Creating a Depave Index

Using Multi-Criteria Analysis to Prioritize Impervious Surface Removal

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Research Question

- Bureau of Environmental Services (BES)
- Impervious surface cover can negatively impact watershed health
- Incorporate equity into site selection

Data

BES:

- Impervious Surface Layer

RLIS:

- Census Block Groups
- Land Use
- Vacant Land

Social Explorer:

- Demographic Data

Depave:

- Depave Projects

Community Watershed Stewardship Program (CWSP):

- Project Sites

ENVIRONMENTAL SERVICES
CITY OF PORTLAND
working for clean rivers

Methods

Part One – Land Use:

- Determine % of block group covered by:
  - Impervious Surface
  - Vacant Impervious Surface
  - Land Use Types

Part Two – Demographics:

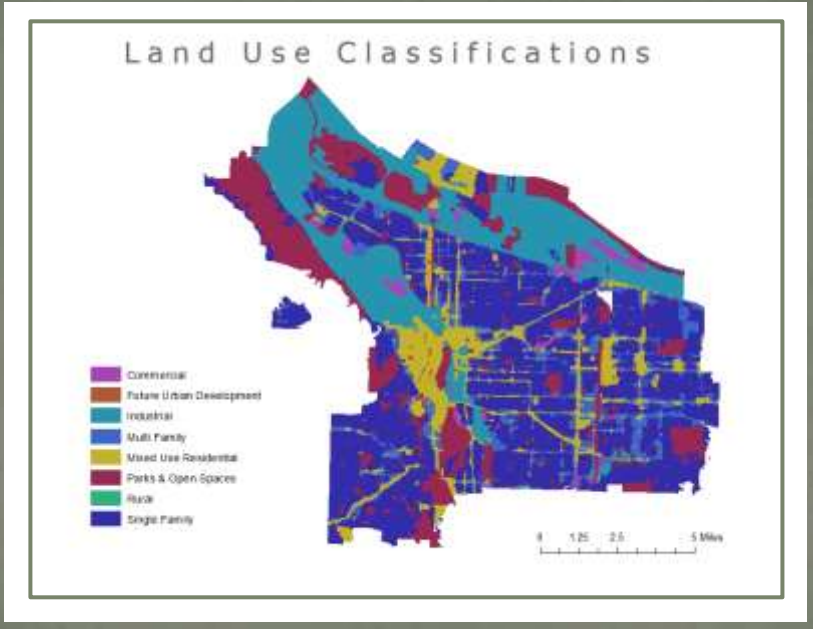
- Join census data to block groups
  - Median Income
  - Education Score
- Regression Analysis

Part Three – Overlay/Weighted Model

- Import database into Excel
- Combine ranks to create an index

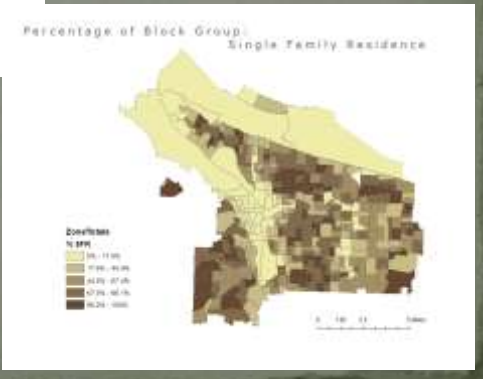
Part One: Land Use

- Zoning data from RLIS
- Total area of each category in each block group
- Determine for each land use type, the percentage of total block group area
- Weight land use types
- Determine rank for each census block group: 1 - 5



- Identity tool to associate land use polygons with block groups
- Summary statistics tool total land use zones per block group

- Lots of bumbling around in Excel and ArcGIS to condense the table table so that each block group only had one row



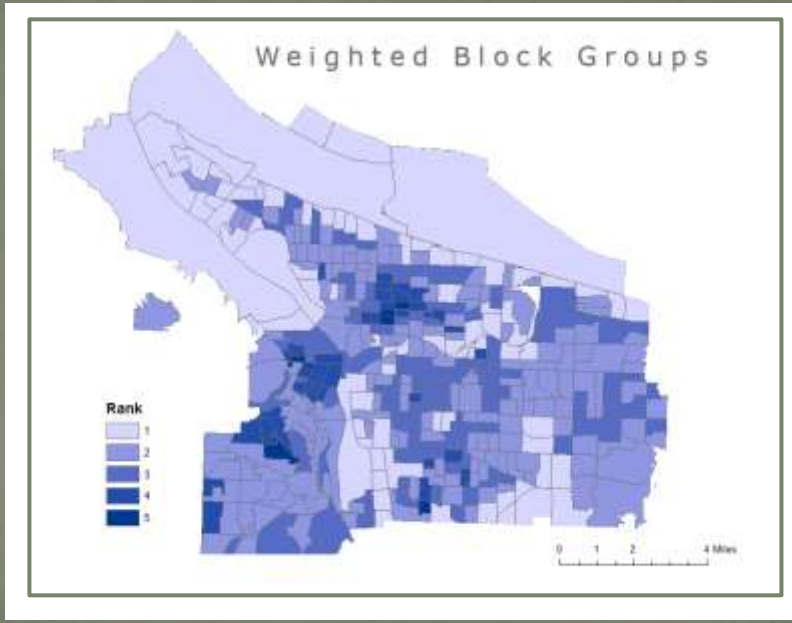
Land Use Weights

- Consulted experts: Dr. Vivek Shandas, Urban Planning Dept. & Emily Hauth, BES (Sustainable Stormwater)
- Independent cross verification
- 1 = Lowest need
- 5= Highest need

Parks/Open Space – 1
Single Family Residential – 1
Multi Family Residential – 2
Mixed Use Residential – 3
Commercial – 4
Industrial - 5

Land Use Weighted Average

- Percentages were combined with the rank specific to each land use to determine an ultimate rank for each block group
- Lower rated block groups had more land cover that was of a lower rank (i.e. Single family residential)



Impervious Surface

- BES impervious surface data
- Split the impervious surface by block group
- Recalculate the geometry to ensure correct size
- Use spatial statistics to determine the amount of square feet of impervious surface per block group

Impervious Surface

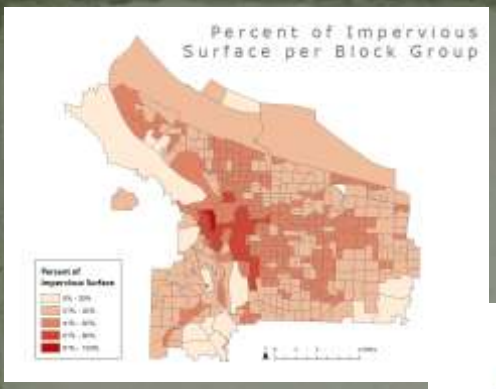
- The block groups were weighted by percent of cover:
  - 0% - 20% was given a weight of 1
  - 21% - 40% was given a weight of 2
  - 41% - 60% was given a weight of 3
  - 61% - 80% was given a weight of 4
  - 81% - 100% was given a weight of 5
- These weights were determined by consulting our expert Dr. Vivek Shandas and Arnold & Gibbons (1996)

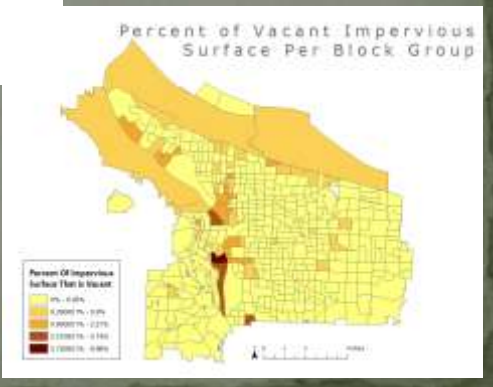
Vacant Impervious Surface

- BES Impervious surface and RLIS vacant land
- Created an intersection of the vacant and impervious layers
- Recalculate the geometry to ensure correct size
- Use spatial statistics to determine the amount of square feet of impervious surface per block group

Vacant Impervious Surface

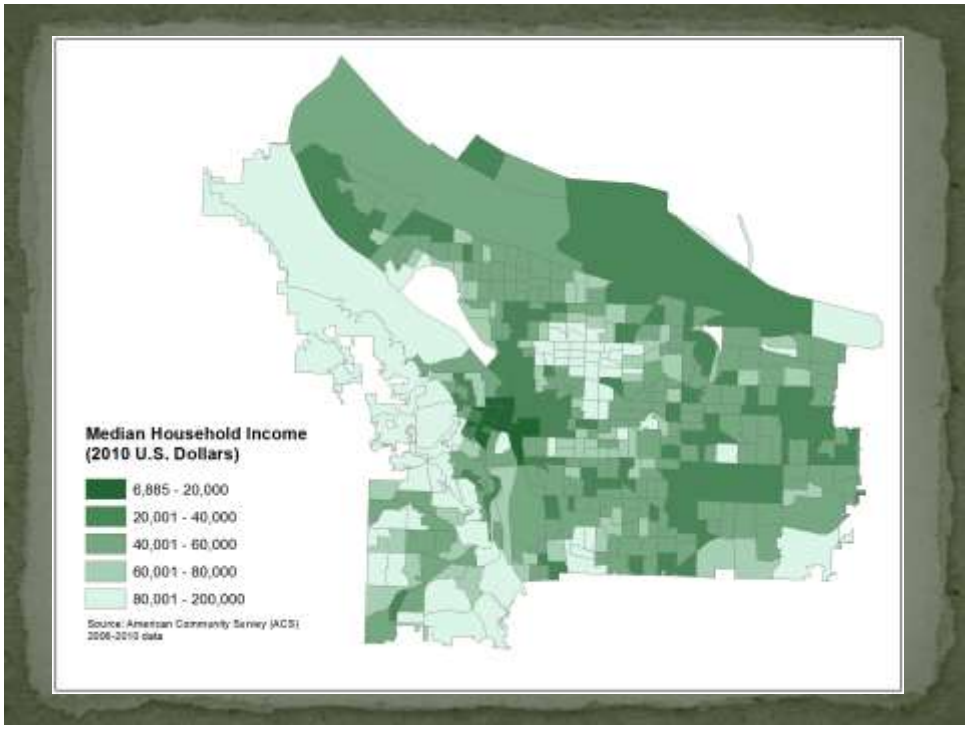
- The vacant impervious surface area was extremely low
- The block groups were weighted using natural breaks:
  - 0% - 0.26% was given a weight of 1
  - 0.261% - 0.9% was given a weight of 2
  - 0.91% - 2.21% was given a weight of 3
  - 2.22% - 5.74% was given a weight of 4
  - 5.75% - 9.98% was given a weight of 5

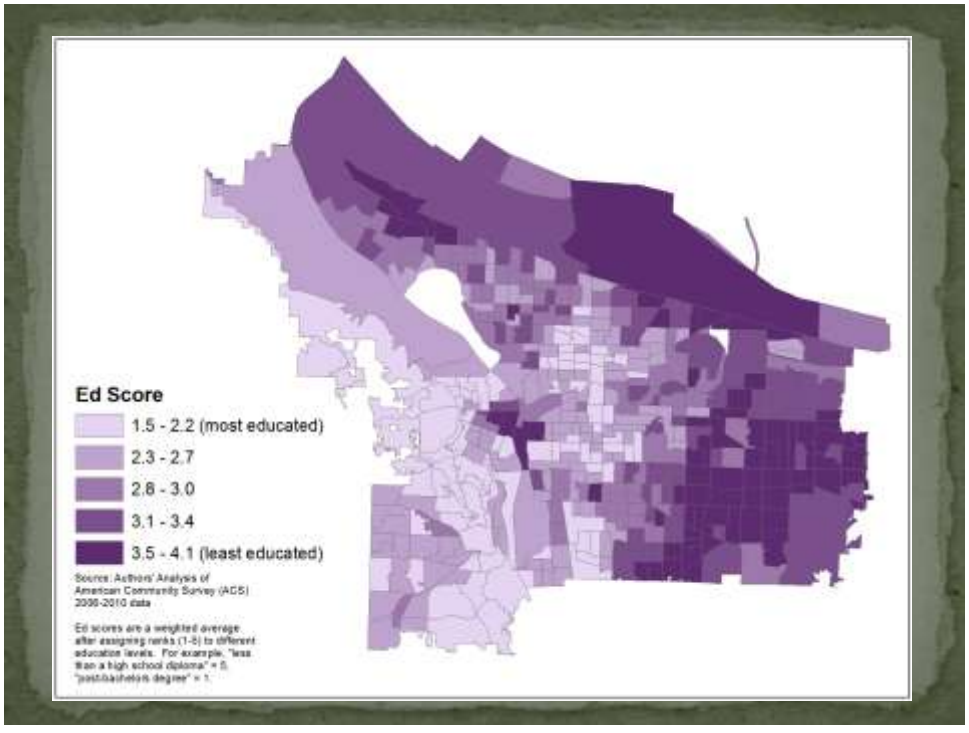




Part Two: Demographic Analysis

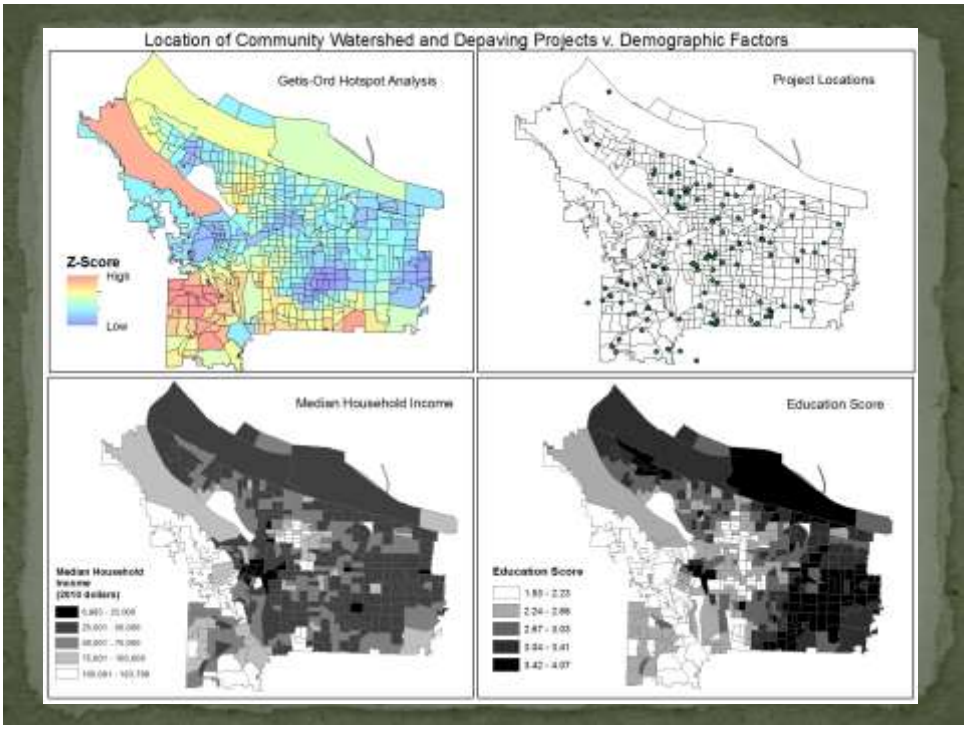
- Median Income and Education Level
  - Calculated Education Score
  - Classified 1-5
- CWSP and Depave project sites
  - Geocoded CWSP sites
  - Hand plotted Depave sites
- Regression Analysis
  - Negative binomial model in SPSS


Median Household Income
(2010 U.S. Dollars)
6,885 - 20,000
20,001 - 40,000
40,001 - 60,000
60,001 - 80,000
80,001 - 200,000
Source: American Community Survey (ACS)
2006-2010 data


Ed Score
1.5 - 2.2 (most educated)
2.3 - 2.7
2.8 - 3.0
3.1 - 3.4
3.5 - 4.1 (least educated)
Source: Authors' Analysis of
American Community Survey (ACS)
2006-2010 data
Ed scores are a weighted average
after assigning ranks (1-5) to different
education levels. For example, "less
than a high school diploma" = 5,

Community Projects

- Watershed stewardship in Portland relies heavily on community-initiated projects
- Depave and CWSP follow this model
- Is there a relationship between the location of community-initiated watershed projects and community demographics?
  - Hypothesis: income and education level may impact the likelihood of community-initiated projects



Regression Analysis (SPSS)

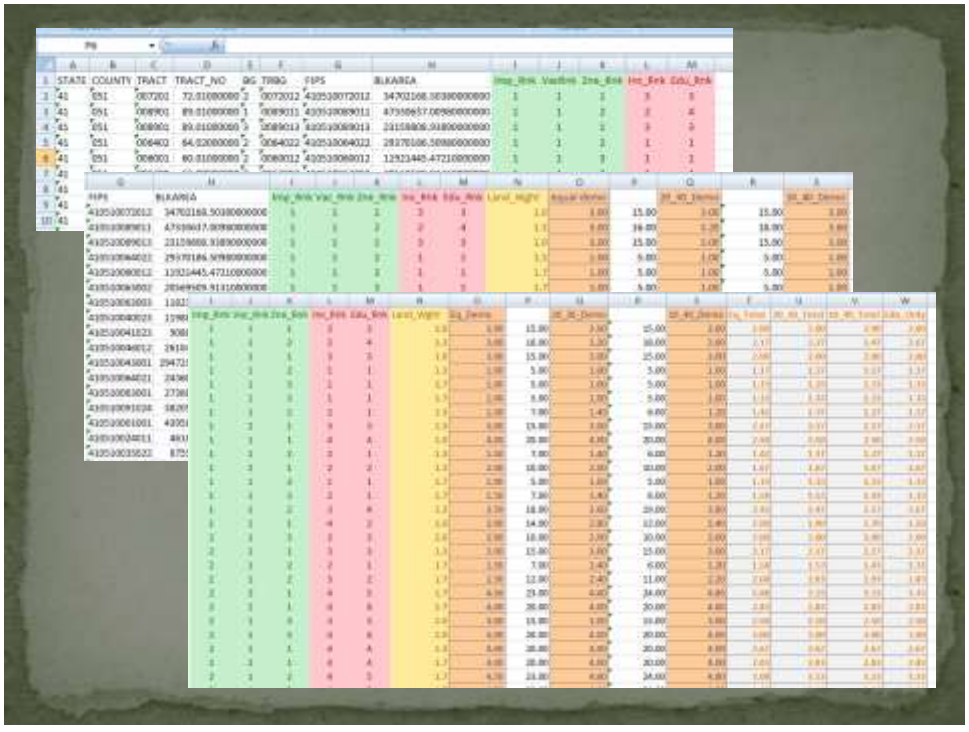
Tests of Model Effects

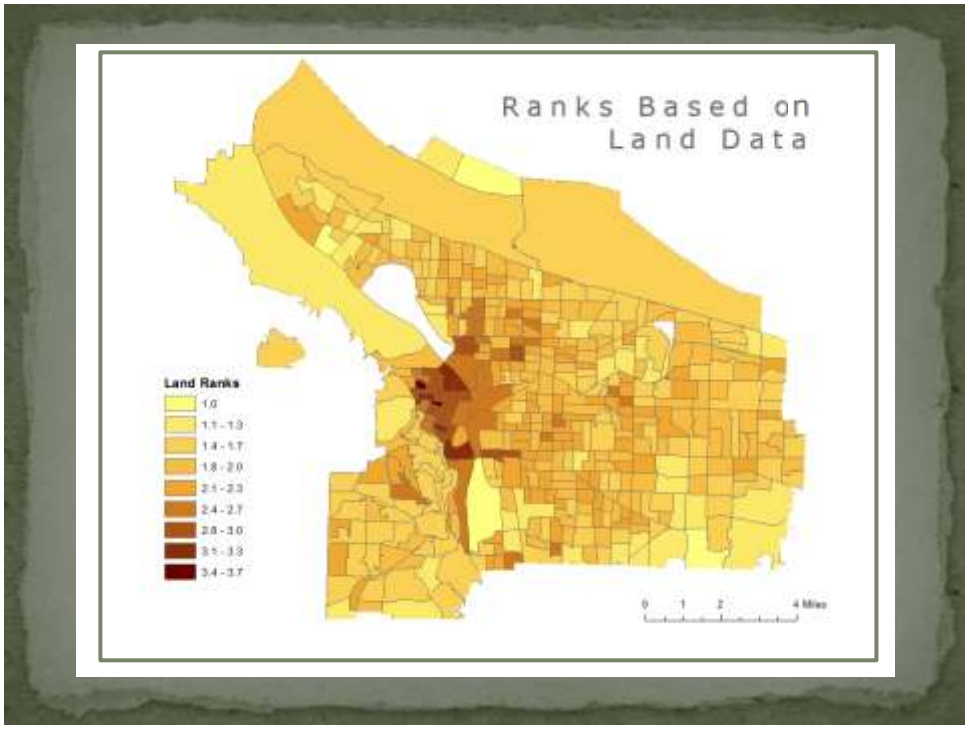
Source	Type III		
	Wald Chi-Square	df	Sig.
(Intercept)	.315	1	.575
MEDIAN_HH	1.061	1	.303
AVG_DIST_MI	.194	1	.660
ED_SCORE	3.273	1	**.070**

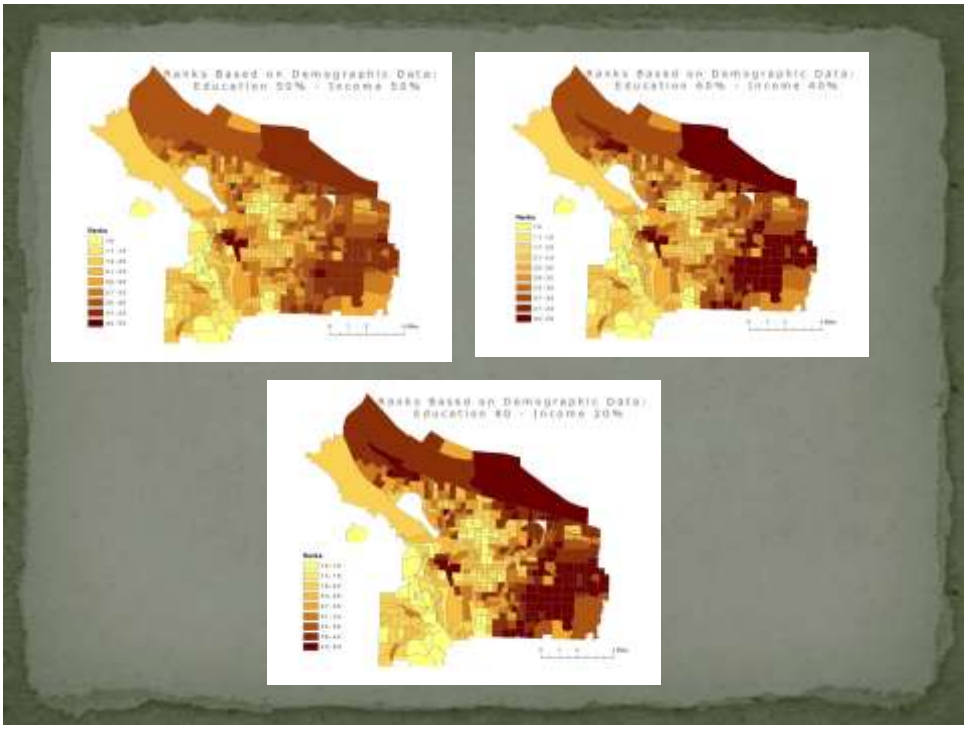
Parameter Estimates

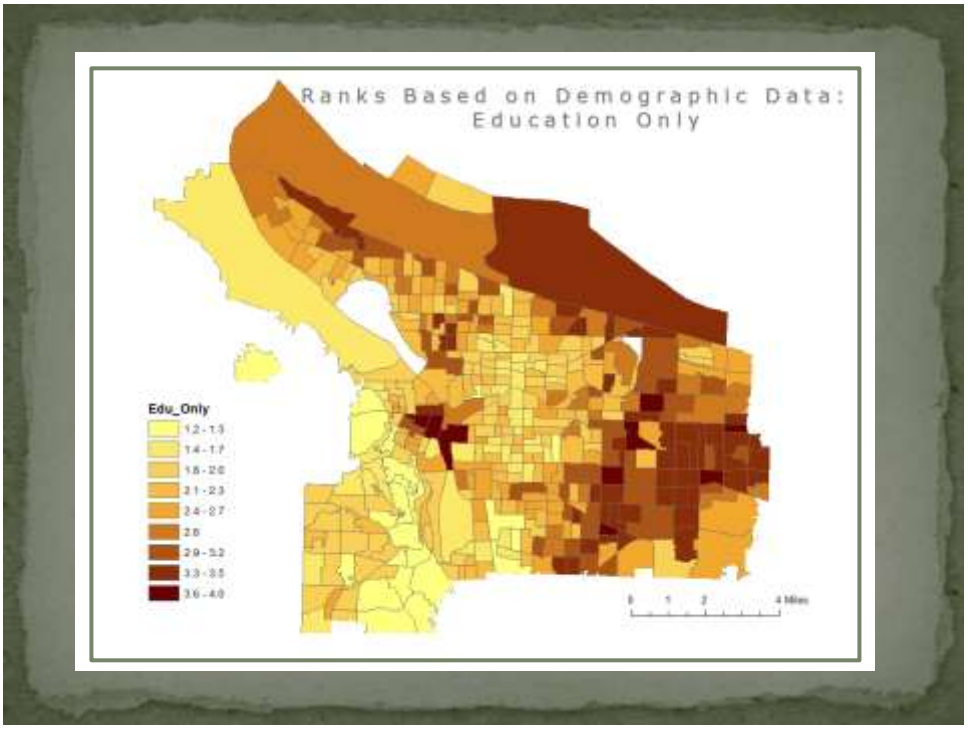
Parameter	B	Std. Error	95% Wald Confidence Interval	
			Lower	Upper
(Intercept)	.504	.8990	-1.258	2.266
MEDIAN_HH	-5.097E-6	4.9483E-6	-1.480E-5	4.601E-6
AVG_DIST_MI	.029	.0661	-.100	.159
ED_SCORE	**-.562**	.3108	-1.171	.047
(Scale)	1[a]			
(Negative binomial)	1			

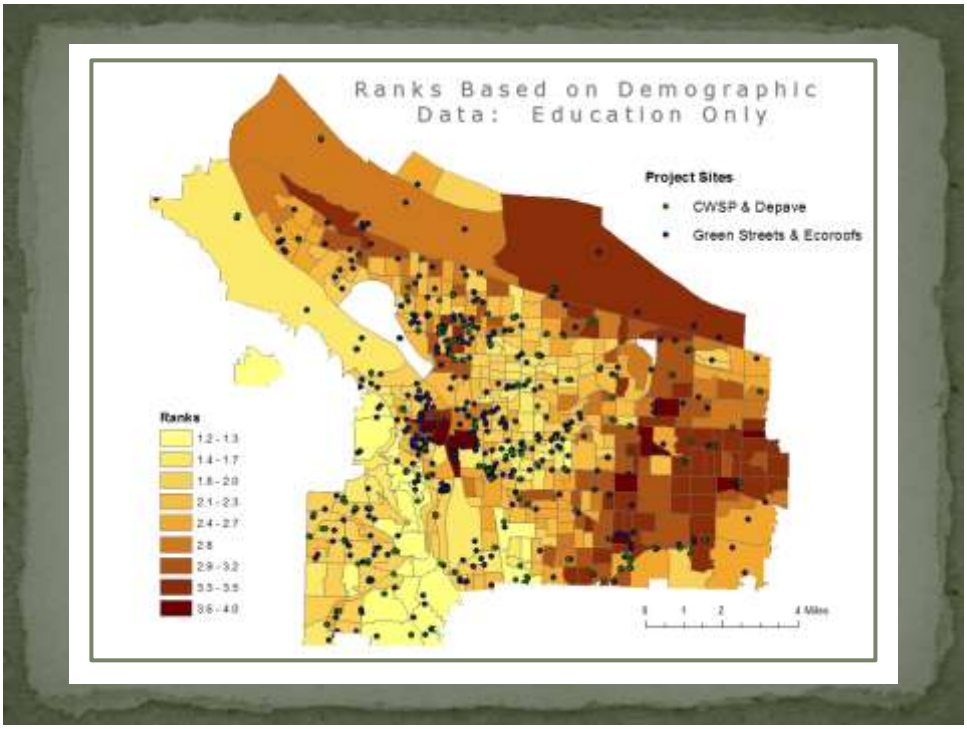
Results




Ranks Based on
Land Data
Land Ranks
1.0
1.1 - 1.3
1.4 - 1.7
1.8 - 2.0
2.1 - 2.3
2.4 - 2.7
2.8 - 3.0
3.1 - 3.3
3.4 - 3.7
0
1
2
4 Miles


Ranks Based on Demographic Data:
Education 50% - Income 50%
Ranks Based on Demographic Data:
Education 60% - Income 40%
Ranks Based on Demographic Data:
Education 80 - Income 20%


Ranks Based on Demographic Data:
Education Only
Edu_Only
12 - 13
14 - 17
18 - 20
21 - 23
24 - 27
28
29 - 32
33 - 35
36 - 40
0 1 2 4 Miles



Problems

- Did not check for correlation between land use variables
- Enumeration unit based on population, skewing data related to industrial areas
- Did not account for biophysical factors (i.e. proximity to rivers, soil type)

Sources

- Fuller, D.O., Williamson. R., Jeffe, M., and James, D. 2003. Multi-criteria evaluation of safety and risks along transportation corridors on the Hopi Reservation. Applied Geography, 23 (2-3): 177-188.
- Gemitzi, A., Tsihrintzis, V. A., Voudrias, E., Petalas, C. and Stravodimos, G. 2007. Combining geographic information system, multicriteria evaluation techniques and fuzzy logic in siting MSW landfills. Environmental Geology. 51 (5): 797-811.
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- Lee, S. and Pradhan, P. 2007. Landslide hazard mapping at Selangor, Malaysia using frequency ratio and logistic regression models. Landslides, 4: 33-41.
- Chester L. Arnold Jr. & C. James Gibbons. 1996. Impervious Surface Coverage: The Emergence of a Key Environmental Indicator, Journal of the American Planning Association, 62:2, 243-258

QUESTIONS?