MODELING
RADON EXPOSURE RISK
IN MASSACHUSETTS

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ADVANCED GIS

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NAD 1983 State Plane – Massachusetts Mainland FIPS 2001

Data Sources

- Bedrock Lithology provided by the USGS and distributed by MassGIS
- Public Water Percentages: Data from the 1990 US Census and distributed by MassGIS
- Age of Homes: Data from the 2000 Census and distributed by the Massachusetts Dept. of Public Health
- County, town, boundaries from MassGIS

1 abstract

Radon is the number one cause of lung cancer among non-smokers, and exposure significantly increases the risk of lung cancer among smokers. Radon is responsibly for 21,000 deaths every year[1].

This investigation evaluates the risk of radon exposure spatially in Massachusetts. **Bedrock geology, the percentage of homes on public water, and the age of homes** impacts one's risk for radon exposure, and were used as variables in the analysis. A risk map was developed using two overlay models: a fuzzy overlay, and a weighted overlay.

Results for both overlay models show that Worchester county, western Middlesex, Hampden, Franklin, and Berkshire counties all have pockets of high risk, with Worchester being particularly prone to exposure.

2 methodology

linear regression to determine variable weights - Ideally, a regression model would determine variable weights for an overlay analysis. However, the state of Massachusetts only has county-level data for measured radon exposure. The linear regression model showed only housing age is significant. However, geology is the main determinant behind radon risk, so it was determined that the truthing data was not sufficient to develop a true regression. This informed the decision to use two overlay models: weighted and fuzzy

weighted overlay

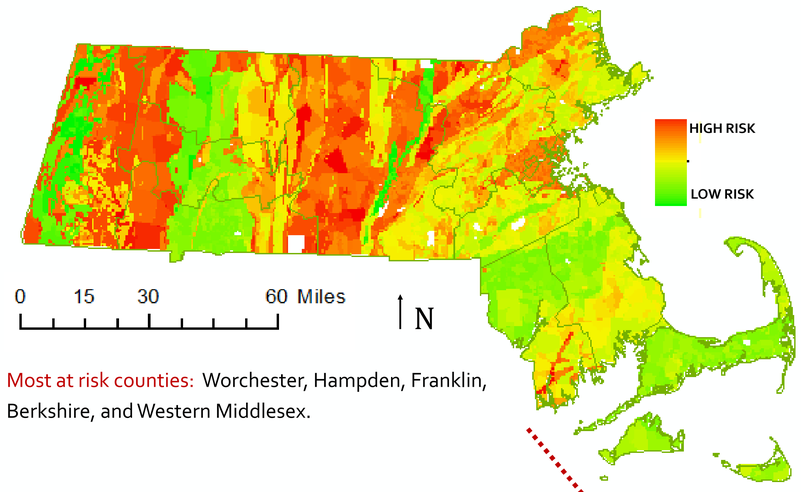
This model determined areas most suitable for radon by weighting variables as least to most effective in creating an environment prone to radon. The geology was weighted most heavily, and factored based on how much uranium is in the general bedrock types.[2]

$$\begin{bmatrix}1&2\\1&1\end{bmatrix} + \begin{bmatrix}0&4\\3&0\end{bmatrix} = \begin{bmatrix}1&6\\4&1\end{bmatrix}$$

fuzzy overlay

A fuzzy overlay model mirrors a general overlay model but tries to account for inaccuracies in spatial data. This usually occurs when classes are defined. For this analysis, these inaccuracies would arise from forcing continuous data like housing ages, percentages of homes on public water, and uranium content into classes. Fuzzy logic defines how likely an area is to be a member of class.

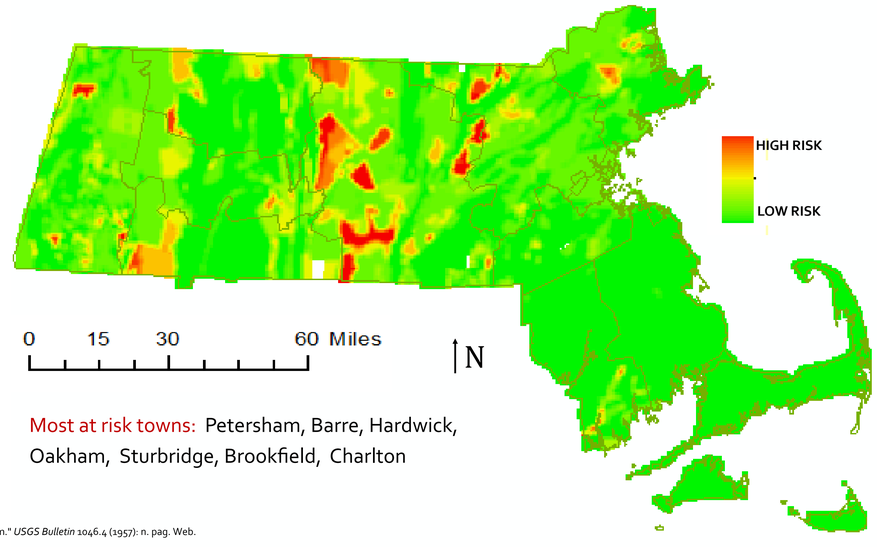
3 weighted overlay model



Most at risk counties: Worchester, Hampden, Franklin, Berkshire, and Western Middlesex.

The weighted overlay model shows significantly more areas at high risk than the fuzzy overlay. The fuzzy overlay model may be more helpful in pinpointing specific high-risk towns, while the weighted overlay is more applicable for a county-level understanding of radon risk.

4 fuzzy overlay model



Most at risk towns: Petersham, Barre, Hardwick, Oakham, Sturbridge, Brookfield, Charlton

5 conclusion

Both models show significant radon risks in Worcester county, although the fuzzy model does show a few particular areas which seem to be at a highlighted risk within Worcester county. Both models are mostly driven by bedrock geology, and mirror the EPA's 1988 map on measured radon values. Both overlay models produce a risk map that is significantly higher in resolution and pinpoint areas, such as Petersham, where residents should be more aware of radon.

Tufts

[1]Environmental Protection, and Agency. *EPA Assessment of Risks from Radon in HomesEPA ASSESSMENT OF RISKS FROM RADON IN HOMES* (n.d.): n. pag. Web. Klepper, M. R.

[2]"Notes on the Geology of Uranium." *USGS Bulletin* 1046.4 (1957): n. pag. Web.