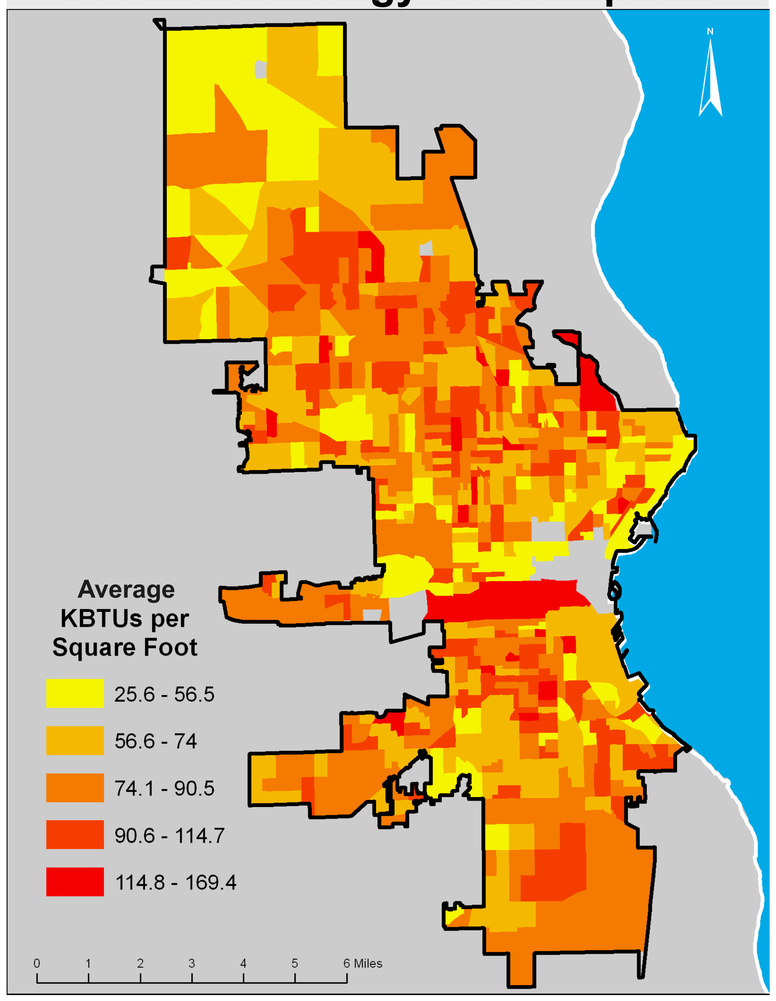
A Regression Analysis of Energy Efficiency in Milwaukee

Predicted Energy Consumption



Project Background

Why Weatherize?

Because many existing weatherization programs are available only to homeowners, renters are often left in the cold, so to speak. Unfortunately, without government help, most rental units will not be weatherized due to the split incentive structure between landlords, who do not pay energy bills and therefore have no motivation to weatherize, and tenants, who do not wish to spend significant sums to weatherize homes they may only live in for one or two years. This situation hurts not only the families who live in these units, whose already tight budgets are stretched further, but society as a whole due to the increased emission of greenhouse gasses. In addition, a literature review revealed evidence that home modifications can often hurt the energy efficiency of homes when not done by professionals, which adds weight to the argument in favor of government assistance (Etzion et al 2001). This project aims to assist Milwaukee policy makers in the distribution of weatherization funds to low-income renters by identifying Block Groups predicted to have high levels of energy consumption per square foot.

Methodology

Because actual energy data is generally difficult to obtain due to the privacy concerns of utility companies, alternate techniques for predicting energy use must be utilized. In order to identify areas of the city most in need of weatherization programs, this project uses a regression model developed by Neil Veilleux (2010) in order to ascertain a Block Group level estimate of the average energy usage per square foot of residential property. This figure, KBTUs per square foot per year, can be seen in the map to the left. A number of variables contribute to this estimate, including age of structure, type of heating fuel, median income, tenure, number of heating and cooling degree days, presence of seniors, and average square footage of residential units. These results can be seen in the table above.

ln(Btus in thousands)	Coef.	Std. Err.	P>|t|	Median	B*Median	Impact on Btus (delogged $Btus_{adj}e^{(B*Median)}$)
Hhld income	-4.39E-06	2.10E-06	0.002	39571	-2.16E-01	0.80492973
ln(SqFt)	0.199901	0.017044	0.000	7.6	1.52E+00	4.57285688
Inter.: of Hhld income & ln(SqFt)	9.47E-07	2.71E-07	0.000	265204	2.47E-01	1.28002407[illegible]
Own/rent	+0.1046334	0.016976	0.000	1	+6.41E-02	0.94738281
Senior	0.0040909	0.017105	0.811	0	7.92E-04	1.00079209
ln(# of Hhlders)	0.2656190	0.012232	0.000	1	2.30E-01	1.26263609[illegible]
Heating Deg Days	0.0000891	4.74E-06	0.000	6668	5.94E-01	1.81143400[illegible]
Cooling Deg Days	0.0001429	9.86E-06	0.000	418	8.83E-02	1.09239394
Electric heat	0.0779802	0.017181	0.000	0	1.56E-02	1.01583909
Nat gas heat	0.6198097	0.02034	0.000	1	4.05E-01	1.49890589
LP heat	0.4954137	0.029051	0.000	0	2.63E-02	1.02661668
Fuel Oil heat	0.7719102	0.030209	0.000	0	3.86E-02	1.03934992
Wood heat	+0.0327276	0.011814	0.134	0	+1.44E-03	0.99836458
Kerosene heat	0.0897868	0.061474	0.082	0	4.49E-03	1.00449632
pre_1940	0.1569789	0.029447	0.000	0	5.49E-02	1.05647998[illegible]
y1940_49	0.0994412	0.034787	0.004	0	1.89E-02	1.01407088[illegible]
y1950_59	0.0759706	0.030194	0.009	0	1.27E-02	1.01279274[illegible]
y1960_69	0.0582681	0.030372	0.055	0	2.16E-02	1.02179276[illegible]
y1970_79	0.0462147	0.028162	0.101	0	2.01E-02	1.02030771[illegible]
y1980_89	0.0256615	0.02812	0.363	0	5.83E-03	1.00581392[illegible]
y1990_99	0.0286124	0.028298	0.312	0	0.00E+00	1
MW (division 3)	0.0114[illegible]	0.019974	0.566	1	1.15E-02	1.01151491[illegible]
_cons	8.456884	0.139224	0.000	1	8.46E+00	4706.425886

Findings

Several conclusions can be drawn from this analysis regarding the effects of specific variables upon energy consumption. Although it was posited that the presence of seniors would increase energy consumption, this variable was not found to be significant. Other variables that were not significant predictors of energy usage included Milwaukee's Midwest location, the use of wood or kerosene heat, and structures built after 1960. This means then, that all other inputted variables do impact energy use, including many that are generally assumed, such as income, number of people, building size, other heating types, and older structures. These findings generally support common assumptions regarding which factors might affect energy use.

Conclusions

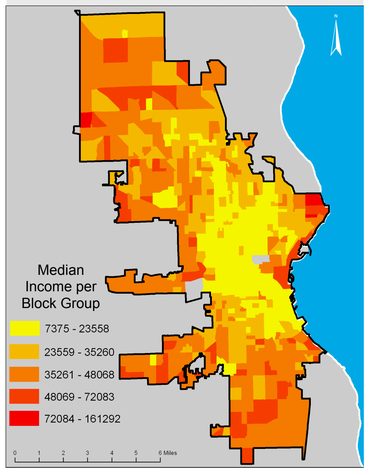
Several methodological limitations may have affected the accuracy of this project's findings. Most significantly, it must be remembered that regression models are only estimates, and actual utility data must be ascertained in order to truly understand energy consumption. In addition, Milwaukee's tax assessor database lacks information for many large apartment buildings. This may inflate energy estimates due to the overrepresentation of smaller apartments and single family homes, which tend to have larger floor areas. Finally, because Milwaukee's zoning code allows mixed-use developments, some non-residential properties may have been inadvertently included.

Beyond recreating this project with real utility data, these energy use estimates can be used in conjunction with other variables to better target weatherization programs. For example, the KBTU map could be overlaid with median income and tenure in order to isolate Block Groups with high energy use, low median income, and high proportions of renters. Such a project would greatly aid policy makers wishing to target funds to low-income renters.

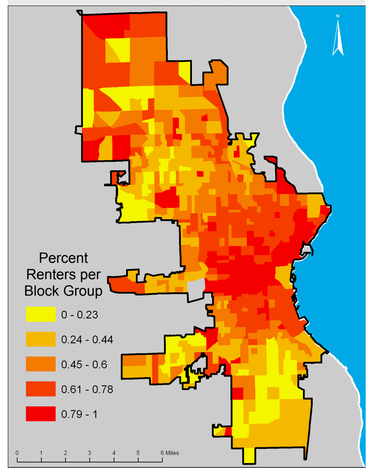
Mapped by Elizabeth Panella, Introduction to GIS, Spring 2010

Data Sources: City of Milwaukee, ESRI, US Census Bureau, US Department of Energy, Weather Underground

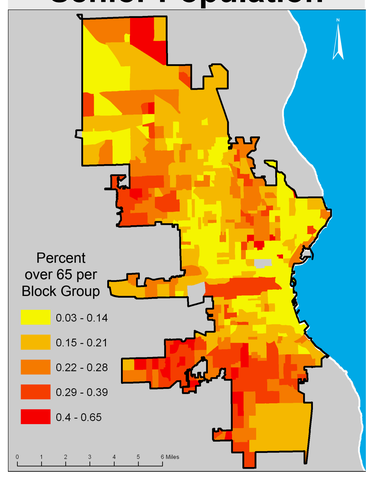
Household Income



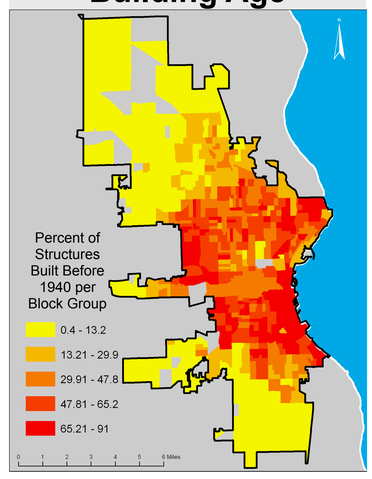
Tenure



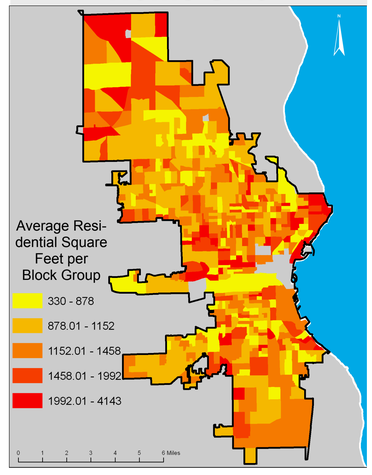
Senior Population



Building Age



Home Size



Natural Gas Usage