Geospatial Analysis of Lung Cancer Incidence & Mortality Rate

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Office of Health Equity & Virginia Cancer Registry

Virginia Department of Health

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Analysis on Lung Cancer Incidence Rate Around High Way and Superfund Sites

What is Superfund?

Thousands of contaminated sites exist nationally due to hazardous waste being dumped, left out in the open, or otherwise improperly managed. These sites include manufacturing facilities, processing plants, landfills and mining sites.

In the late 1970s, toxic waste dumps such as Love Canal and Valley of the Drums received national attention when the public learned about the risks to human health and the environment posed by contaminated sites.

What is Superfund?

The National Priorities List (NPL) is the priority list of hazardous waste sites in the United States eligible for long-term remedial investigation and remedial action (cleanup) financed under the federal Superfund program.

Of the 40,000 federal Superfund sites across the country, approximately 1,600 are on the NPL. The vast majority are shorter-term cleanups that are not listed on the NPL.

Data Used

1. Cancer Data
   - Lung cancer 2009-2018 from Virginia Cancer Registry
   - Age 35 and above
   - VA residents
   - No name, SSN, DOB, or address provided
   - Consolidated SS2000, Derived SS2000 and SS2018
   - State specific data, smoke, alcohol etc. included

2. Social economic and EPA data

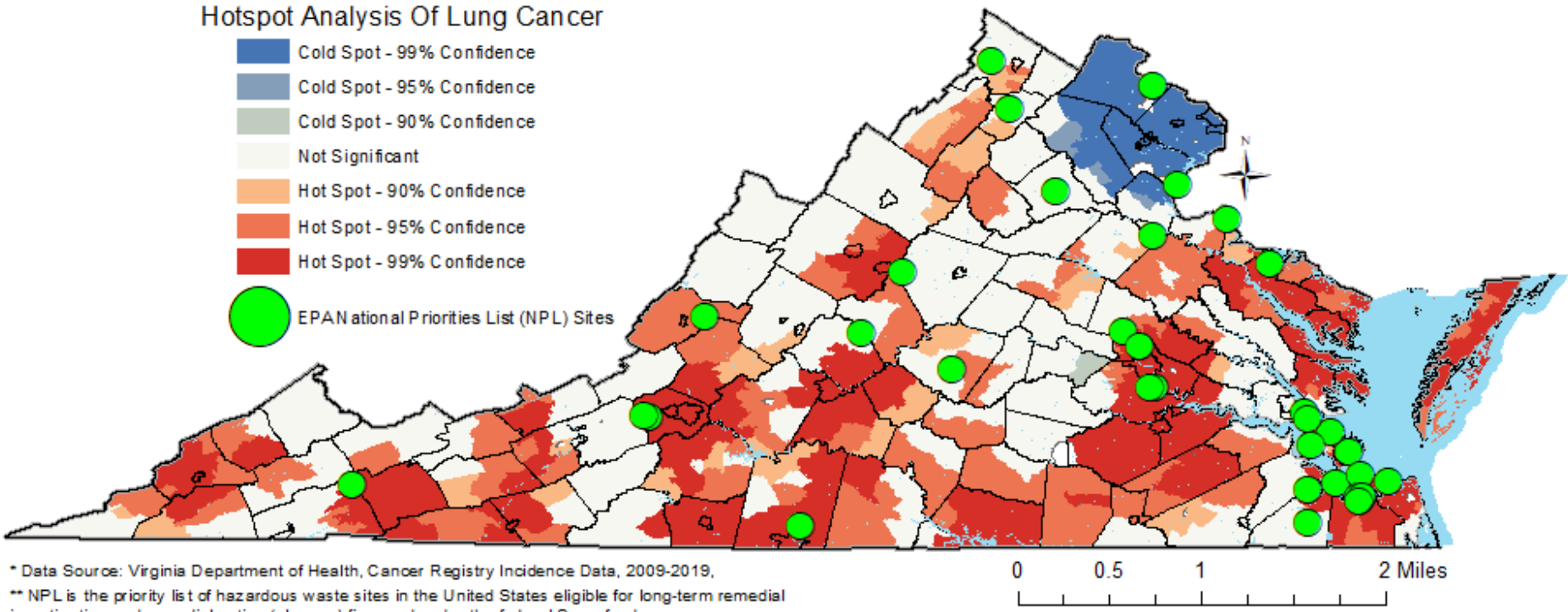
   Locality data on Population density, EPA environmental, Walkability, income inequality, education, job participation, access to health care, access to employment, food access, etc.

Virginia

Lung Cancer * Rate per 100,000 Population

Hot Spot Analysis at Census Tract

Overlaid with EPA Superfund Site**
2009 - 2019



* Data Source: Virginia Department of Health, Cancer Registry Incidence Data, 2009-2019,

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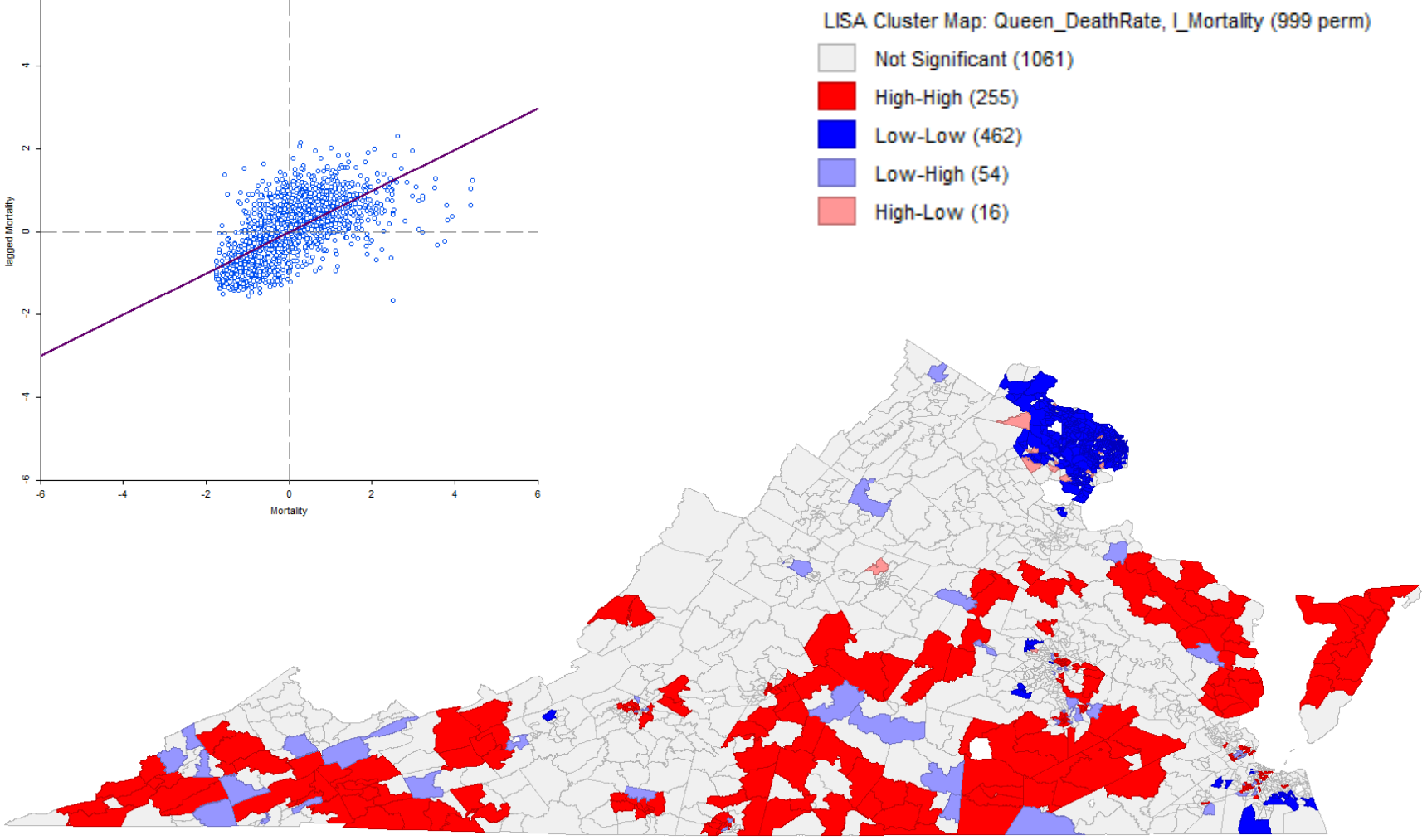
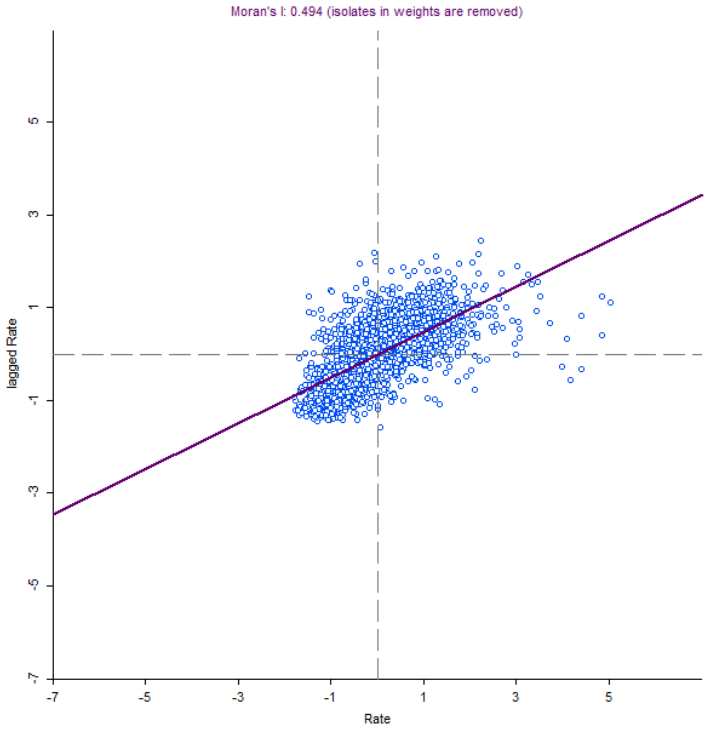
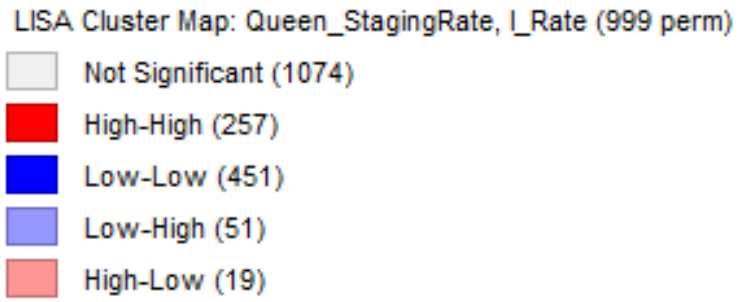
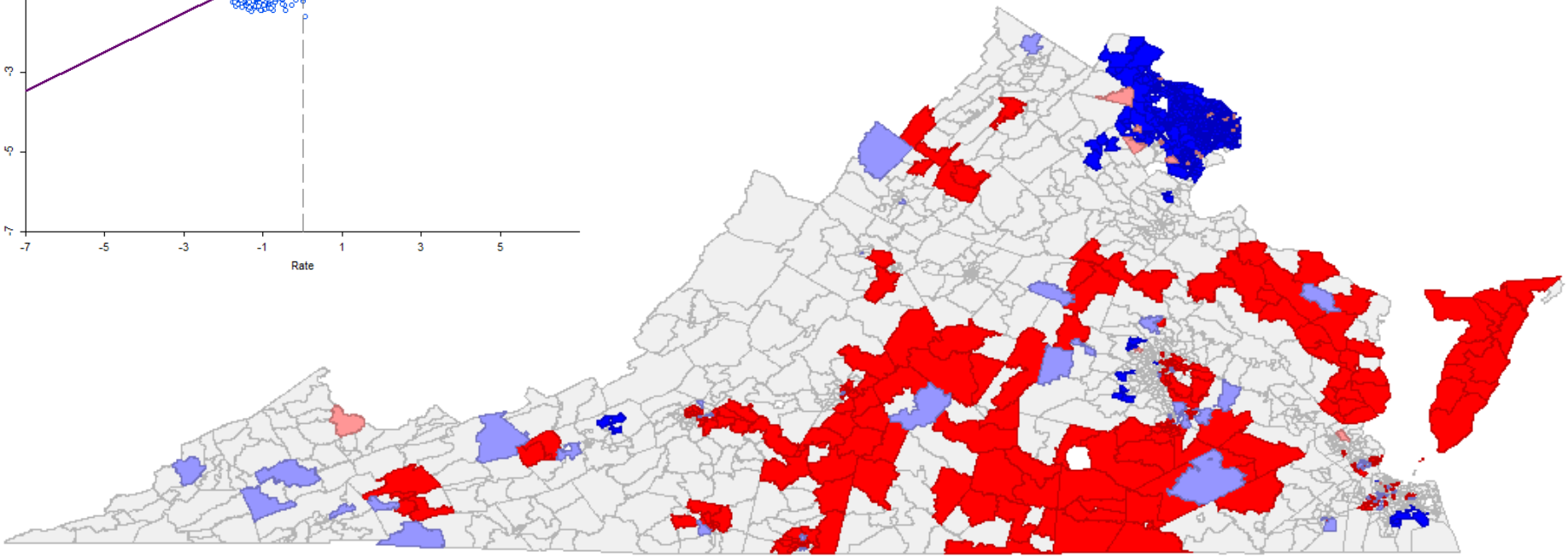
GeoDA – Spatial Pattern-Lung cancer Mortality Rate



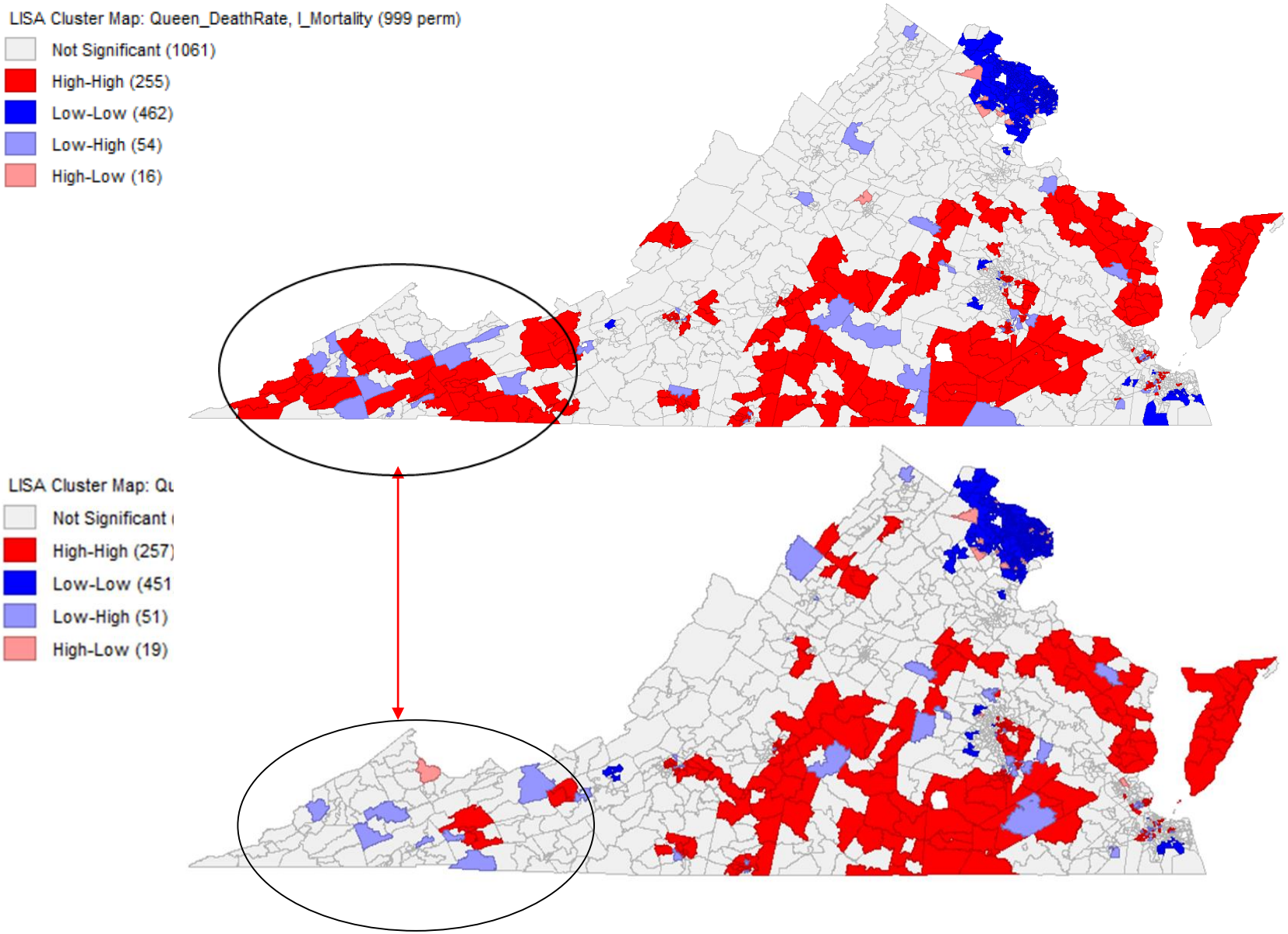
GeoDA – Spatial Pattern-Lung cancer Late Stage Rate







Map of Lung Cancer Mortality Crude Rate and Rate of Lung Cancer Diagnosed At Late Stage, VA 2009-2018

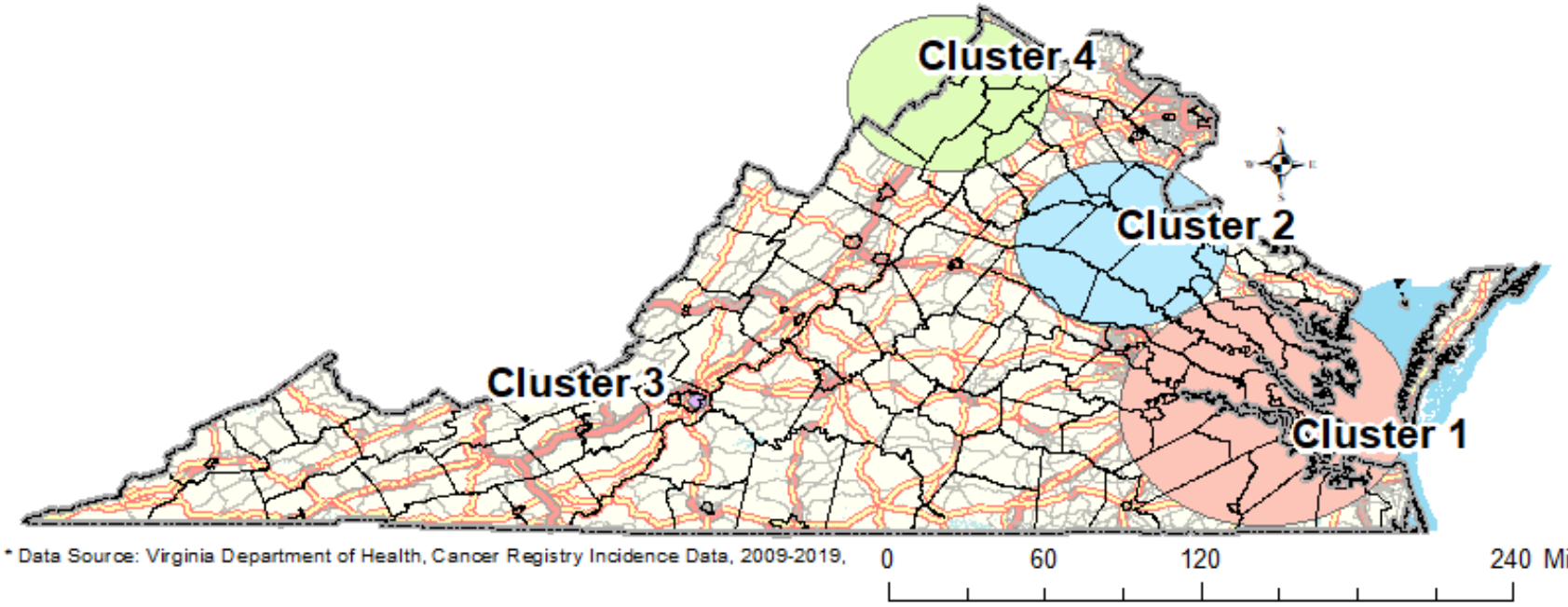


Virginia

Geographical Location of Lung Cancer * Clusters

Using SaTScan to Detect Geographic Targets for Lung Cancer

2009 - 2019



CLUSTER	RADIUS	LLR	*P VALUE*	OBSERVED	EXPECTED	RELETIVE RISK
Cluster 1	71.2	202.1	0.00001	14,300	12,318	1.22
Cluster 2	51.7	61.9	0.00001	3,737	3,117	1.21
Cluster 3	4.4	61.8	0.00001	576	349	1.66
Cluster 4	48.3	14.6	0.0009	1,900	1,677	1.14

Virginia

Geographical Location of Lung Cancer * Clusters

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Overlaid with EPA Superfund Site**

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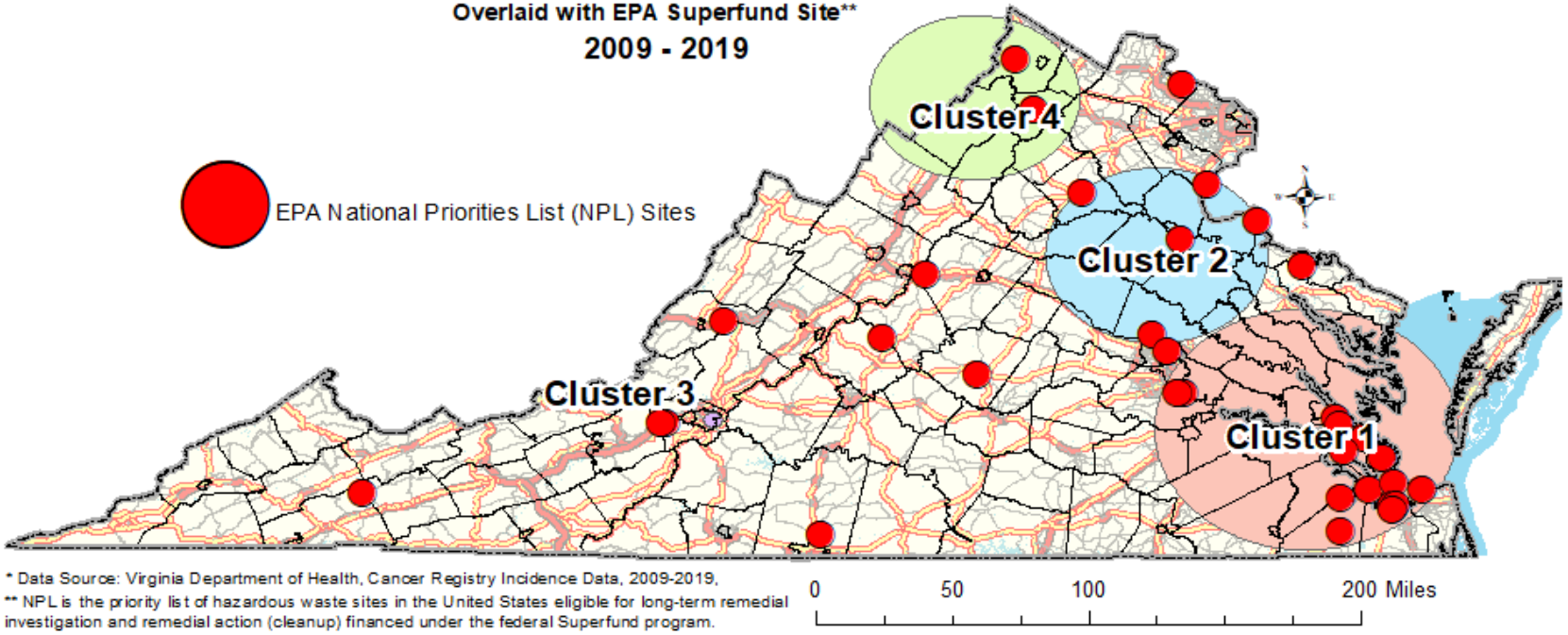

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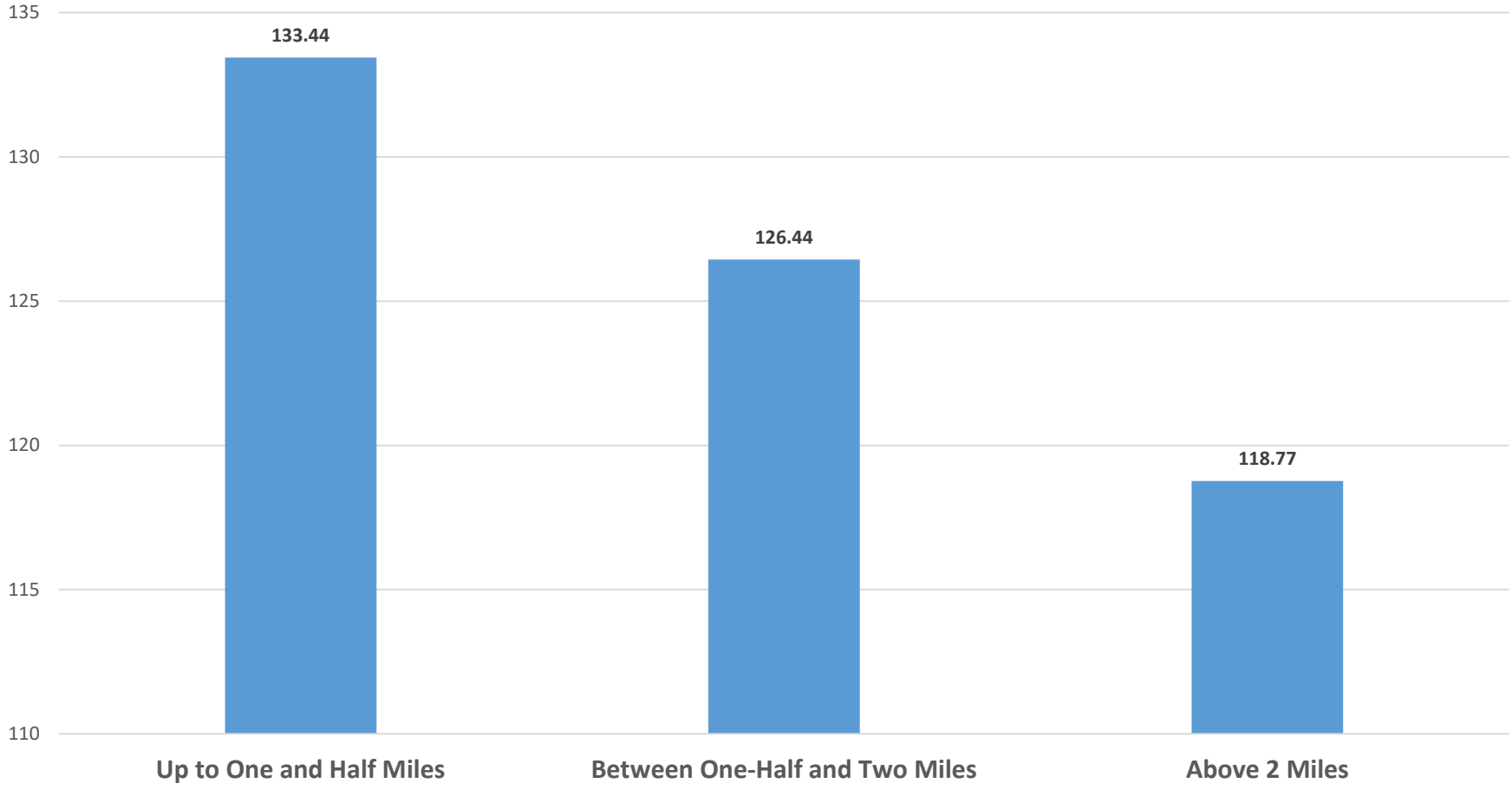
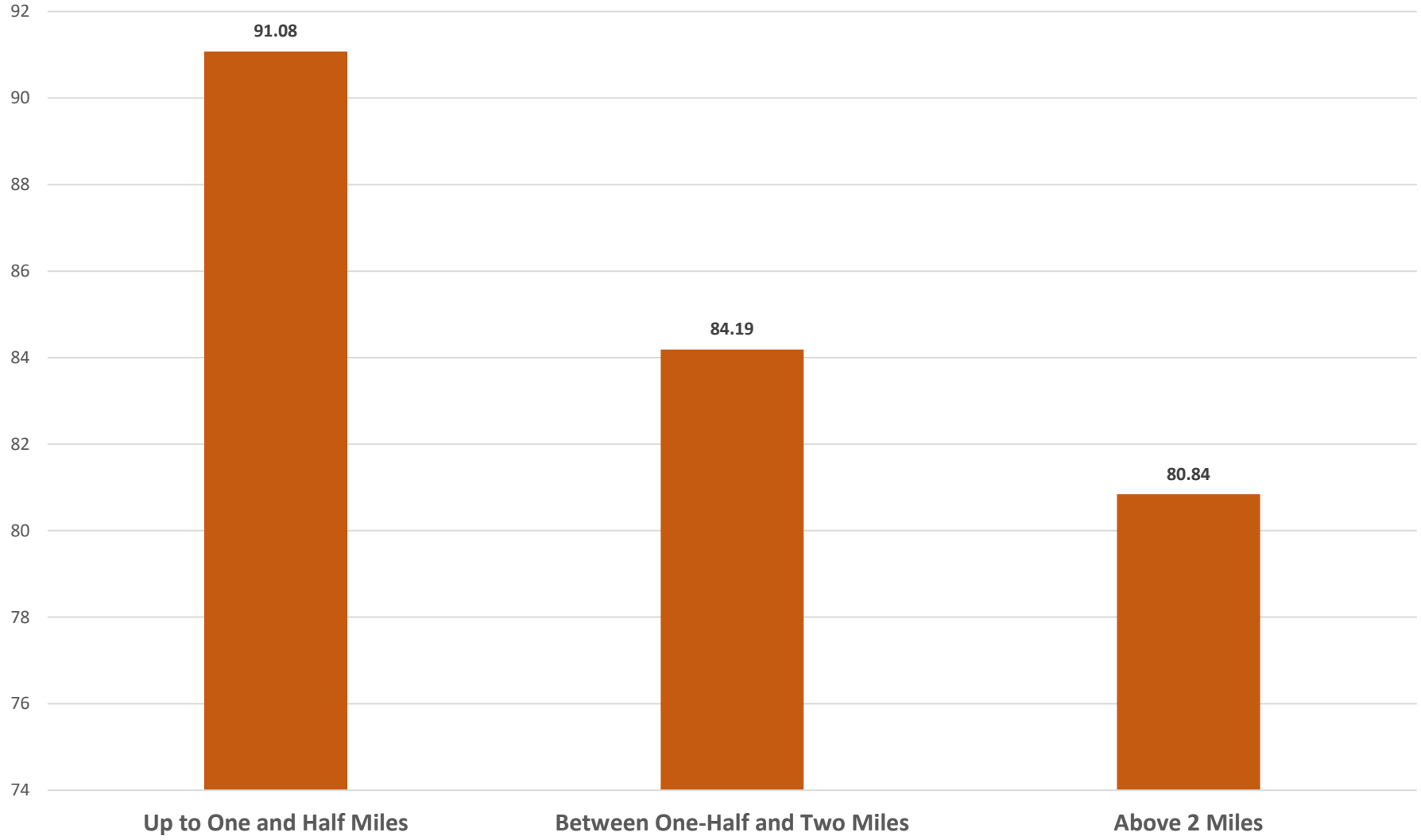
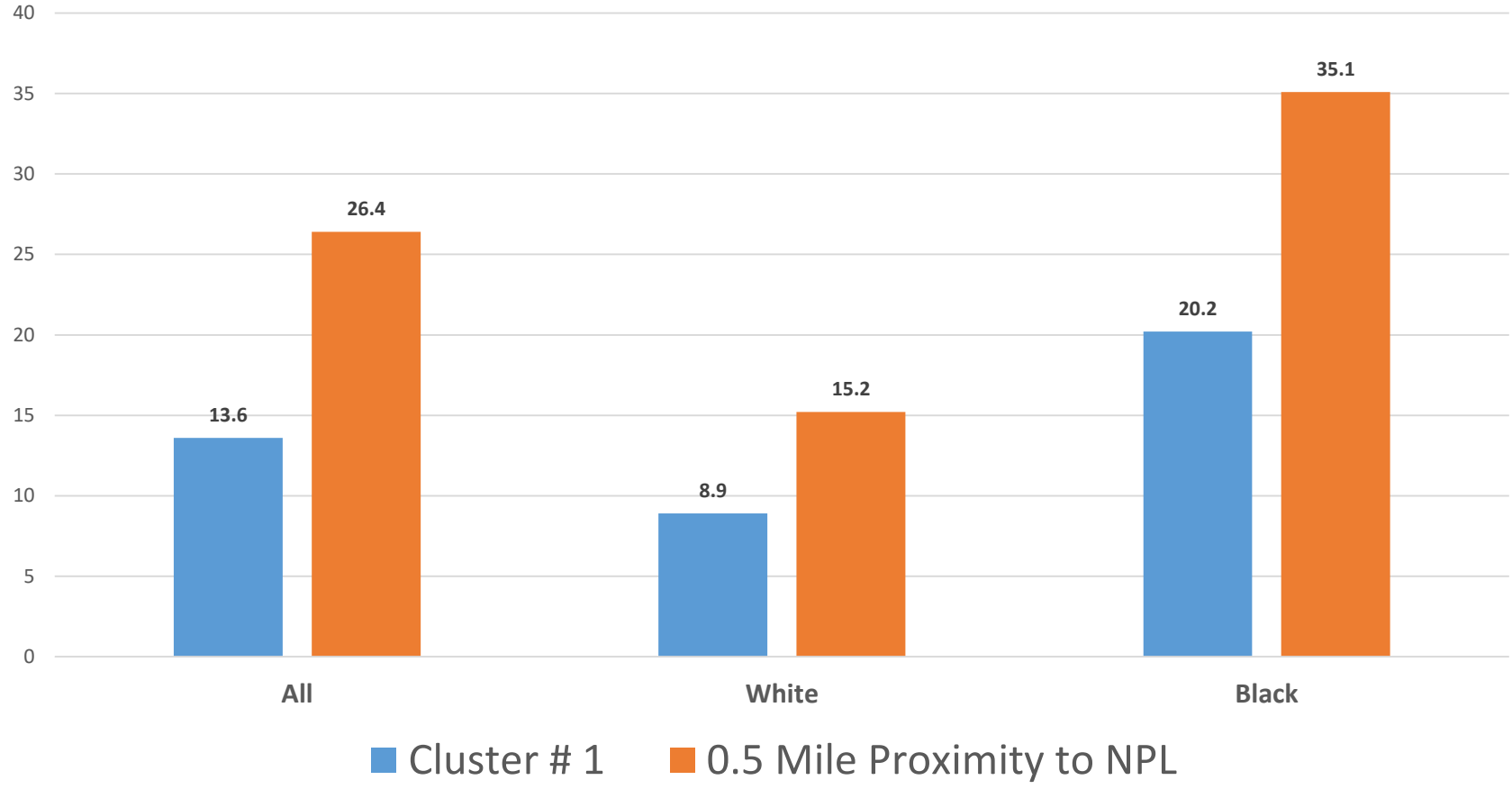
Residential Proximity to EPA SuperFund Sites & Lung Cancer Incidence in Virginia, per 100,000 Population



Residential Proximity to EPA SuperFund Sites & Lung Cancer Mortality in Virginia, per 100,000 Population



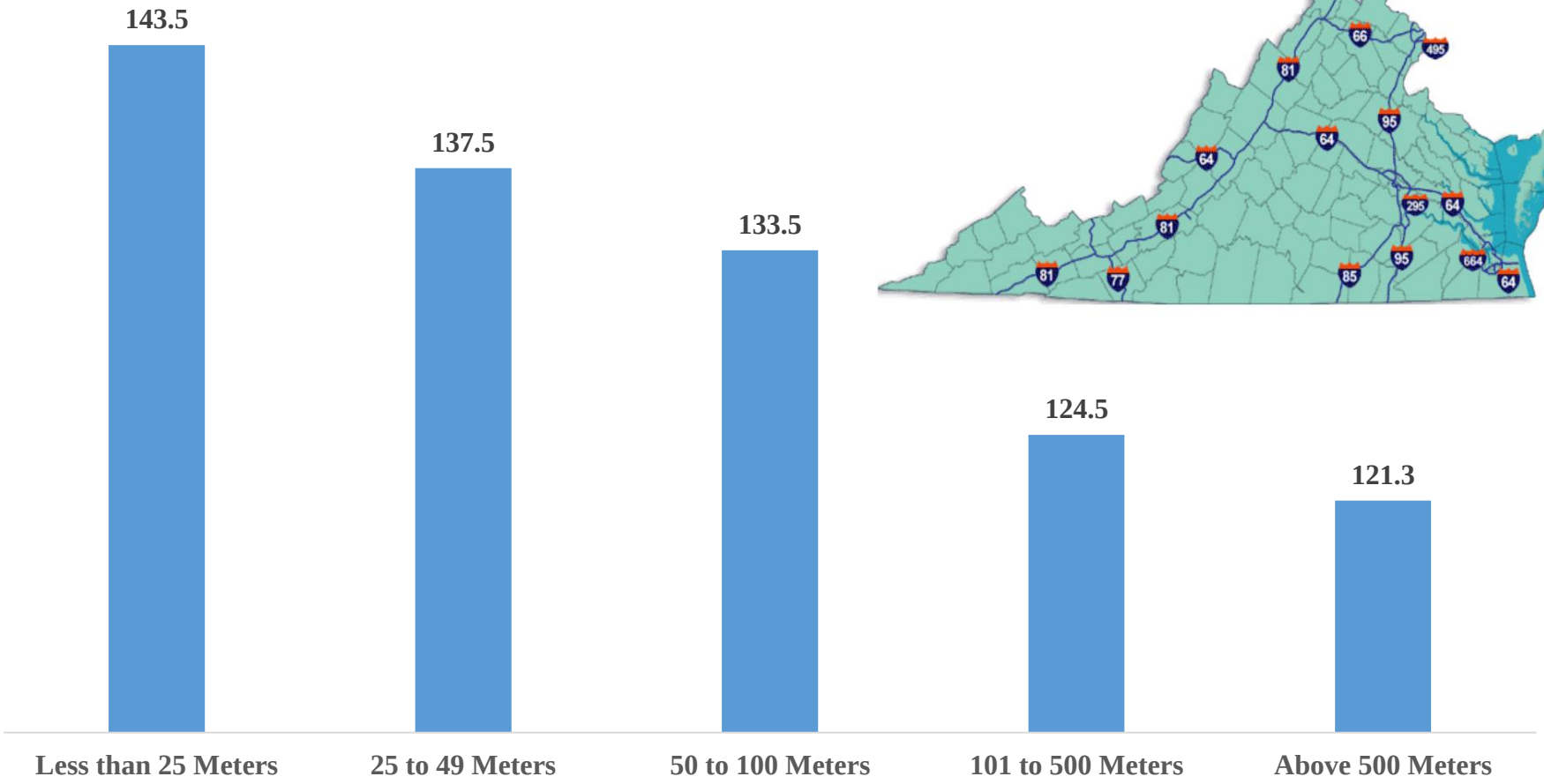
Cluster #1 and Half Mile Proximity to NPL * Sites Federal Poverty Level (1 FPL) by Race



Segment Profile of Pop. residing One & half miles from Superfund Sites

- White Alone 54.9%, Black Alone 33.3%, Asian Alone 3.7%, Other Race 8.1%
- Per Capita Income $28,090 (US - $31,950)
- Median household income is $55,097 in the area, compared to $58,100 for all U.S.
- Currently, 50.7% of the 74,417 housing units in the area are owner occupied; 41.7%, renter occupied; and 7.6% are vacant
- 30.8% of household has a net worth less than $15,000

Residential & Lung Cancer Crude Incidence Rate (per 100,000) Proximity From Virginia Highway By Distance

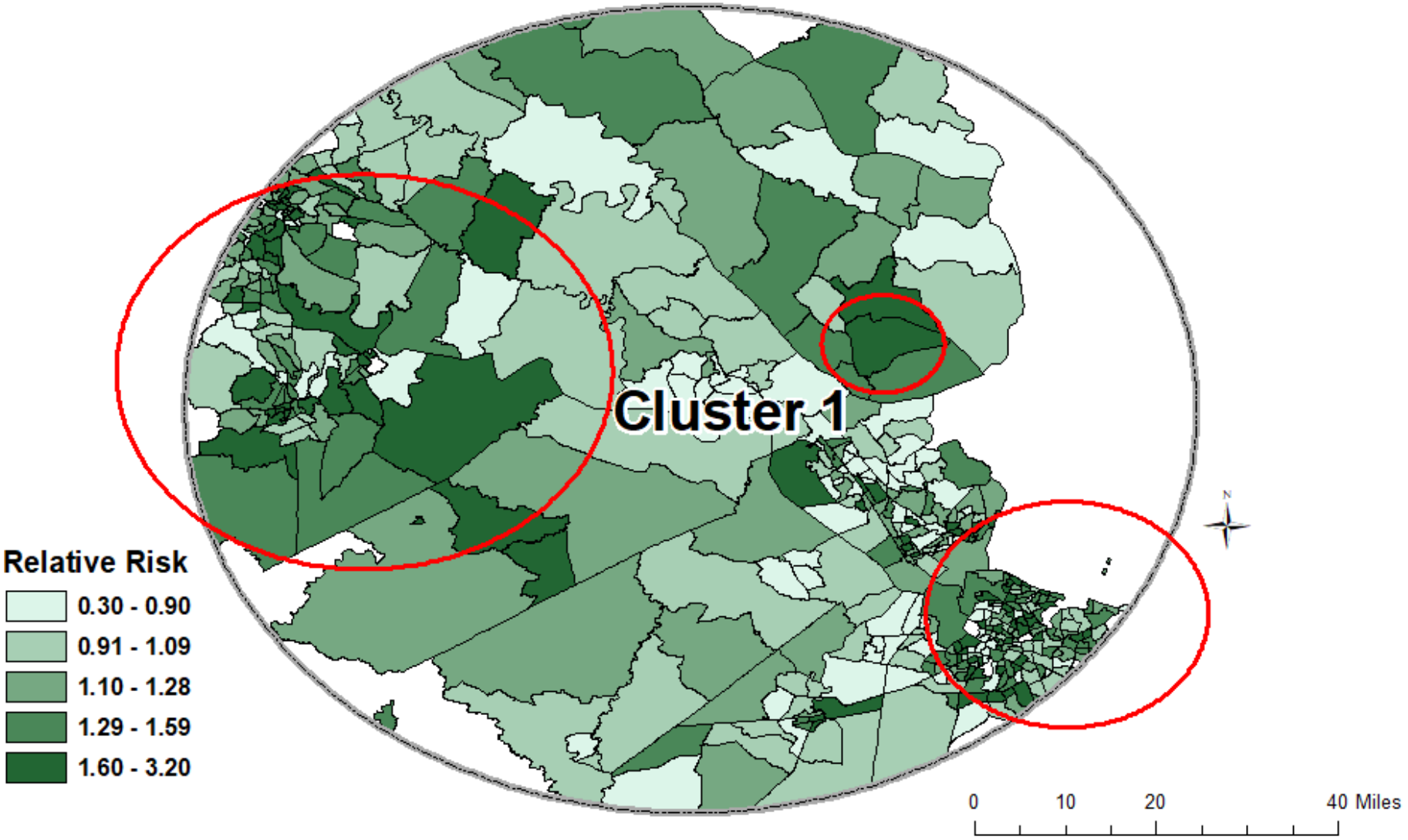


Hampton Roads Metropolis

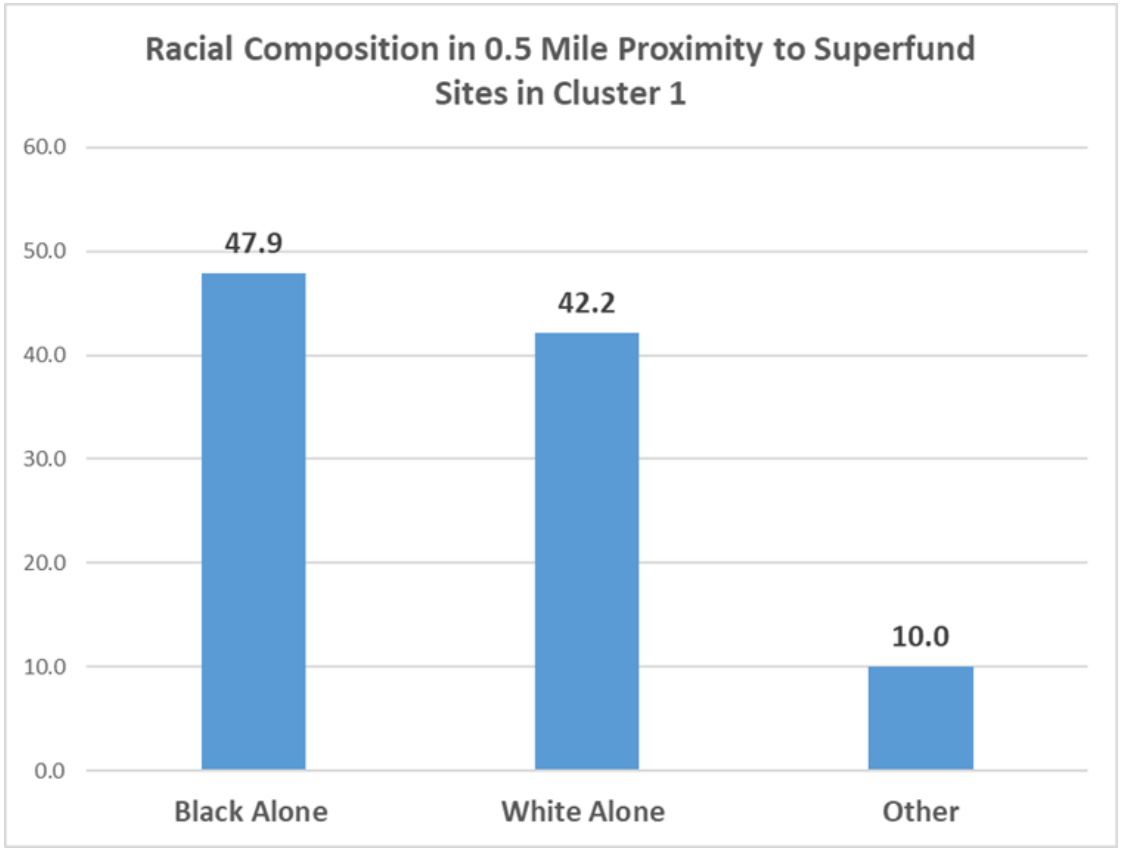
Lung Cancer Relative Risk

Optimal Cluster Reporting Sizes within Cluster # 1

2009 - 2019



0.5 Miles Proximity from Superfund Sites in Cluster #1



- Relative Risk = 1.44
- Current median household income is $44,333 in the area, compared to $58,100 for all U.S. households.
- Current per capita income is $22,002 in the area, compared to the U.S. per capita income of $31,950.
- Currently, 35.2% of the 4,878 housing units in the area are owner occupied; 54.1%, renter occupied

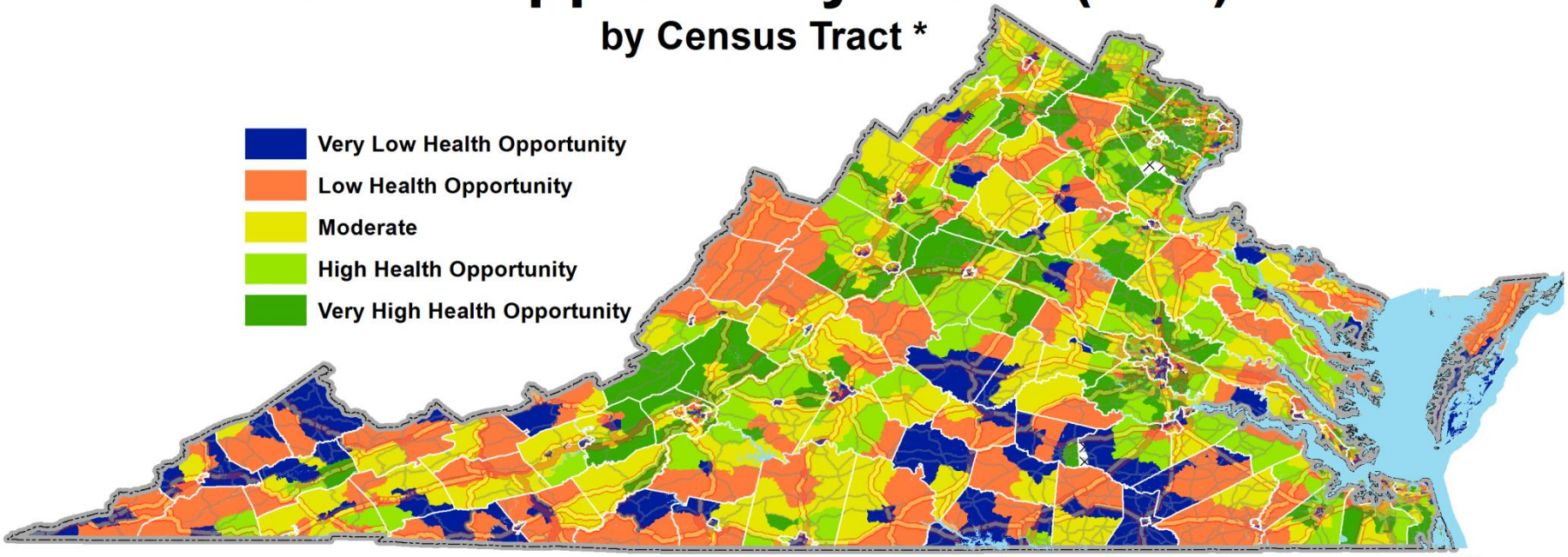
Lung Cancer Data Modeling

Neighborhood Effect

Virginia

Health Opportunity Index (HOI)

by Census Tract *

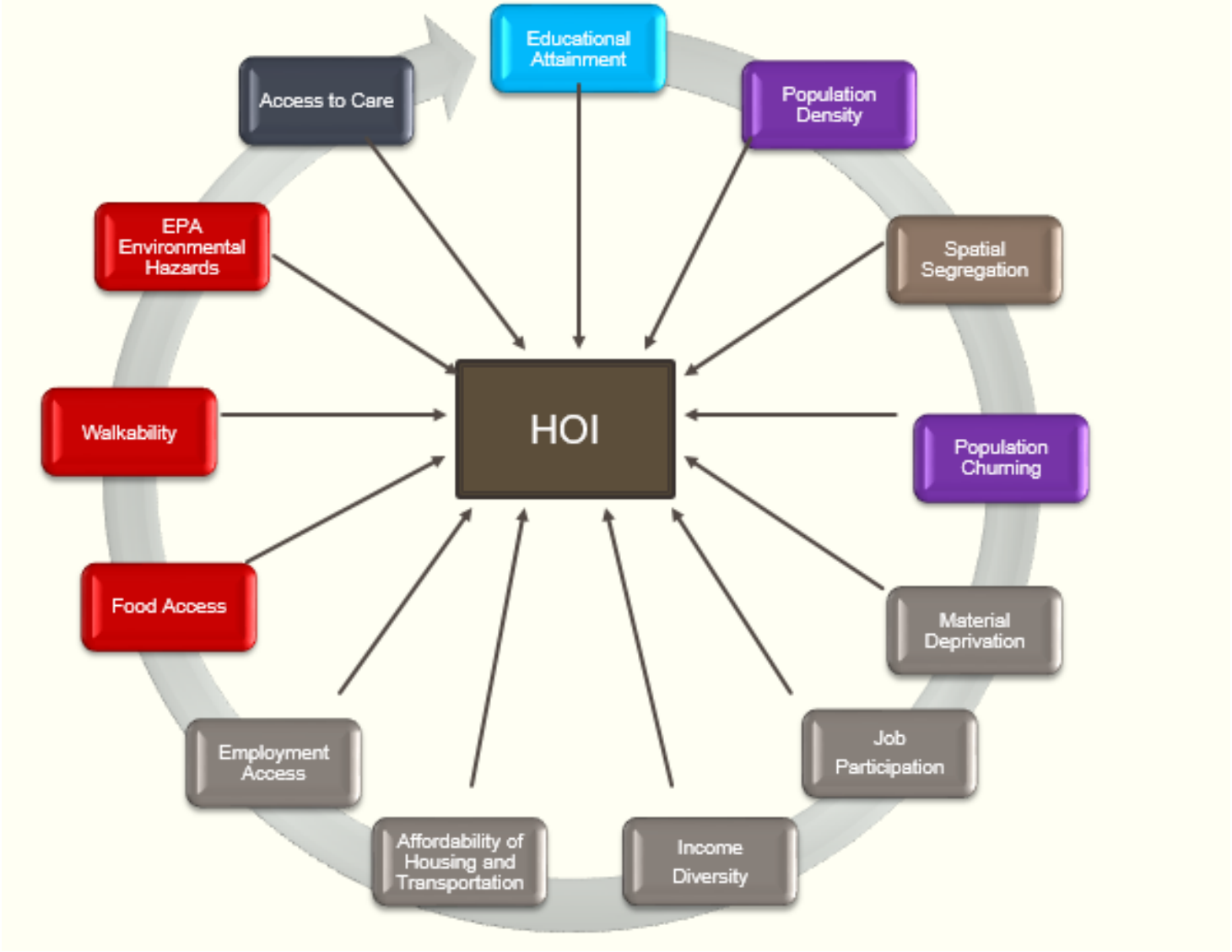


* Health opportunity Index (HOI) – The HOI is a composite measure comprising 4 componets that reflect a broad array of social determinants of health. The 4 components include: 1. Consumer Opportunity Profile 2. Economic Opportunity Profile 3. Wellness Disparity Profile 4. Community Environmental Profile (Note: the 4 components were derived from 13 initial indices)

The HOI was developed to assist the public, businesses, policy makers, communities, healthcare organizations and public health professionals in identifying key social and economic factors (also known as social determinants of health) that affect the health outcomes of the residents of Virginia communities. The set of factors chosen to be included within the HOI was designed to capture the processes by which “opportunities to be healthy” emerge; upon determination of the community HOI score it can suggest where specific interventions may aid in developing a healthy community. Not only does the HOI assist in identifying such areas, it can facilitate a positive attitude toward change within the local community

Healthy People 2020: Five Elements of SDOH

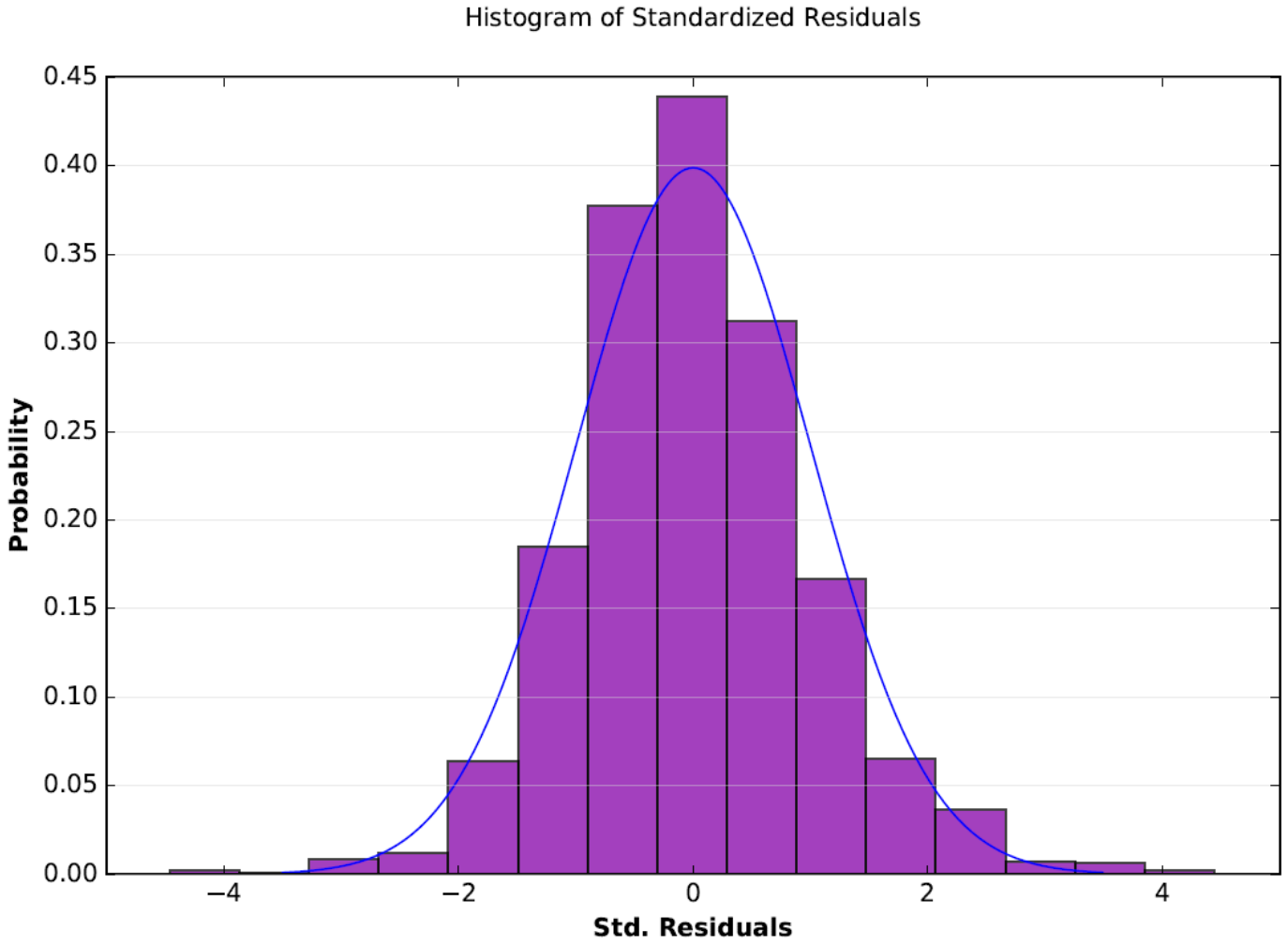
Health Opportunity Index



Lung Cancer Data Modeling

Ordinary Least Square Diagnostics

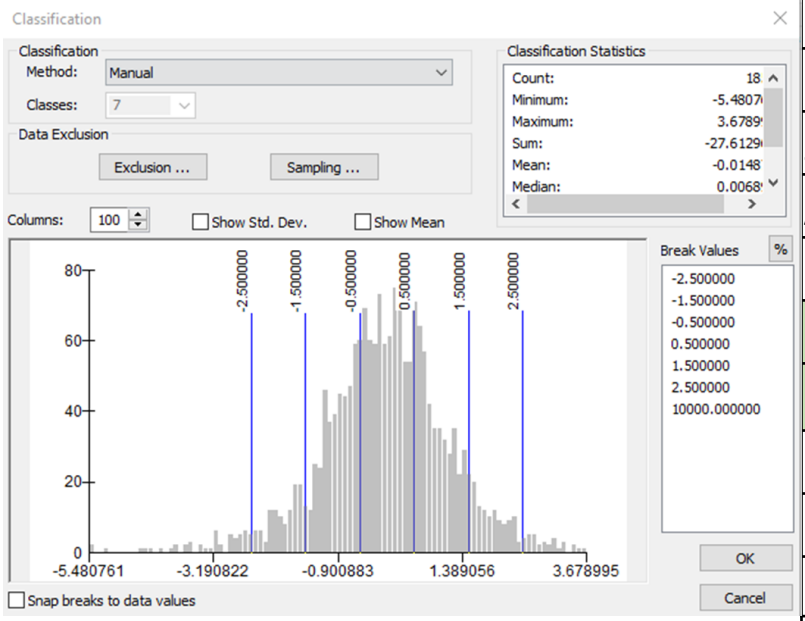
Variables	Coefficient [a]	Standard Error	Probability	Robust Probability	VIF [c]
Intercept	**504.0**	**21.1**	0.000000*	0.000000*	
Access to Healthcare	-26.6	8.7	0.002323*	0.002931*	1.13
Access to Employment	**81.0**	**35.4**	0.022290*	0.0634920	**1.90**
Affordability	**-66.3**	**12.8**	0.000000*	**0.000579***	**2.71**
EPA Environmental	**-18.8**	**10.9**	0.0850210	0.1203670	**1.39**
Population Churning	**30.2**	**10.5**	0.003989*	**0.042989***	**1.59**
Education	**-276.3**	**24.8**	0.000000*	**0.000000***	**3.41**
Food Access	**-7.3**	**14.3**	0.6097600	0.6711010	**1.11**
Income Inequality	**-69.5**	**15.0**	0.000006*	**0.000193***	**1.70**
Job Participation	**-143.6**	**14.2**	0.000000*	**0.000000***	**2.34**
Population Density	**-151.2**	**20.8**	0.000000*	**0.000001***	**1.84**
Segregation	**-18.2**	**5.9**	0.001992*	**0.002444***	**1.01**
Material Deprivation	**-19.4**	**12.8**	0.1304530	0.2067550	**3.17**
Walkability	**66.5**	**14.3**	0.000005*	**0.000018***	**2.29**



OLS Diagnostics

Input Features:	Hotspot_PolyRate_Select	Dependent Variable:	RATE
Number of Observations:	1856	Akaike's Information Criterion (AICc) [d]:	19280.427279
Multiple R-Squared [d]:	0.486691	Adjusted R-Squared [d]:	0.483068
Joint F-Statistic [e]:	134.344609	Prob(>F), (13,1842) degrees of freedom:	0.000000*
Joint Wald Statistic [e]:	1598.242960	Prob(>chi-squared), (13) degrees of freedom:	0.000000*
Koenker (BP) Statistic [f]:	236.263055	Prob(>chi-squared), (13) degrees of freedom:	0.000000*
Jarque-Bera Statistic [g]:	128.274835	Prob(>chi-squared), (2) degrees of freedom:	0.000000*

Geographically Weighted Regression (GWR) – Standard Residual



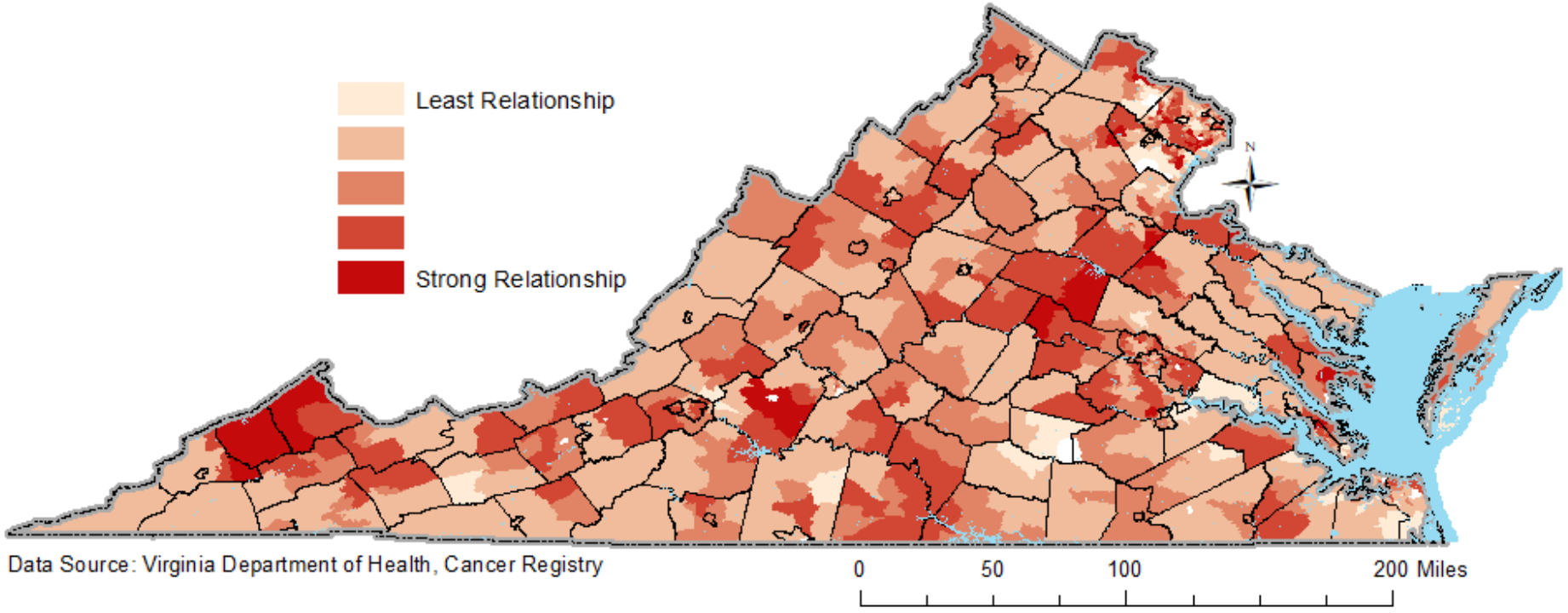
VARNAME	VARIABLE
Neighbors	15.00
Residual Squares	0.50
EffectiveNumber	83.03
Sigma	0.12
AICc	94.79
R2	0.89
R2Adjusted	0.64
Dependent	Lung Cancer Rate per 100,000
Explanatory	Income Inequality
Explanatory	Job Participation
Explanatory	Townson Material Deprivation
Explanatory	Affordability

Virginia

Income Inequality Coefficient Surface

Geographically Weighted Regression Local Parameter Variation

Lung Cancer Spatial Regression

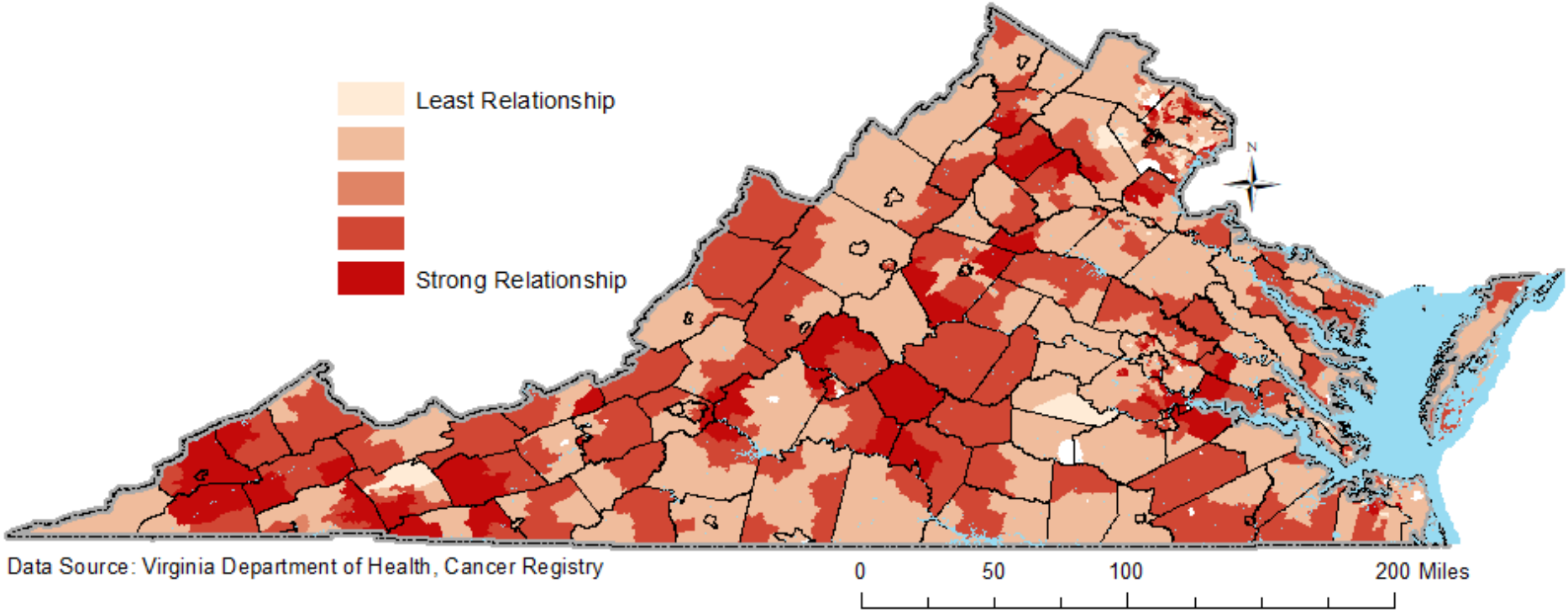


Virginia

Job Participation Coefficient Surface

Geographically Weighted Regression Local Parameter Variation

Lung Cancer Spatial Regression



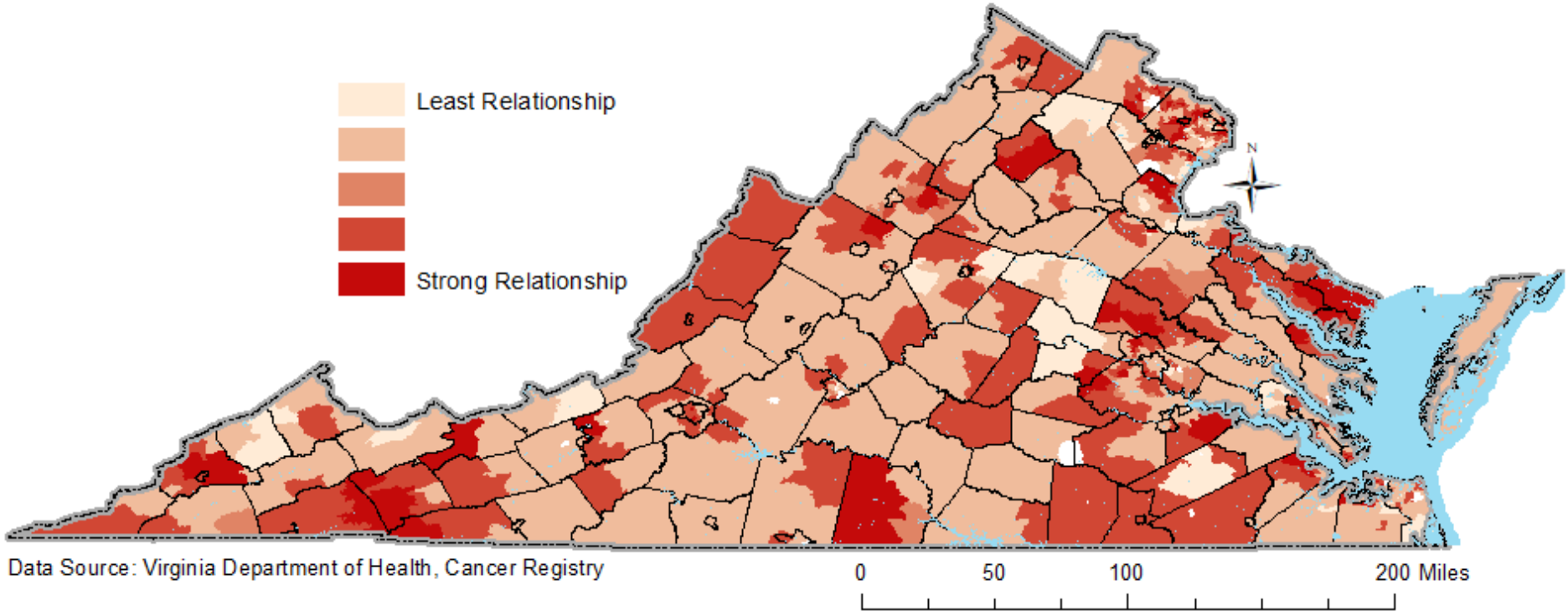
Data Source: Virginia Department of Health, Cancer Registry

Virginia

Material Deprivation (Townsend Index) Coefficient Surface

Geographically Weighted Regression Local Parameter Variation

Lung Cancer Spatial Regression



Conclusion

- This study presents suggestive evidence of an association between proximity to superfund/Highway and lung cancer (More evidence is needed)
- Living in low-socioeconomic status (SES) areas was associated with higher total, lung cancer incidence, and higher total cancer mortality.
- After accounting for individual age and Race living in lower-SES areas remained associated with higher lung cancer incidence, and higher total cancer mortality.

Contact Information

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