Using Geographic Information Systems and Spatial Analysis to Recommend Incinerator Closure

Tufts UNIVERSITY

Shannon Dubois
NUTR 321: Fundamentals of GIS
May 9, 2016

BACKGROUND

Active combustion facilities (incinerators) in the US are relied upon to destroy waste, but they may be detrimental to proximal populations due to their release of toxic emissions, contributing to air pollution potentially resulting in poorer air quality, as well as having a negative impact on certain health conditions (particularly respiratory). Massachusetts has seven active incinerators, two of which are located in the western half of the state (Covanta Springfield Resource Recovery Facility in Agawam and Pittsfield Resource Recovery Facility in Pittsfield).

As though an environmental protection activist group in western Massachusetts wants to advocate for one of these two incinerators to be closed, this analysis is looking to determine how GIS data can be used to decide which incinerator would be most worth closing because of its effect on proximal populations by evaluating their population density and age distribution. Age distribution is evaluated because older people may be more susceptible to adverse health effects from air pollution, especially those suffering from emphysema or COPD, so an incinerator affecting an older population could be considered more detrimental than one surrounded more predominantly by younger people.
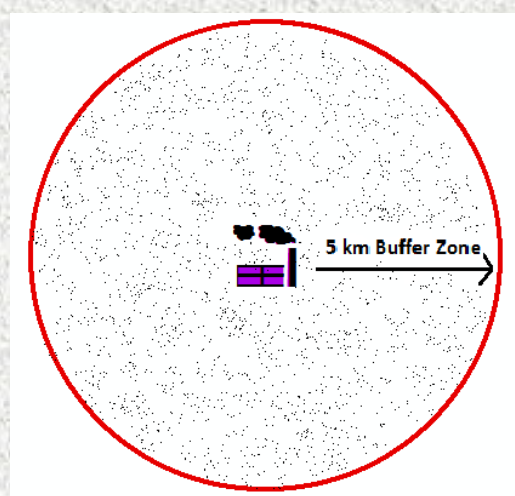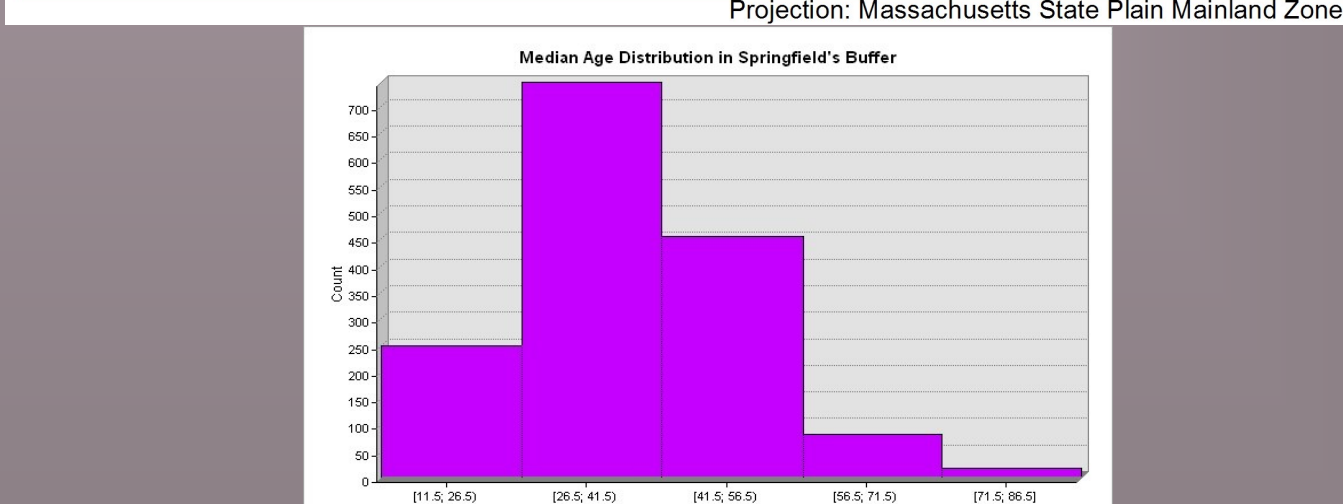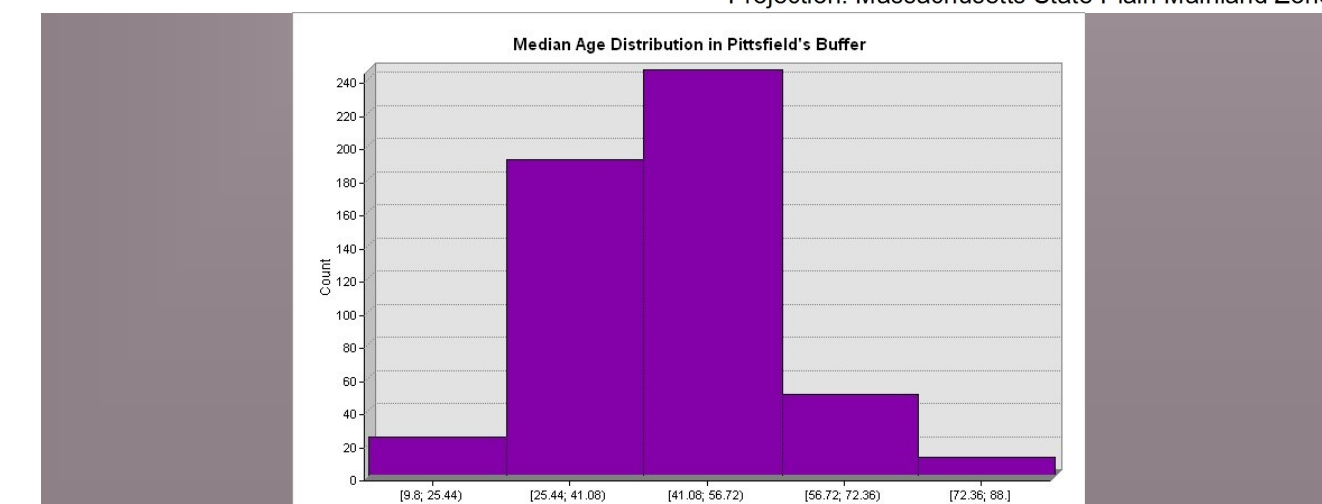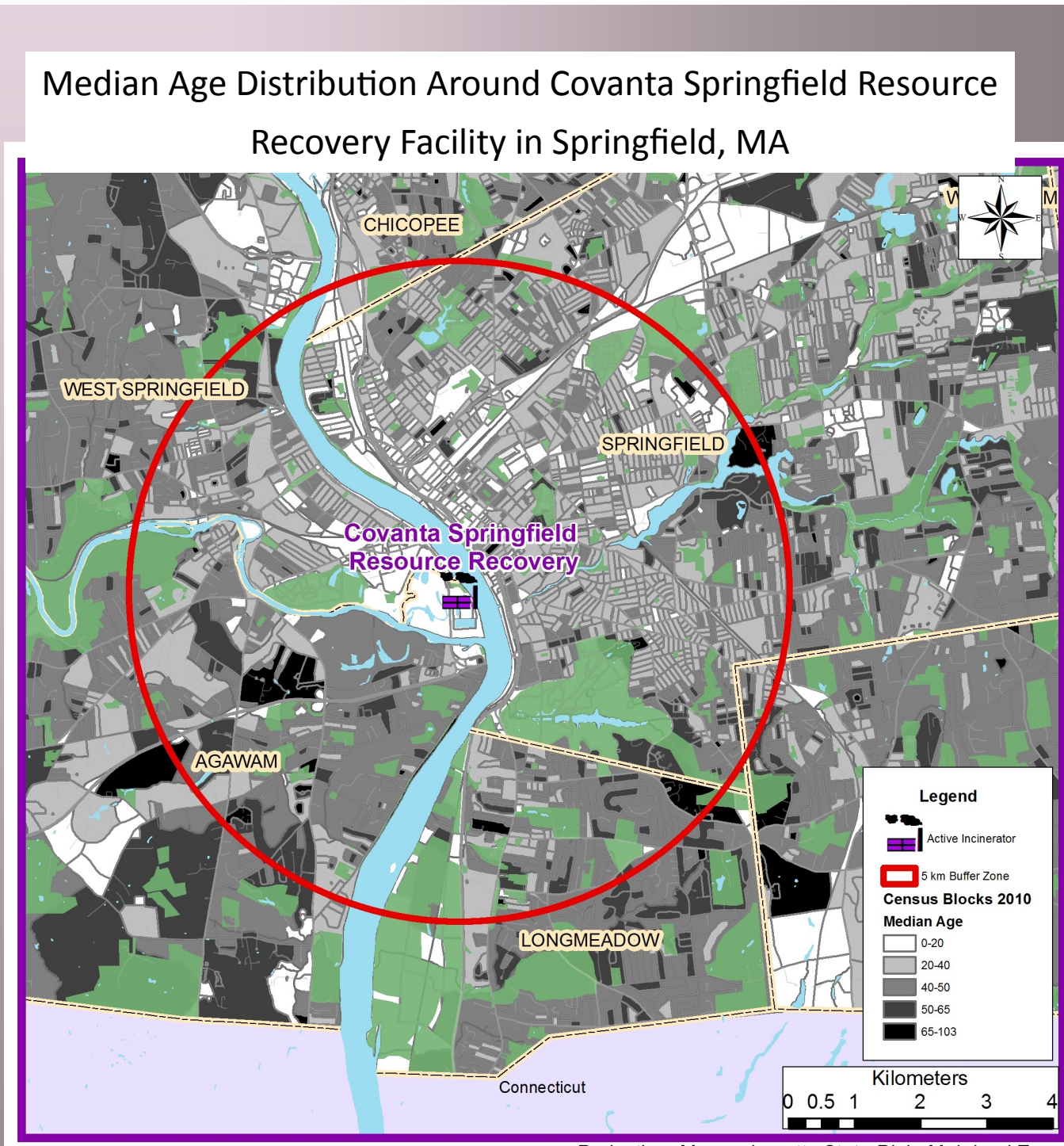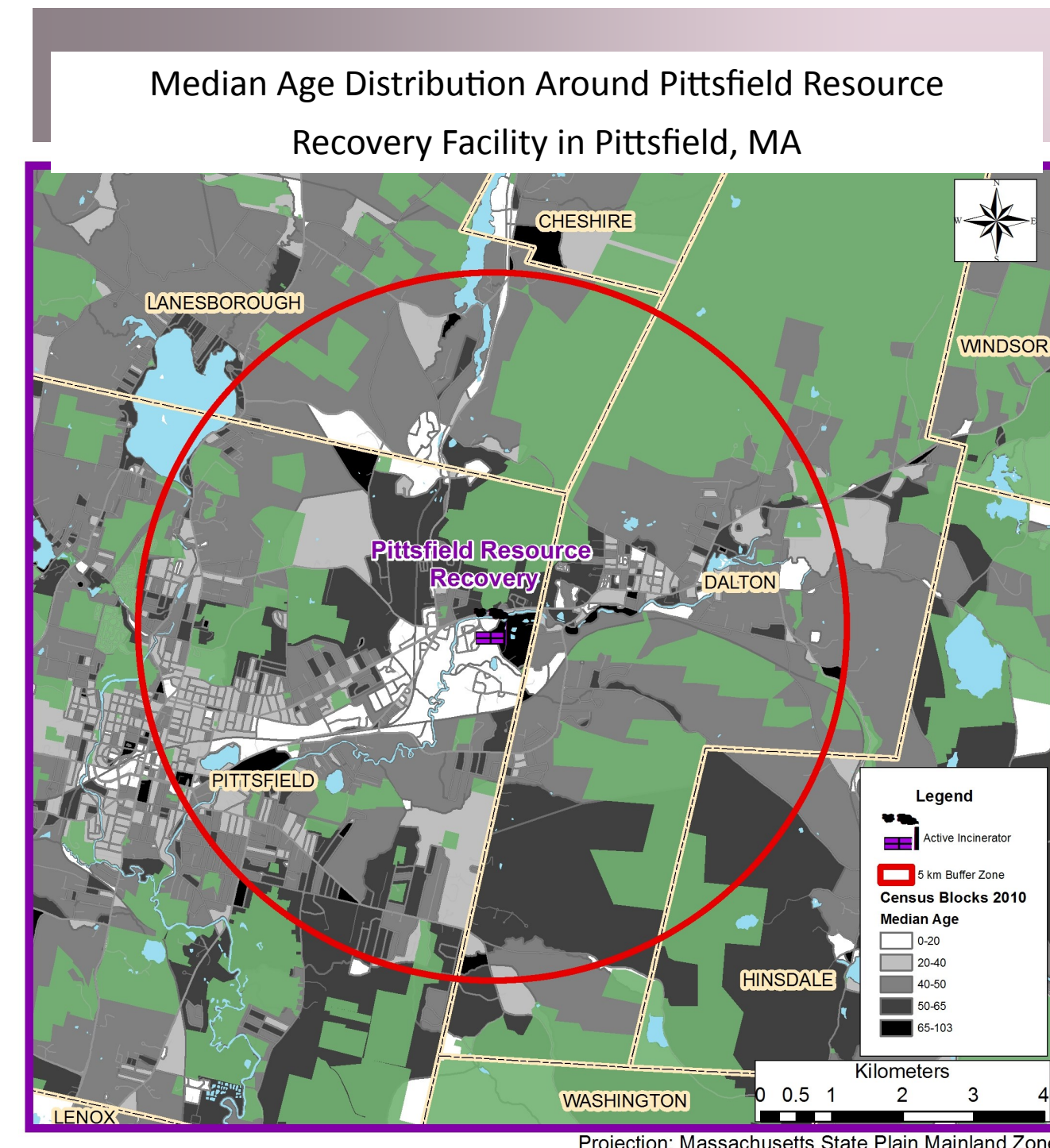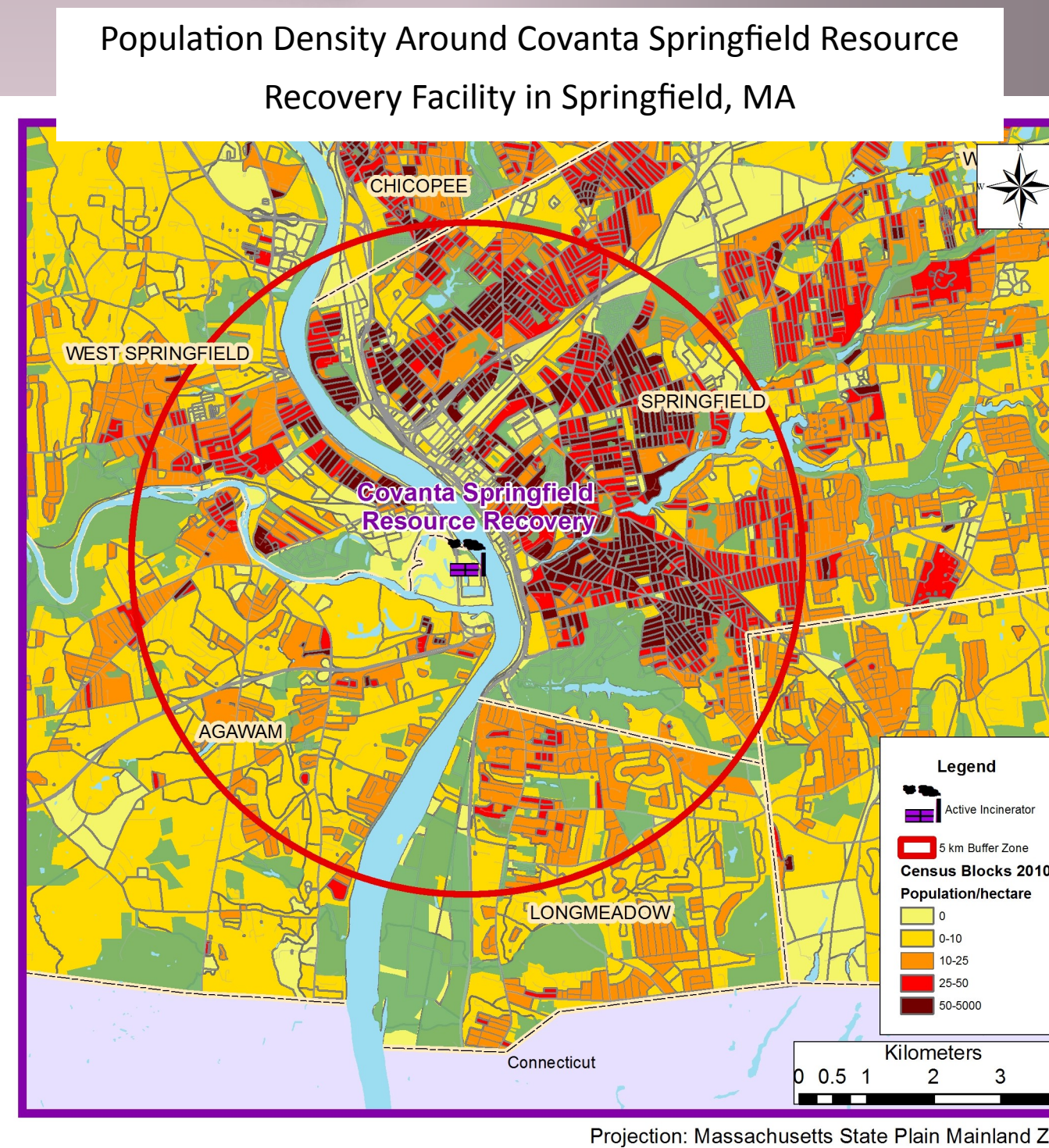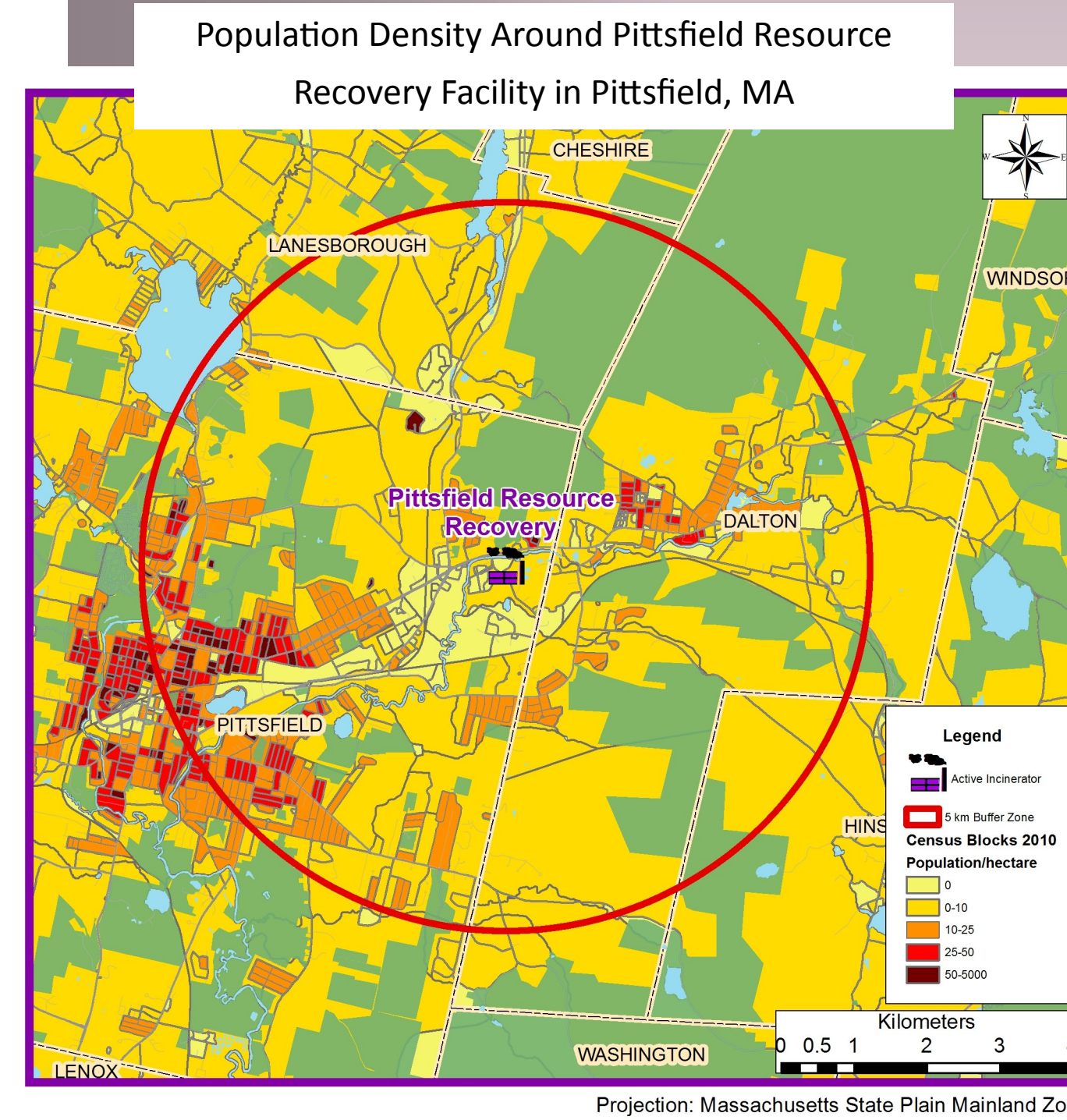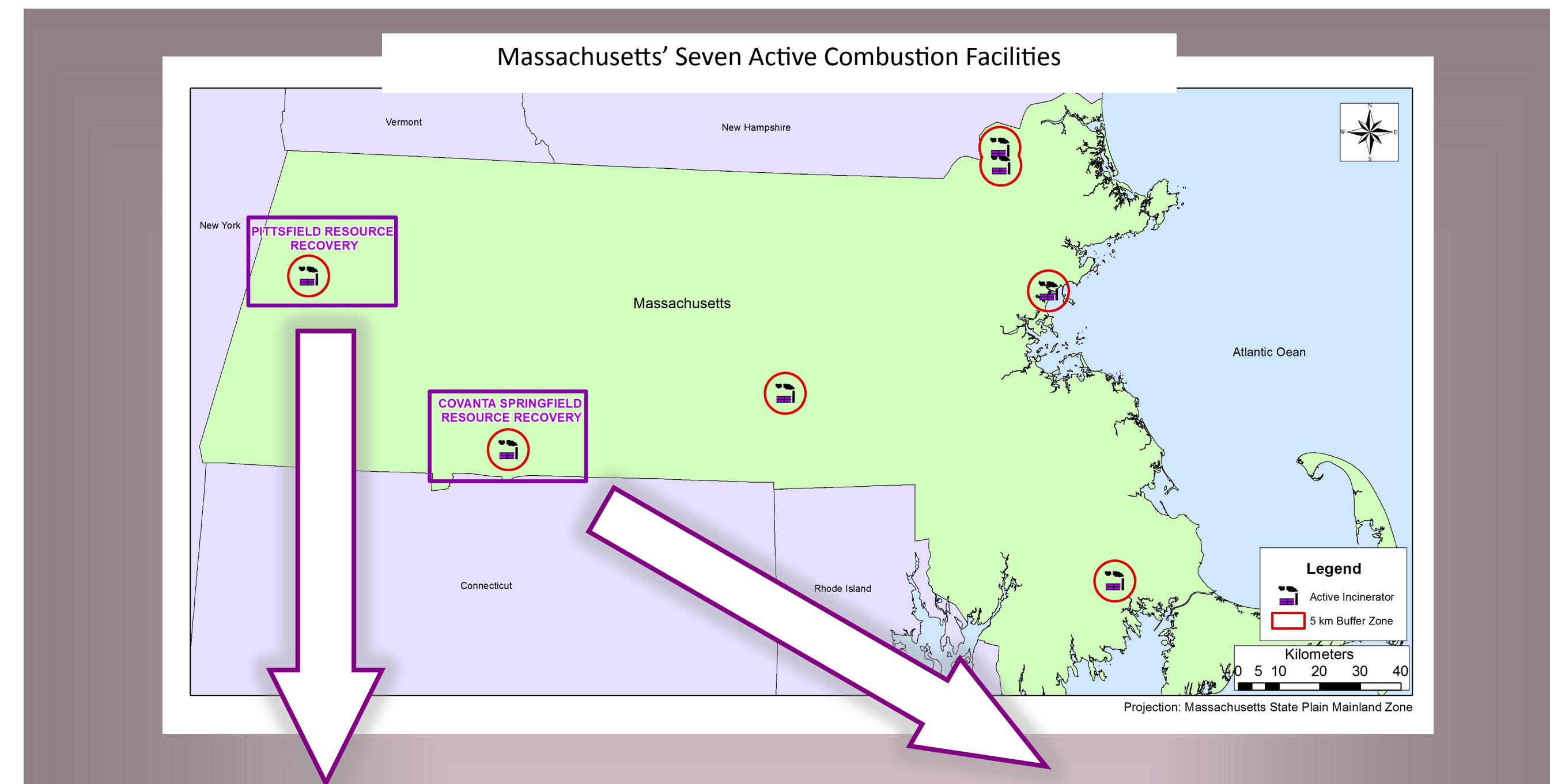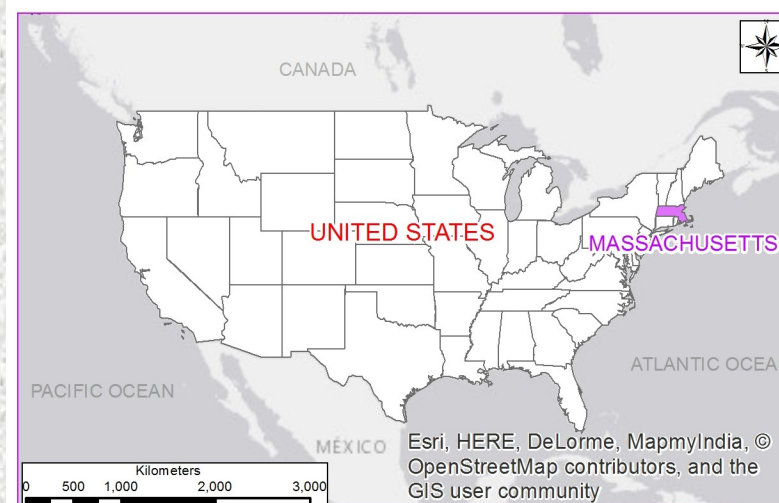
METHODS

In previous research[1], a distance of five kilometers has been considered the area of proximity ("exposure") to combustion facilities, so this analysis focuses on the demographics within a five kilometer buffer area around each incinerator. However, other studies have used a range from three to ten kilometers as an exposure area, so this buffer is not definite and can depend on wind patterns, land features (such as mountains), and characteristics of the incinerator that influence how much and how far emissions travel. In a perfect analysis, all of these factors would be taken into consideration, but with this available data, five kilometers will be used.

The Census 2010 data was collected by mail-in forms from US residents or by door-to-door inquiry to use for determining political seats and federal fund allocation. Census Blocks 2010 population counts were normalized by land area (hectares) to make a choropleth map of population density. Then, Census Blocks 2010 Summary File 1 was used to create another choropleth map depicting the median reported age of the population in each census block. To compare the population between each incinerator's buffer area, a model was used to create the five kilometer buffer around each incinerator and then the select by location tool was used to select blocks whose centroid were within the buffer. Finally, the summary statistics tool was used in the model to yield the population statistics.

Massachusetts Indicated on North America

Massachusetts' Seven Active Combustion Facilities

Population Density Around Pittsfield Resource Recovery Facility in Pittsfield, MA

Population Density Around Covanta Springfield Resource Recovery Facility in Springfield, MA

Median Age Distribution Around Pittsfield Resource Recovery Facility in Pittsfield, MA

Median Age Distribution Around Covanta Springfield Resource Recovery Facility in Springfield, MA

Median Age Distribution in Pittsfield's Buffer

Median Age Distribution in Springfield's Buffer

RESULTS & DISCUSSION

In the blocks whose centroid are within five kilometers of the Pittsfield Resource Recovery Facility, there is a reported total population of **30,187** people. Similarly, within the blocks whose centroid lies within five kilometers of the Springfield Resource Recovery Facility, there is a reported total population of **132,799** people, which is approximately four times as many people. This value is the estimate of the residents counted in the 2010 census per block. An initial visual assessment of these choropleth maps also suggests that Pittsfield has more recreational / open space in its buffer while Springfield has higher population density in its buffer.

Some errors of commission and omission can happen in this model because parts of selected blocks lie outside the buffer and parts of blocks inside the buffer weren't counted because their centroid wasn't within the buffer. However, the granularity of using block level data is pretty good because the blocks are relatively small and it's better than using data at the level of block groups or tracts. Additionally, the Census 2010 counts are now outdated, so population density may have increased or decreased in these areas since this data was published, not to mention the fact that age distribution will also have changed over time.

From this model analysis, the data suggests that the Springfield facility is affecting a lot more people than the Pittsfield facility, so in this respect and in terms of how many people are exposed to emissions in the buffer, Springfield would appear to be more worth closing.

In the model analysis of age distribution, the results are not as clear. In the census blocks in the Pittsfield incinerator buffer, the average median age was **28.5 years**, while it was **23.1 years** in the Springfield buffer. The choropleth map does not reveal any clear trends either as to which incinerator is affecting more older people. The age distribution graphs (while noticeably shown at different scales since the population and block count between the two facilities is different) suggest that Springfield incinerator may be affecting slightly more younger people than older people. This analysis would have been better performed if the SF1 data included the mean instead of median or if there was a more intuitive categorization of raw counts, and further analysis could aim to remedy these issues.

Admittedly, this analysis doesn't have a perfect ability to recommend which incinerator to close because of outdated data and oversimplification. Overall, referring to demographic data to make a suggestion for incinerator closure is only part of the picture– future analyses should also consider data from the incinerators themselves to see which are the most harmful in terms of volume , content, and frequency of emissions, as well as evaluating landscape and wind patterns to determine if a five kilometer buffer is really the best proxy for estimating "exposure," or if the smoke plume travels further than that.

SOURCES

1. García-Pérez J, et al. Cancer mortality in towns in the vicinity of incinerators and installations for the recovery or disposal of hazardous waste. Environ Int. 2013 Jan;51:31-44.
2. MassDEP Solid Waste Diversion and Disposal, Jan 2016, Massachusetts DEP; published by MassGIS, accessed Apr 2016.
3. Datalayers from the 2010 Census, Apr 2012, US Census Bureau; published by MassGIS, accessed Apr 2016.
4. MassDEP Hydrography (1:25,000), Mar 2010, Massachusetts DEP; published by MassGIS, accessed Apr 2016.
5. MassDOT Roads, Jun 2014, Massachusetts DOT– Transportation Planning; published by MassGIS, accessed Apr 2016.
6. Community Boundaries (Towns), Feb 2014, Massachusetts DPW; published by MassGIS, accessed Apr 2016.
7. New England Boundaries, Sept 2007, MassGIS; published by MassGIS, accessed Apr 2016.
8. Ocean Mask, Oct 2008, MassGIS; published by MassGIS, accessed Apr 2016.