# FIXING THE LEAKS

# A regression analysis of leaked natural gas, proposed repairs, and population demographics in Greenfield and Cambridge, MA

## BACKGROUND

Every year in Massachusetts, millions of cubic feet of methane enter the atmosphere via leaks in natural gas pipelines. Massachusetts has some of the oldest infrastructure in the United States, and utility efforts to repair these leaks has been slow-going. As a result, residents are subject to the effects and dangers associated with increased atmospheric methane, from direct health and safety concerns to climate change. Utility companies are responsible for addressing and fixing these leaks, but they are not always effective.[1]

The nonprofit HEET (Home Energy Efficiency Team), based out of Cambridge, measures and maps these leaks, so that they may present the data to utilities, but it is still entirely up to the utility what will be fixed. While utilities have recently increased efforts to address these leaks, the chosen locations of repair sites may leave some communities suffering more than others due to factors such as socioeconomic dynamics and population demographics.

In measuring the efficacy of the utility in addressing leaks, this study focuses on the two municipalities in the US state of Massachusetts: Cambridge, a city near Boston, and Greenfield, located in the western part of the state. The two municipalities are serviced by two different utility companies: Eversource in Cambridge and Berkshire Gas in Greenfield. Each company addresses leaks in different manners and efficacy levels, which can be compared.

## METHODS

For each municipality, census block groups were selected and clipped from US Census data. Leak data, in location and methane concentration, was obtained from HEET, and mapped for each municipality. Major leaks (anything 2.5 ppm above acceptable methane levels)[2] were selected and that data was interpolated to produce a data field of methane values in parts per million across each municipality. Then, proposed sites of repair from 2017-2021 (obtained from the utility companies themselves via HEET) were mapped to compare areas of highest methane to sites of proposed repair (Fig. 1&2). Income was mapped by block group for each municipality, and similarly contrasted with proposed repair sites (Fig. 3&4).

A number of repair sites per block group was obtained by geocoding the addresses of proposed sites and spatially joining those locations to the block groups by location. Each block group then received a count of repair sites that it spatially contained.

Using the program Geoda, local Moran's I tests were used to create cluster maps of each municipality by block group for several factors: number of repair sites, methane levels (ppm), and income (Fig. 5). With Queen contiguity, each map shows block groups with high levels clustered with high, low with low, low with high, and high with low. These maps are meant to be a part of the visual analysis of trends in the amount of repair sites proposed in areas of high or low methane and income.

Finally, in Geoda, a regression was run for both municipalities, with count of repair sites per block group as the independent variable, and methane levels and income as the dependent variables. The p values from the regression were used to determine if methane levels or income had a more significant impact on the locations of proposed repair sites.

## CAMBRIDGE-GREENFIELD COMPARISON

### METHANE CONCENTRATION AND INCOME VS REPAIR SITES

**CAMBRIDGE** **GREENFIELD**

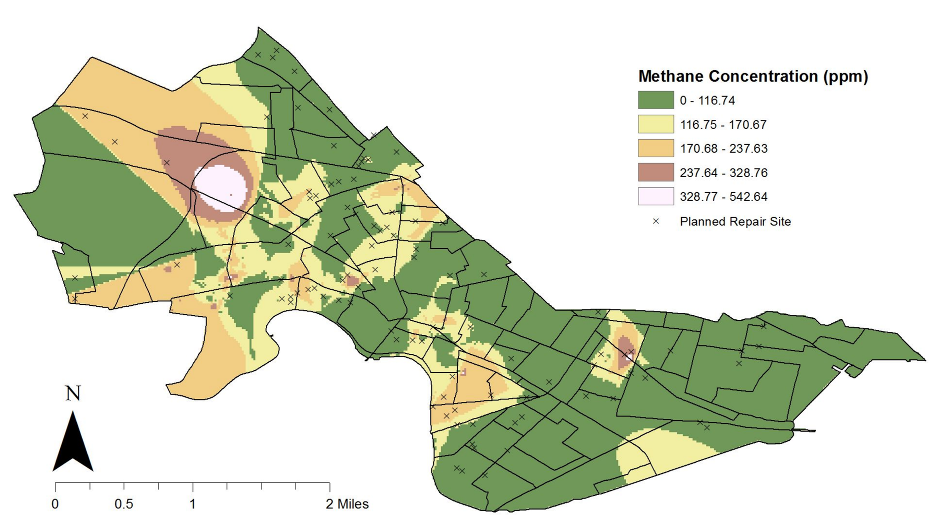



Fig. 1

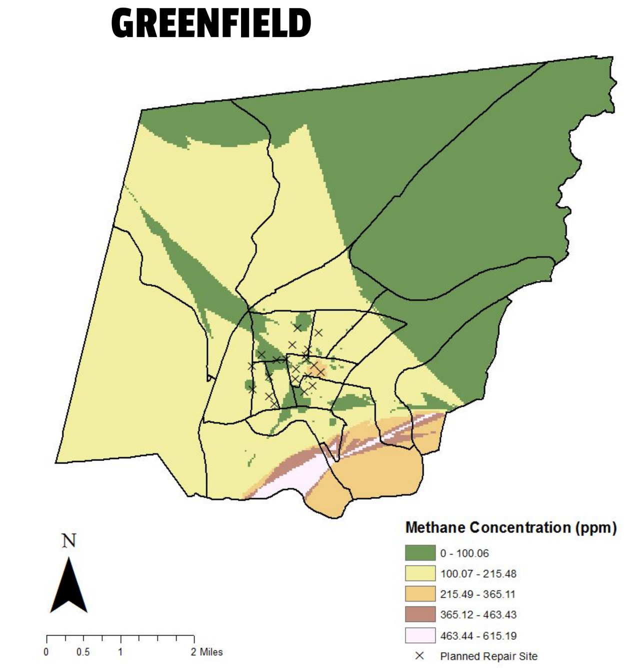



Fig. 2

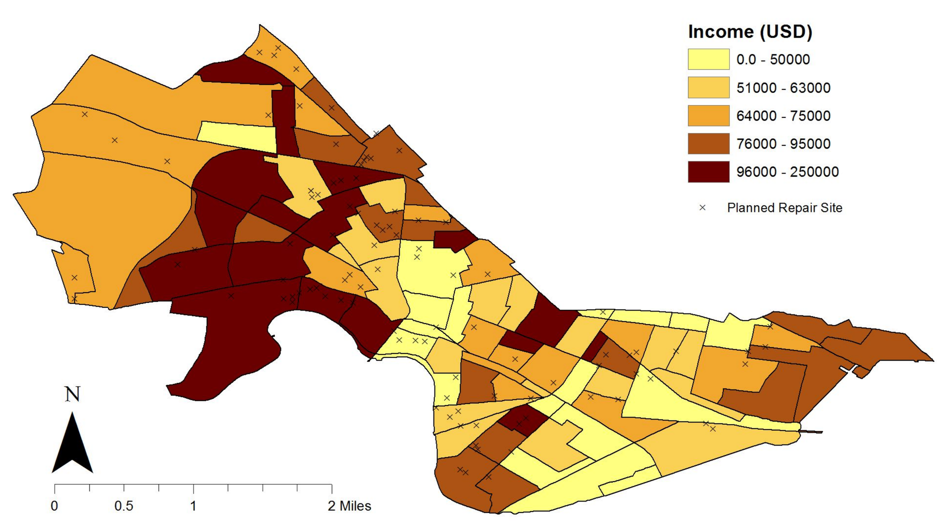



Fig. 3

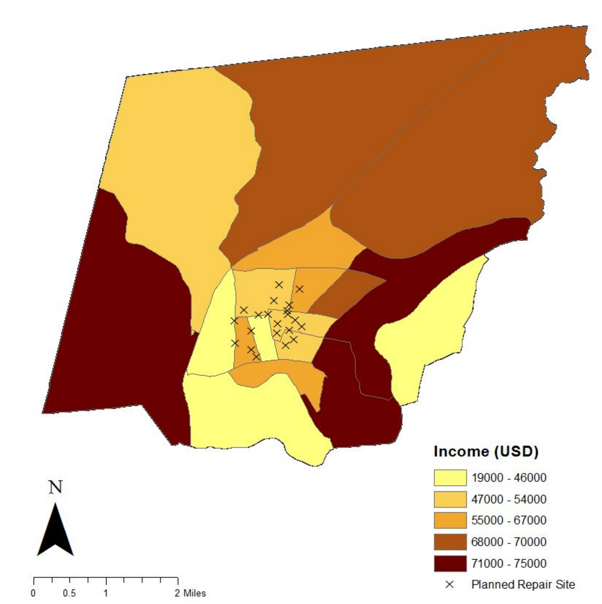
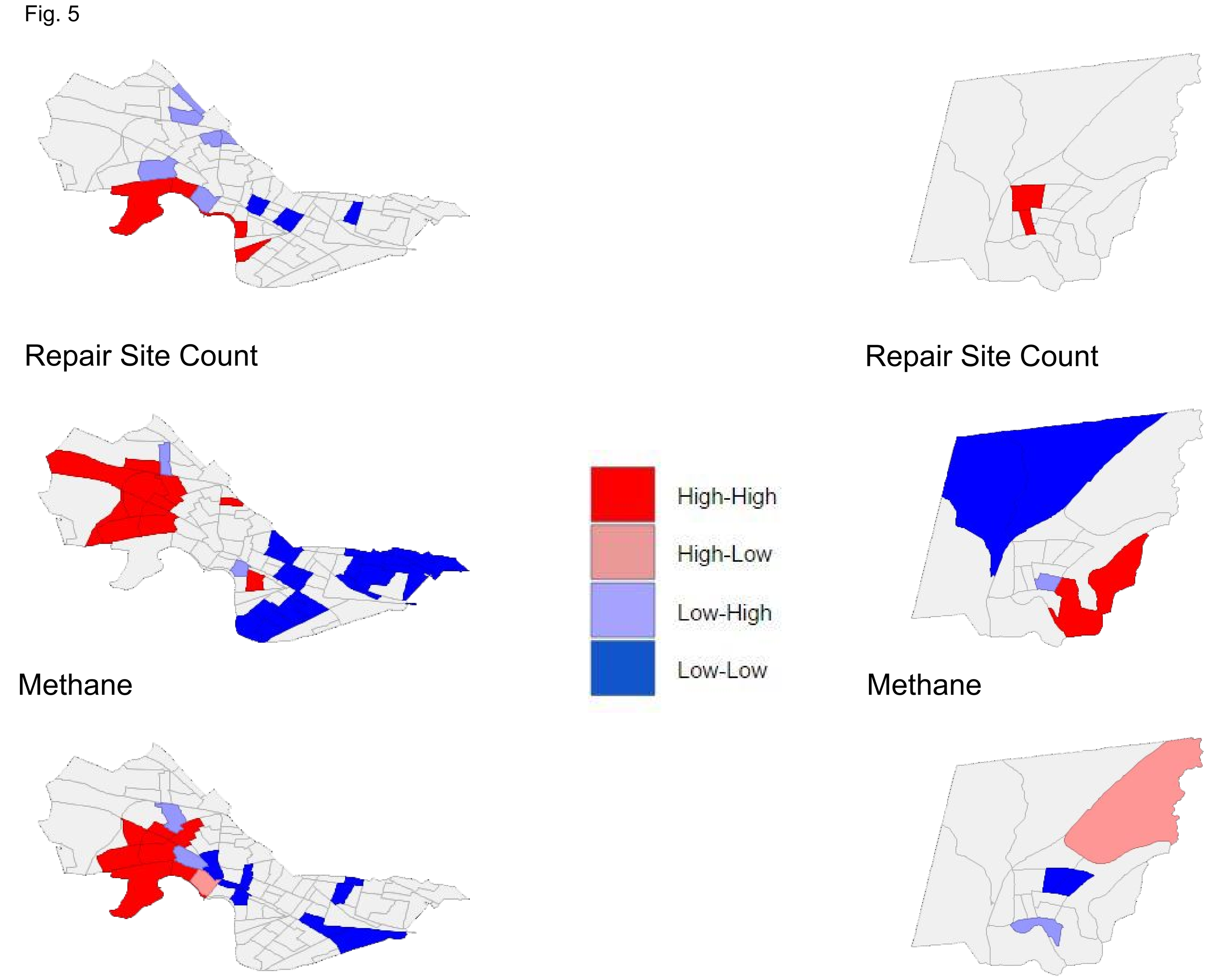



Fig. 4

### LOCAL MORAN'S I CLUSTERING

Fig. 5




## ANALYSIS

In Cambridge, the Moran's I maps indicate that there is little overlap between high clusters of repair sites and high clusters of methane concentration. There is overlap between some high clusters of repair sites and high clusters of income. At a significance threshold of p=0.05, the regression showed no significant correlation between mean methane concentration (p=0.37) or income (p=0.25) and number of repair sites per block group.

In Greenfield, the Moran's I maps indicated no overlap between high clusters of repair sites, methane, and income. The regression produced no significance between number of repair sites and either mean methane level (p=0.48) or income (p=0.40).

While the p values in Cambridge do not indicate a significant factor that plays a role in where repair sites will be located, the p value of income versus repair sites indicated a lower probability of randomness than that of methane versus repair sites. This could indicate that income in a block group has slightly more impact in the utility's selection of repair site than methane concentration in a block group. In Greenfield, the p values were too similar to make any such hypotheses.

Judging by this data and analysis, Eversource Gas may be more socioeconomically biased than Berkshire Gas. It is important to keep in mind, though, that this study was based off of 88 block groups in Cambridge and just 18 in Greenfield. The sample size of Greenfield was much smaller than that of Cambridge, and this must be taken into account with the results.

The study could have been improved by access to the age, material, and repair history of pipelines. This data could have provided further insight into the cause of leaks and motivation of utilities to fix them. A study of all of the cities and towns serviced by Eversource and Berkshire Gas respectively may yield more accurate results.

## DATA AND REFERENCES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12/19/16


Data sourced from:
1. The Home Energy Efficiency Team, Cambridge, MA
2. Tufts M Drive
3. US Census

References:


1. Brandt, A. R. et. al. (2014). Methane Leaks from North American Natural Gas Systems. *Science*,*343*(6172), 733-735. doi:10.1126/science.1247045
2. HEET. Learn more. Retrieved December 1, 2016, from http://www.heetma.org/squeaky-leak/learn-more/


Tufts