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### Types of Spatial Analysis

1. Space as a Variable,
2. Exploratory Spatial Data Analysis (ESDA),
3. Spatial Data Models, and
4. Spatial Process Models.

Each of these (Spatial Variables, ESDA, models of data, and models of process) has different inferential/predictive abilities, and requires different amounts of data and knowledge of the spatial system itself.

See, Geoffrey M Jacques, 2004

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### John Snow, Father of Spatial Epidemiology



Map of Cholera Epidemic 1854



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## Issues of Spatial Analysis

- Attributes of Space as a Variable
- Size of Spatial Unit Matters
  - Levels of Aggregation can change your results
  - Aggregation/Disaggregation is not a linear transformation
- Consistency of Boundaries Over Time
  - Census tract, ZIP Code Boundaries change over time
- Clusters (Tobler's First Law of Geography):
  - 'Everything is related to everything else but near things are more related than distant things'
    - If not true, process is "homogeneous" (stationary)
      - Distance
      - Direction
      - Boundaries
      - Neighborhood
    - If true, process is "heterogeneous" (non-stationary)

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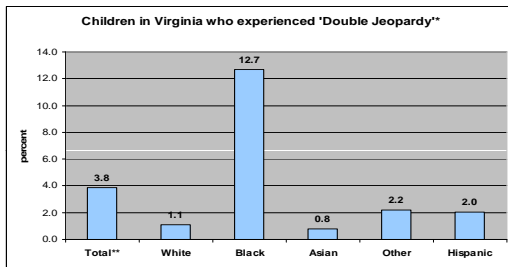
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## Neighborhood characteristics



Double Jeopardy describes children (under 18 years old) that live in poor families and in poor neighborhoods. Poor neighborhoods are defined as census tracts (CTs) with greater than 20.0% poverty. The racial categories include persons of Hispanic and non-Hispanic origin. 'Other' includes American Indian, Alaska Native, Native Hawaiian and other Pacific Islander, some other race alone, and two or more races. \*\*Total number of children living below the federal poverty level reflects the sum of the four racial categories since Hispanic ethnicity could not be determined for each race. Source: Census 2000, SF3, P195.

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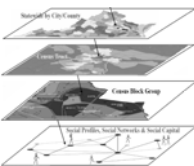
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## Disaggregation and Clustering

### Multilevel Spatial Analysis of Fundamental Causes & the Social Determinants of Health



Richmond City  
 Infant Deaths by Census Block Group, 1990-2005  
 Homicides (%), yellow by Census Tract, 2007



- To identify High Priority Target Areas
- To develop a Proactive Health Surveillance System

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# Aggregation

## Low Education in Virginia

25% or more of residents 25-64 years old had neither a high school diploma nor GED



Source: United States Department of Agriculture: Economic Research Service, 2004 County Typologies; Census 2000, SF3-PCT25.

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# Persistence over Time of Poverty

## The History of Poor Census Tracts\* Richmond City, Virginia 1970-2000

Poor census tracts in the:

- Current decade (2000)
- Last 2 decades (1990-2000)
- Last 3 decades (1980-2000)
- Last 4 decades (1970-2000)



\* Poor census tracts—20 percent or more residents were below the federal poverty level as determined by the US Census [1970, 1980, and 1990 census tracts normalized to Census 2000 boundaries]

Source: Neighborhood Change Database: Geolytics, Inc. Neighborhood Change Database 1970-2000 Tract Data Long Form Release 1 (CD-ROM). Brunswick, NJ: Geolytics, Inc. (Producer and Distributor), 2004.

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# Attributes of Space as a Variable

## Isolated Rural Areas\* in Virginia Over 60 minutes travel time from an Urbanized Area

Isolated Rural  
Large Rural  
Small Rural  
Urban



\* Based on Rural Urban Commuting Codes, RUCA 2.0 - Zip Code Level.

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# Breast Cancer

Some Preliminary Research

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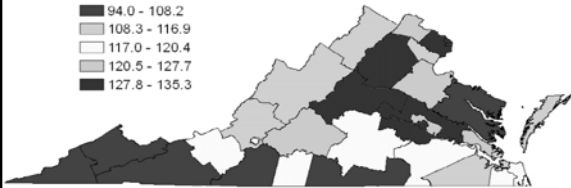
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## Breast Cancer Incidence Jurisdictional/ Health District Data

Cancer Incidence Rate by Health District, Breast (Female), 2001-2005

Age-Adjusted Rate (per 100,000)

- 94.0 - 108.2
- 108.3 - 116.9
- 117.0 - 120.4
- 120.5 - 127.7
- 127.8 - 135.3



Source: Virginia Cancer Registry, Virginia Department of Health.  
Rates are age-adjusted to the 2000 U.S. standard population.

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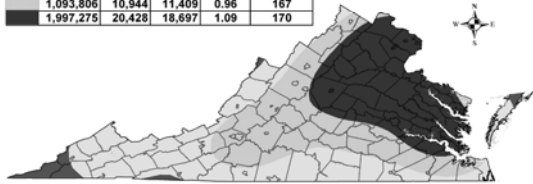
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## Kernel Density Smoothed Surface Virginia

Female Breast Cancer Incidences Rate/100,000\*  
Kernel Density Ratio Surface

	POP	OBS	EXP	RR	R/100,000
■	33,410	224	408	0.55	112
■	431,134	4,148	5,129	0.81	160
■	1,093,806	10,944	11,409	0.96	167
■	1,997,275	20,428	18,697	1.09	170



\* Data Source: Virginia Cancer Registry Incidence Data 2000-2005  
Age Adjusted to VA 2000 Standard Population. Kernel Density  
Computed at ZIP Code Level.

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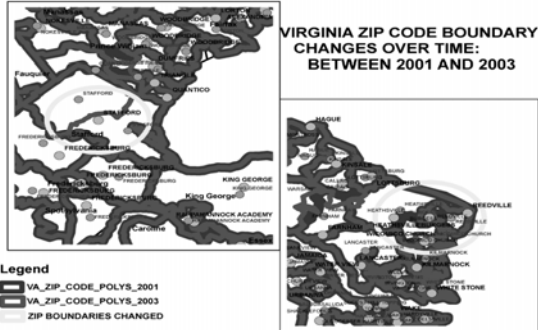
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## Zip Code Boundary Changes & Standardization




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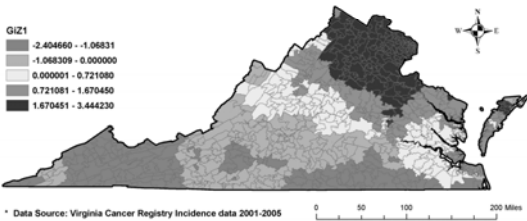
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## Basic Global Spatial Cluster Analysis

### Virginia Female Breast Cancer Incidences Hotspot Analysis with Rendering Residual Rate/100000\*




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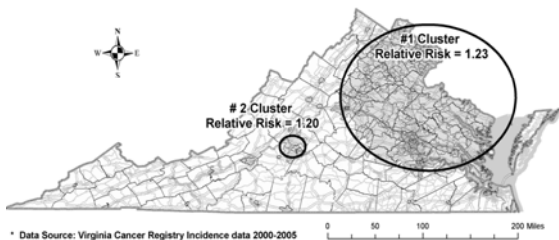
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## SaTScan Cluster Analysis

### Virginia Breast Cancer Relative Risk Clusters Based on Age-Adjusted Indirect Standardization



Analysis based on SaTScan (v7.0, 2006) clustering algorithms developed by Martin Kulldorf for NCI. Data represent female breast cancer, which have been age-adjusted to 2000 Virginia Standard Population. Relative Risks take into account SaTScan adjustments based on distributions within contiguous areas.

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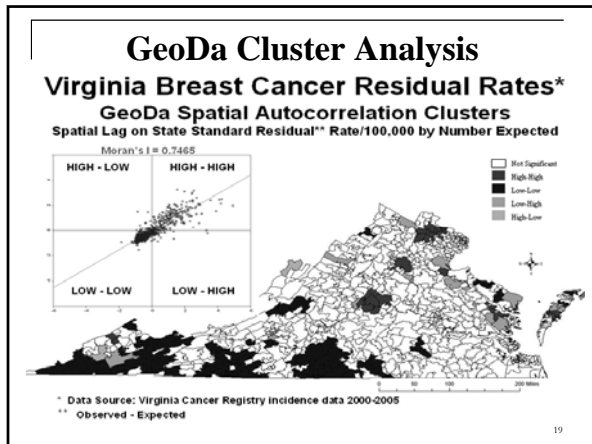
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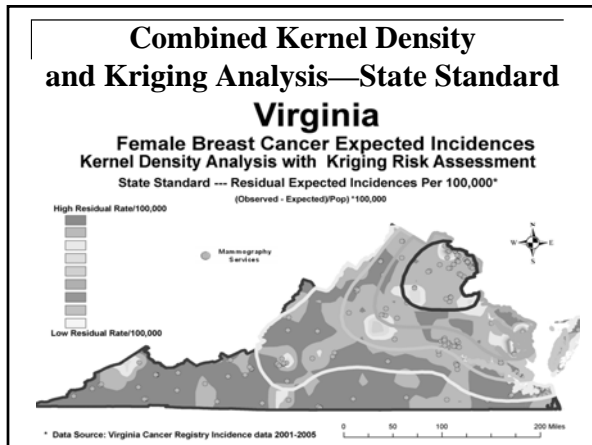
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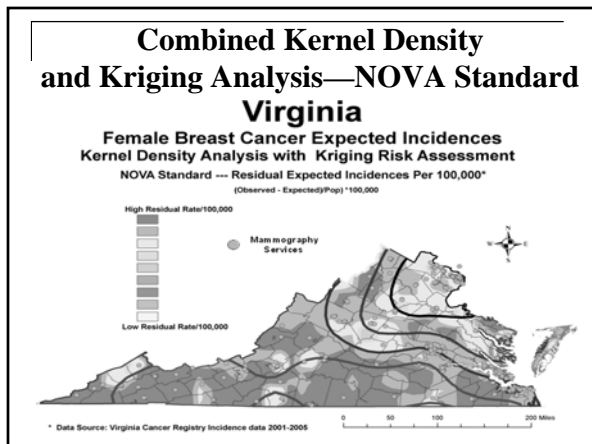
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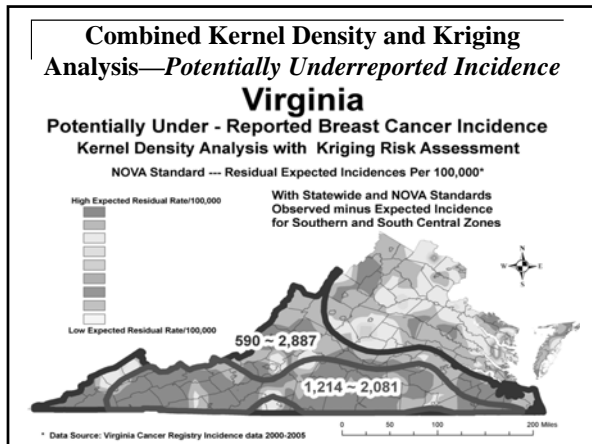
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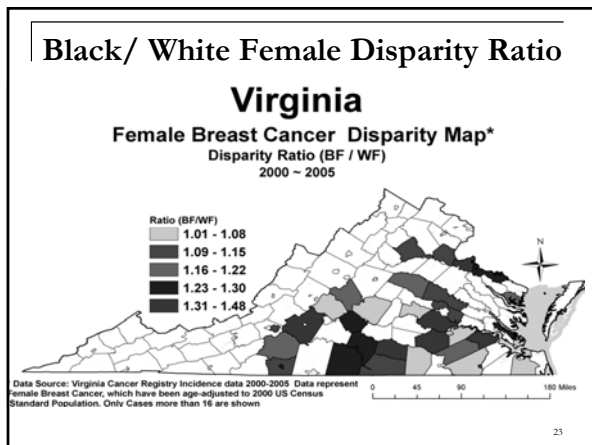
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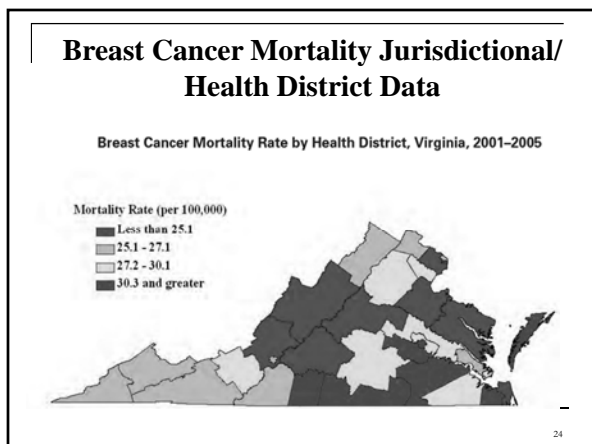
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# Childhood Medicaid Asthma

Preliminary Research

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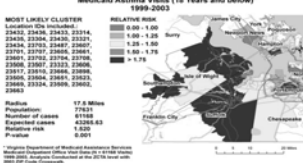
## Childhood Medicaid Asthma Outpatient Visit Clusters\*

\*Clusters Ranked from Highest to Lowest Log Likelihood Ratios

**MAP 12 Virginia**  
SaTScan Cluster Analysis - Most Likely Global Clusters  
Based on Medicaid Outpatient Asthma Visits\*  
(18 Years and below)



**TABLE 13 SOUTHEAST VIRGINIA**  
SaTScan Cluster Analysis - Most Likely Cluster Area  
Based on Medicaid Outpatient Asthma Visits  
Medicaid Asthma Visits (18 Years and below)  
1999-2003




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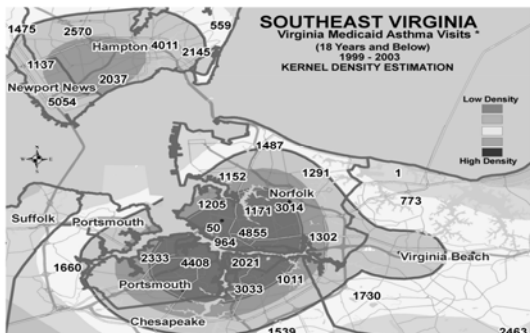
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## High Priority Target Area—Childhood Asthma Outpatient Cluster #1—N per ZCTA



\* Source: Virginia Department Of Medical Assistance Services, Medicaid Outpatient Office Visit Data (N = 61,168 Visits), 1999-2003

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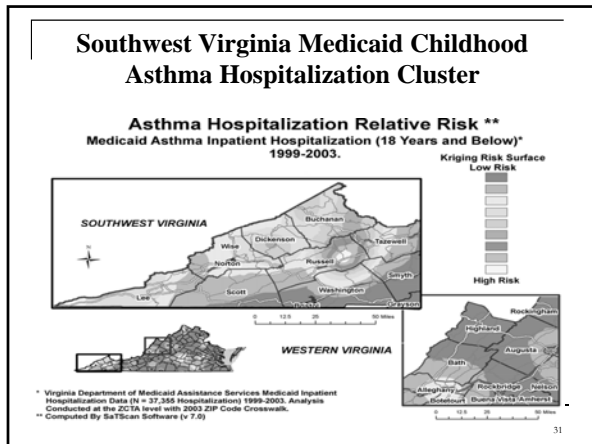
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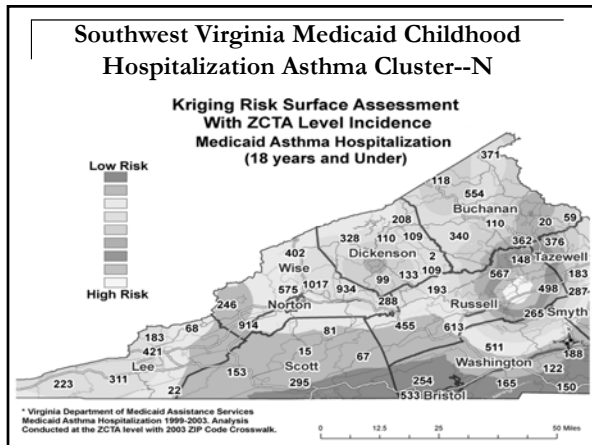
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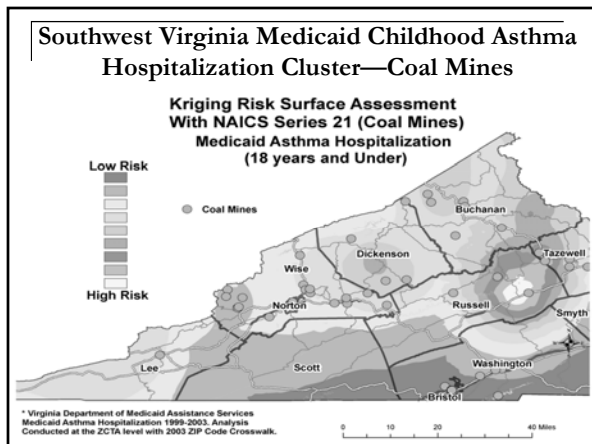
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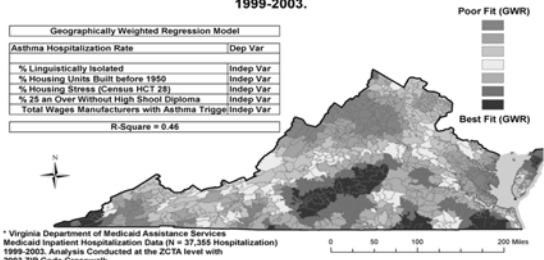
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# Local R<sup>2</sup> For Geographically Weighted Regression

## Virginia

Geographical Weighted Regression (GWR)  
 Medicaid Asthma Inpatient Hospitalization (18 Years and Below)\*  
 1999-2003.




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## Current Projects

- Develop multi-level framework
- Georeferenced Health Data
- High Priority Target Areas
  - Statewide identification of areas in public health crisis
- Models of Care
  - Needs assessment for non-traditional models of care
- Multivariate analysis using spatial regression
  - Distance, cost analysis for services and sentinel events
- Longitudinal Studies
  - Neighborhood Change Database (Census 1970, 1980, 1990, 2000)
- PRIZM NE database
  - Lifestyle and social marketing data
- Claritas Demographics 2007 and 2008
  - Census tract, block group, and zip code level

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