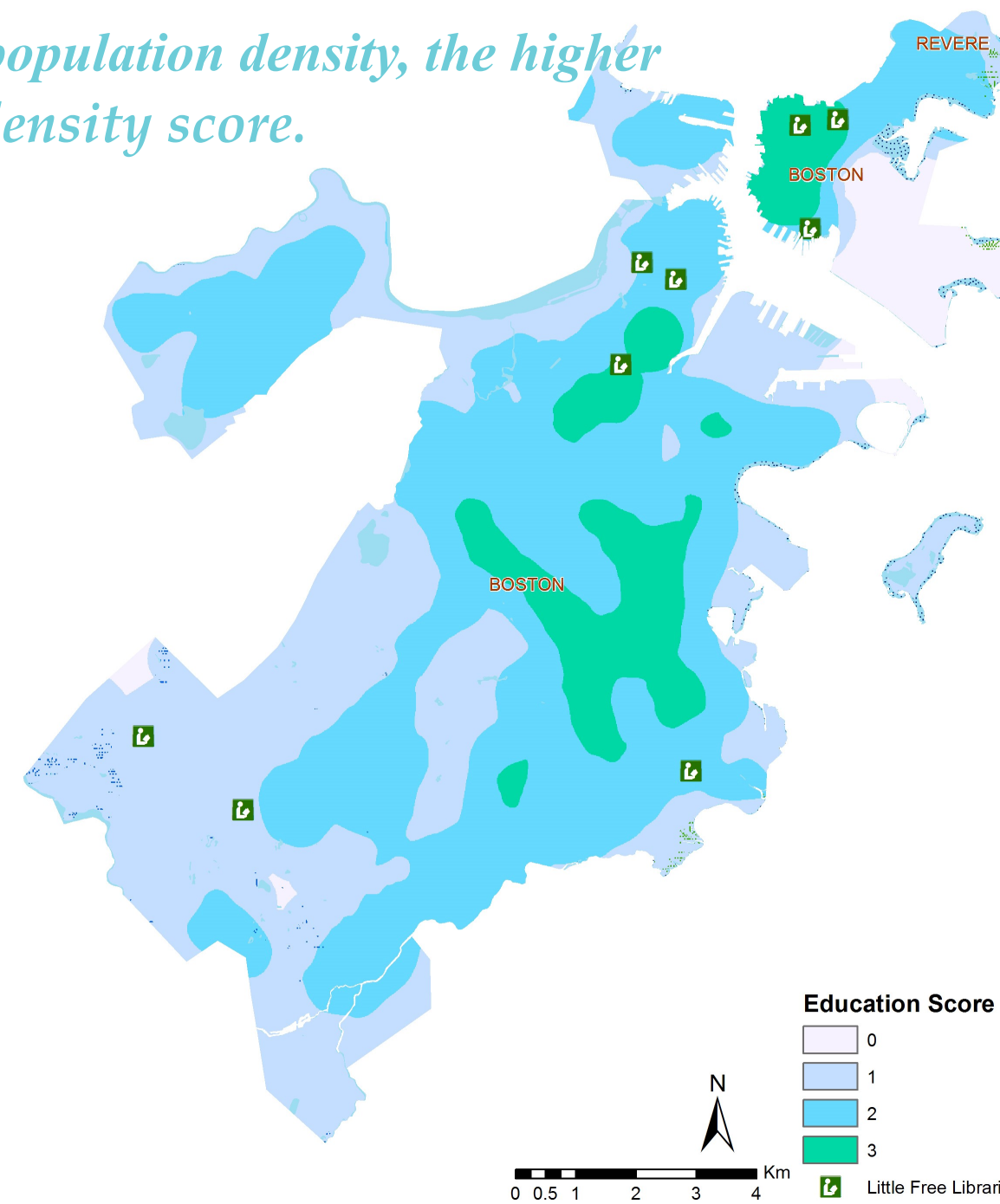
## Geospatial Evaluation and Proposal of Little Free Library Locations in Boston, MA - A Residential Model



### Population Score

Population data are obtained from 2010 US Census. As the exact distribution of population within a census block is unknown, a focal tool is used to estimate the accessibility of a location within a given radius. The Focal Statistics tool performs a neighborhood operation on population density by census block that computes an output raster. Each cell on the output raster represents the estimated sum of population within 500-m radiation. The raster is then reclassified based on the 4-level scale (Left map).

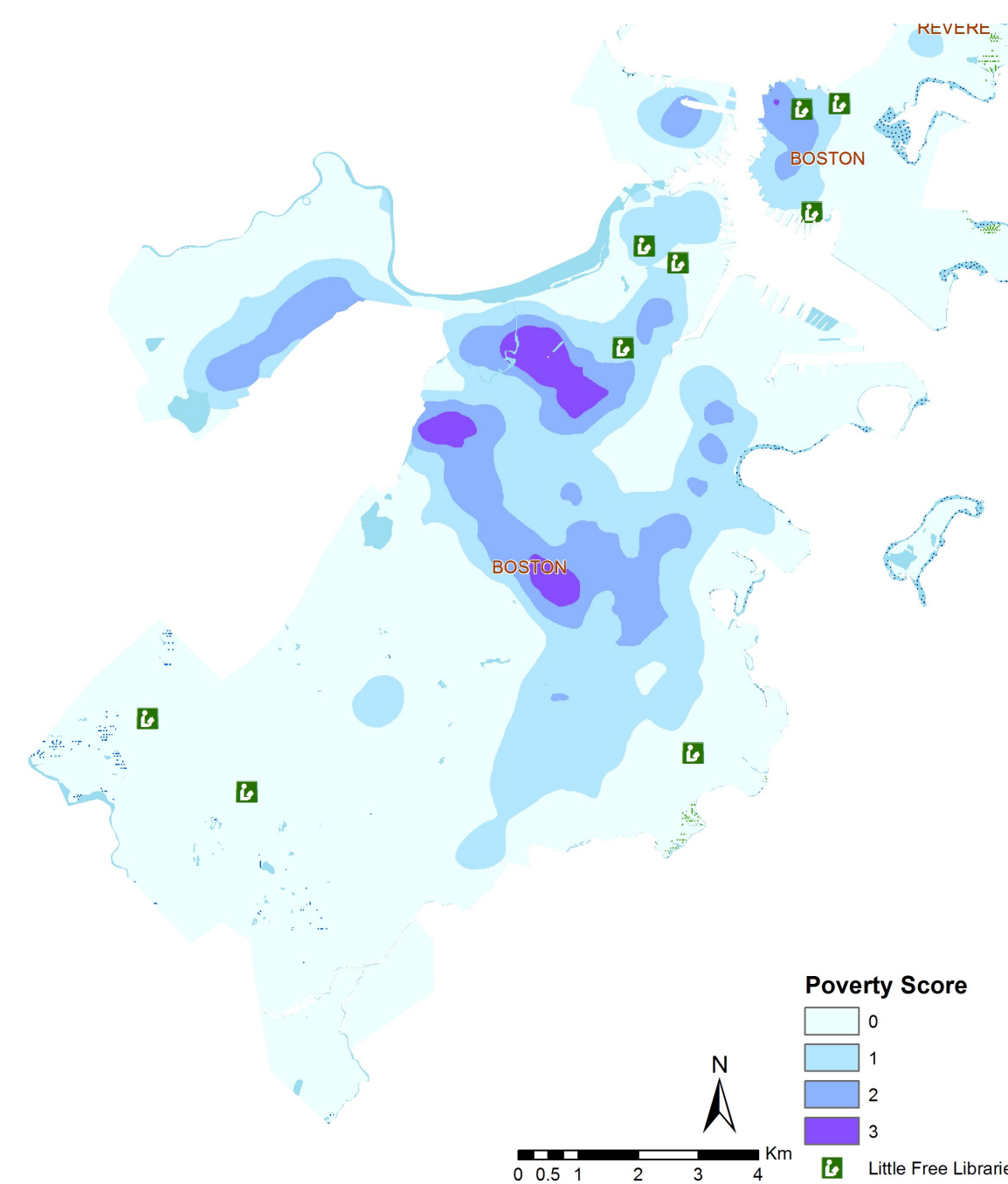
*The higher population density, the higher population density score.*



### Education Score

The indicator for the score is the total number of people > 25 year old do not complete high school within 500-m radius. The educational attainment raster is generated by adopting the focal statistic sum tool on the number of people receive lower than high school degree (polygons) by block group. Each cell on the raster represents the estimated population over 25 receive lower than high school degree within 500-m radius. The raster is reclassified based on the 4-level scale (Right map).

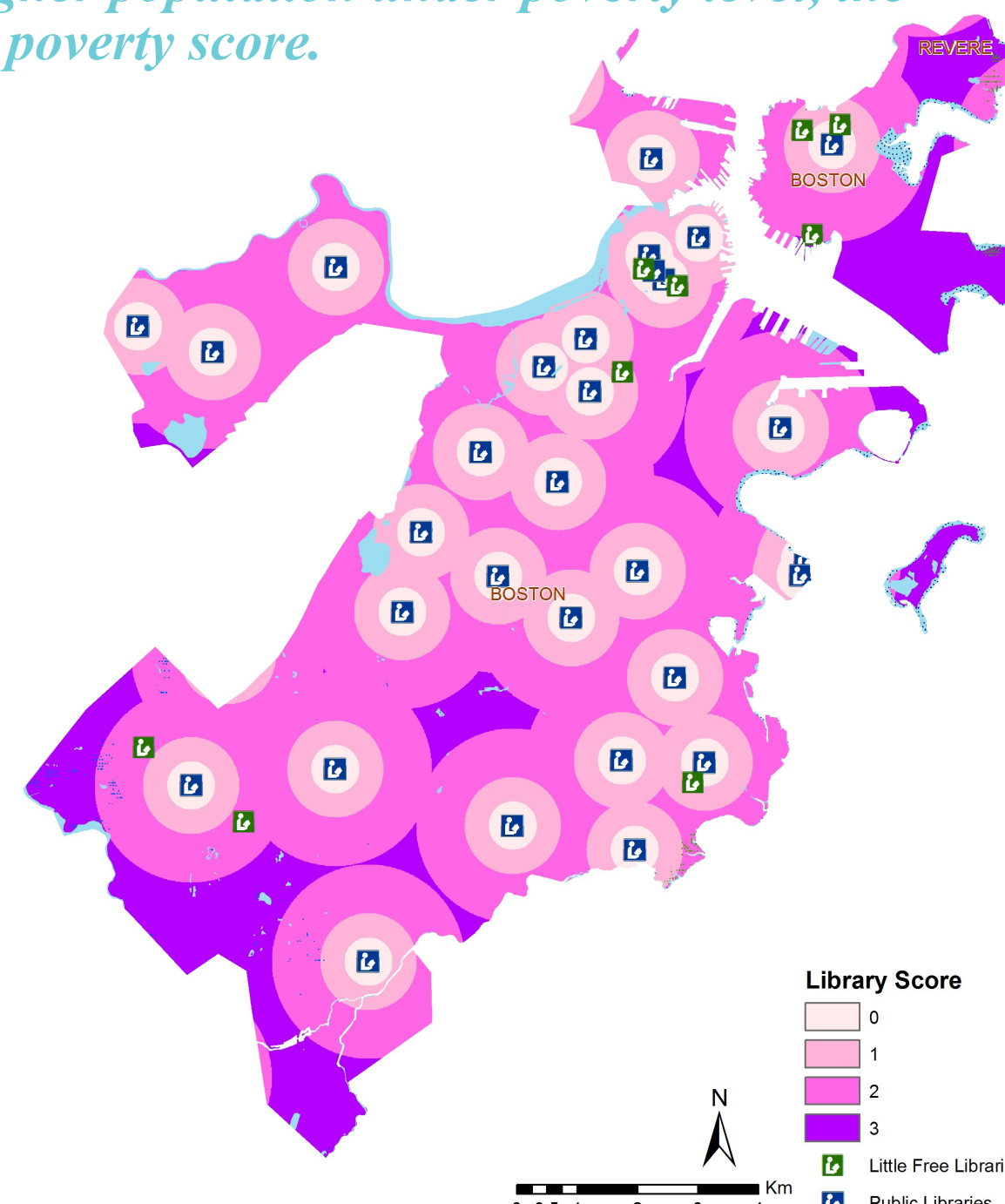
*The higher population over 25 receiving lower than high school degree, the higher the education score.*



### Poverty Score

The indicator for poverty is the population living under the poverty line in each block group. To calculate the values of the indicator, the number of people whose income-to-poverty ratios are <0.5 and between 0.5-1 were added up in the dataset. Income-to-poverty ratios represent "the ratio of family or unrelated individual income to their appropriate poverty threshold. Ratios below 1.00 indicate that the income for the respective family or unrelated individual is below the official definition of poverty". Similarly, the poverty model adopts the focal sum method. Each cell on the raster represents the estimated sum of population are under poverty level within 500-m radiation. The raster is then reclassified based on the 4-level scale (Left map).

*The higher population under poverty level, the higher poverty score.*

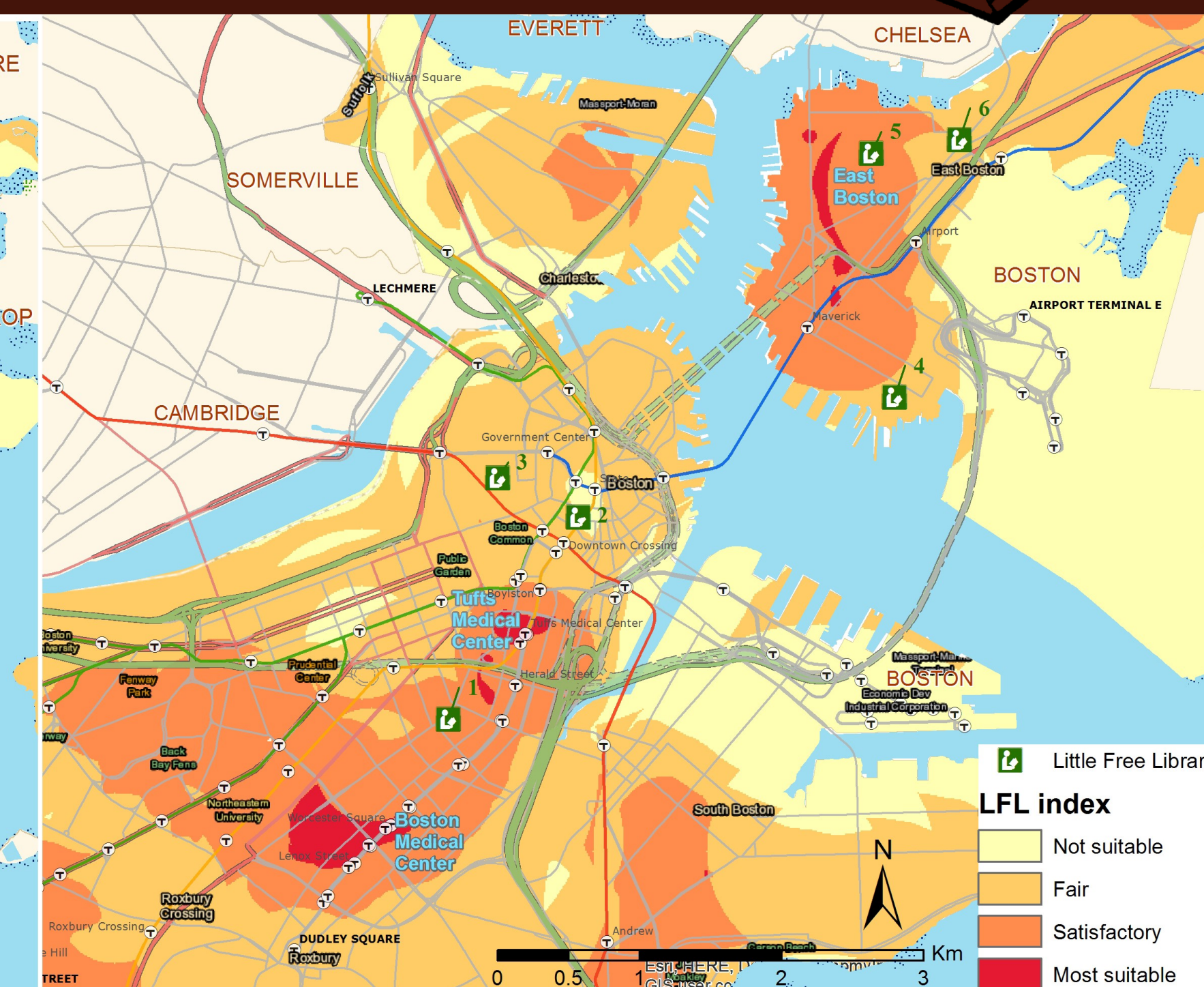
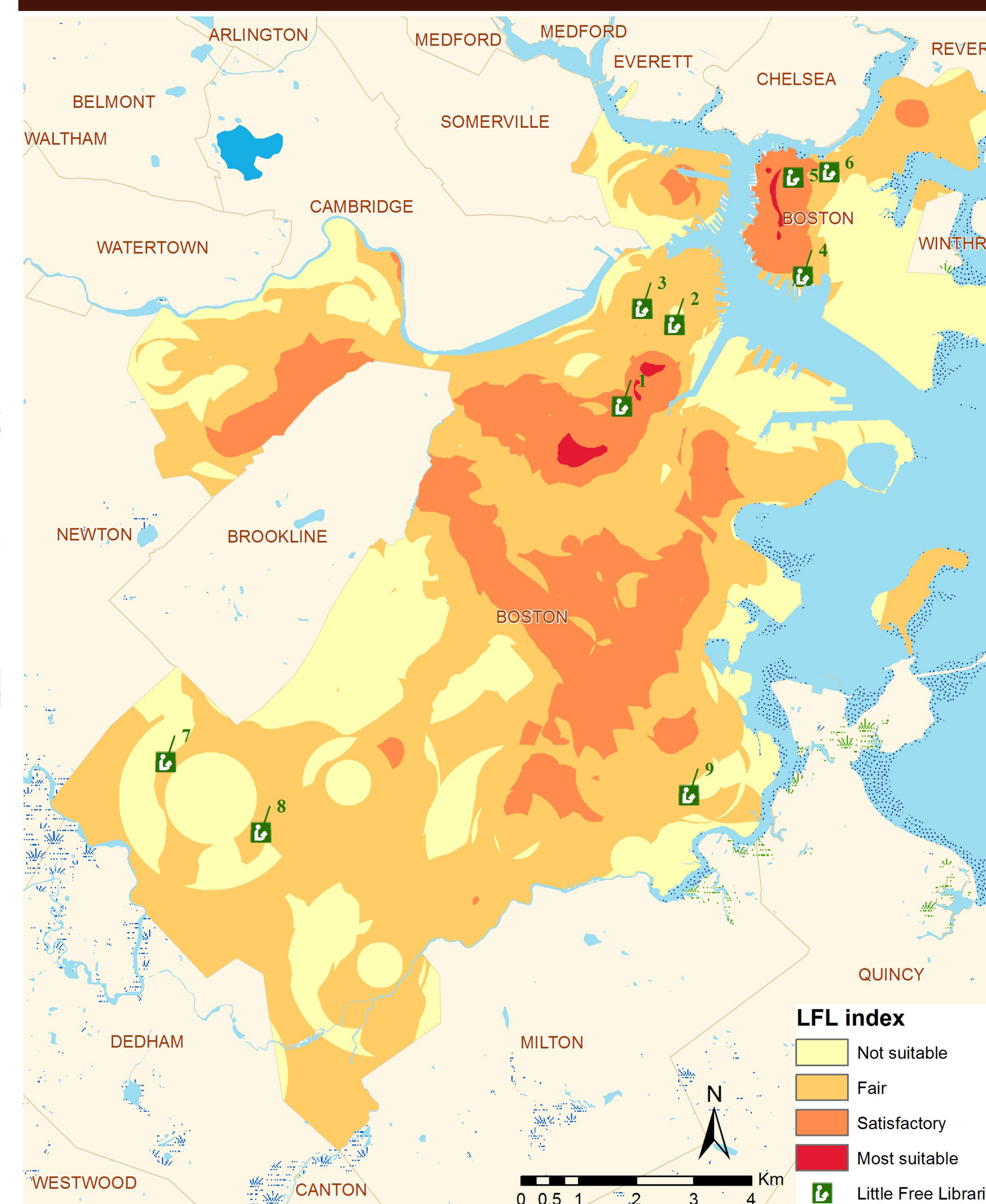


### Library Score

The library dataset contains points which represent locations of all public libraries and their branches currently registered with the Massachusetts Board of Library Commissioners (MBLC). The distance to the library is a raster generated by the Euclidean distance tool. The layer is reclassified based on the following criteria, assuming the average walking pace of 80m/min (Right map).

- 0: <400m (5min walk)
- 1: 400-800m (5-10min walk)
- 2: 800-1600m (10-20min walk)
- 3: >1600m (>20min walk)

## RESULTS



### Areas of High Suitability

Based on the LFL index, we identified areas of high suitability. The most suitable areas are clustered around Tufts Medical Center, Boston Medical Center, and East Boston Area, suggesting a high need to establish new LFL for the residents in the area.

### Future Step

As the residential model only captures the static population living in a certain area, the next step of the project is to create a dynamic model that targets the non-residential population in Boston. The Crowd center (dynamic) model will focus on the moving crowds such as employees and students by identifying areas that (1) have higher employee density, (2) are closer to MBTA T stations and bus stops, (3) closer to commercial area and crowd centers such as schools, parks, hospitals, government office and etc.

Eventually, the residential model and moving crowd models will be combined to identify the locations with highest LFL index for both population.

### Evaluation of Existing LFLs

The map above is the final LFL index in Boston city, overlaid with the existing LFL locations. As shown on the map, compared with South and West of Boston, Downtown and East Boston are more suitable for LFL locations as there are larger population under poverty line, completing lower education, living farther away from public libraries. We also applied the LFL index on the existing LFLs to evaluate their suitability, as shown in the table below.

LFL No.	Address	LFL Index	LFL score	Population	Poverty	Educa-tion	Library
1	36 Milford St, Boston, MA 02118	Satisfactory	8	3	1	3	1
2	Near Old South Meeting House, downtown	Not Suitable	3	1	0	2	0
3	45 Myrtle St, Boston, MA 02114	Fair	6	3	1	2	0
4	241 Webster St, Boston, MA 02128	Fair	5	1	0	2	2
5	148 Trenton St, Boston, MA 02128	Satisfactory	9	3	2	3	1
6	4 Eagle Square, Boston, MA 02128	Fair	4	1	0	3	0
7	108 Lasell St, West Roxbury, MA 02132	Fair	4	1	0	1	2
8	30 Martin St, Boston, MA 02132	Fair	4	1	0	1	2
9	234 Minot St, Boston, MA 02124	Not Suitable	3	1	0	2	0

### CITATION

Population: TIGER/Line® Shapefiles and TIGER/Line® Files, 2010; Massachusetts, U.S. Bureau of the Census, Last Updated: March 26, 2012.

Poverty, Education: 2011 – 2015 American Community Survey. U.S. Census Bureau's American Community Survey Office, 2015.

Libraries: Massachusetts Board of Library Commissioners (MBLC); published by MassGIS, Last Updated: August 2017, accessed Dec 7, 2017.

Little Free Library. (n.d.). Little Free Library, accessed December 19, 2017.

*Little Free Library(R) and the phrase "Take a Book. Return a Book" is used by permission of Little Free Library LLC, a non-profit 501(c)(3) organization*

### AUTHOR

Yi Zhao, yi.zhao@tufts.edu

Fa17-NUTR-0231 Fundamentals of GIS, December 2017