Migration and Neighborhood in Rapidly Growing West African Cities

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Rabat, Morocco
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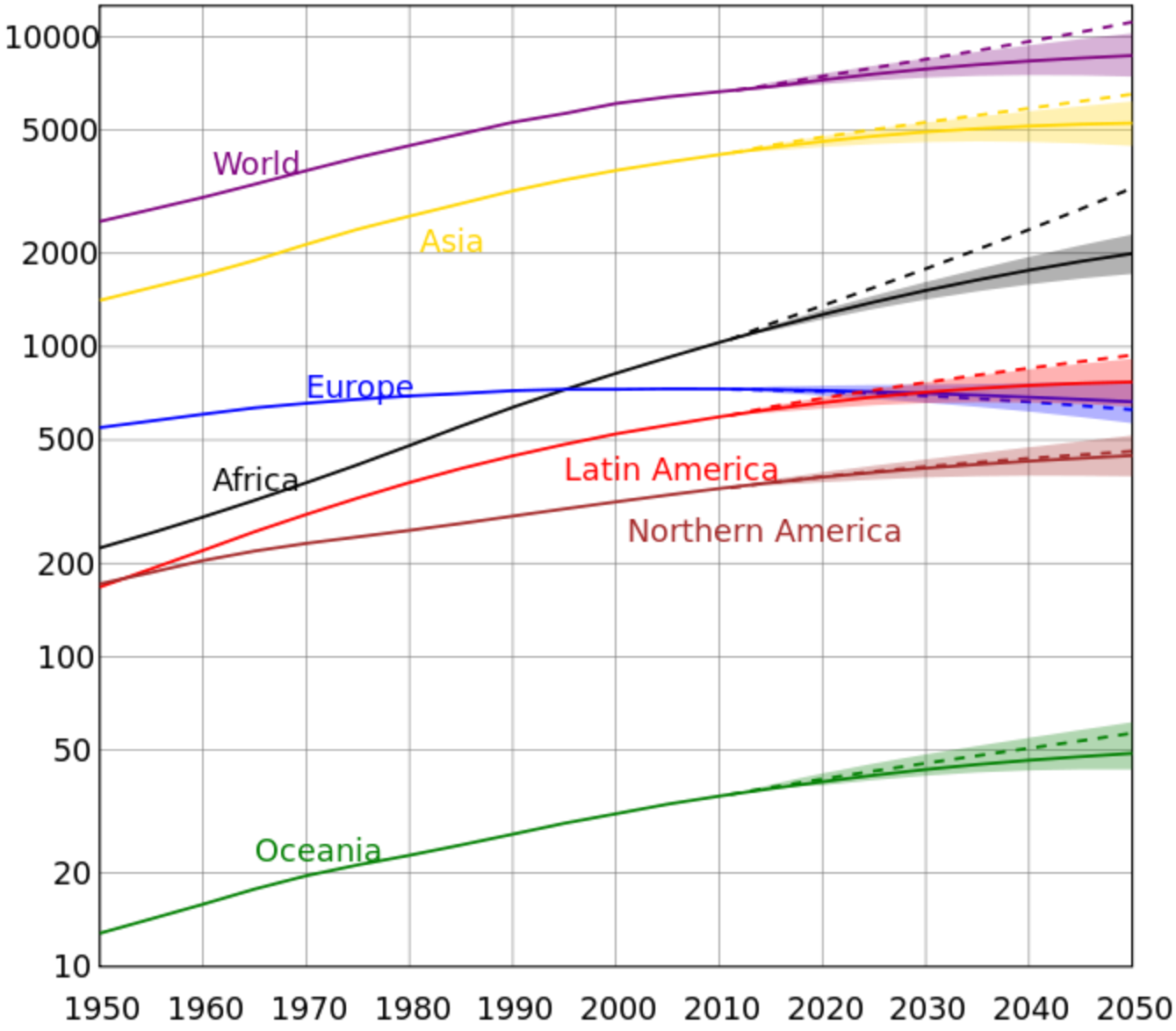
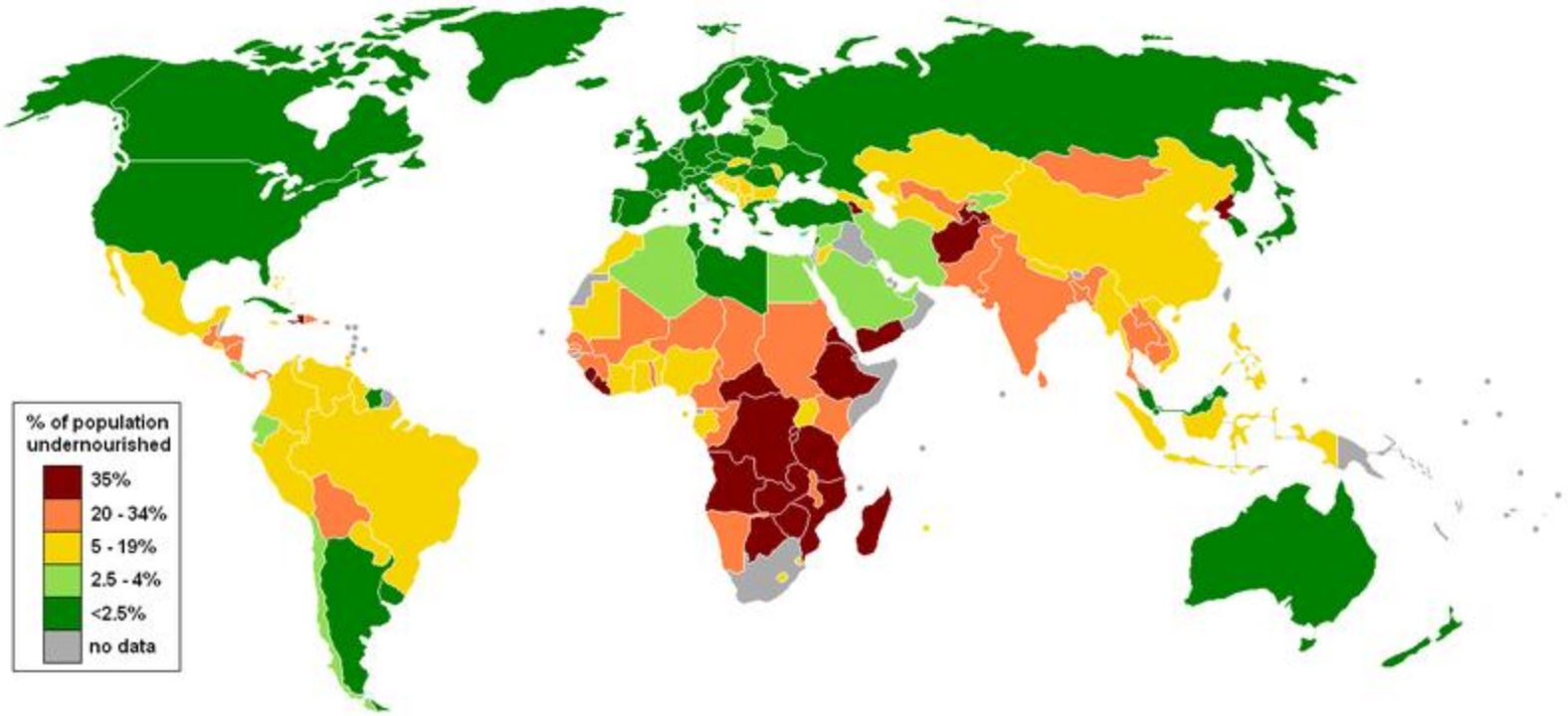
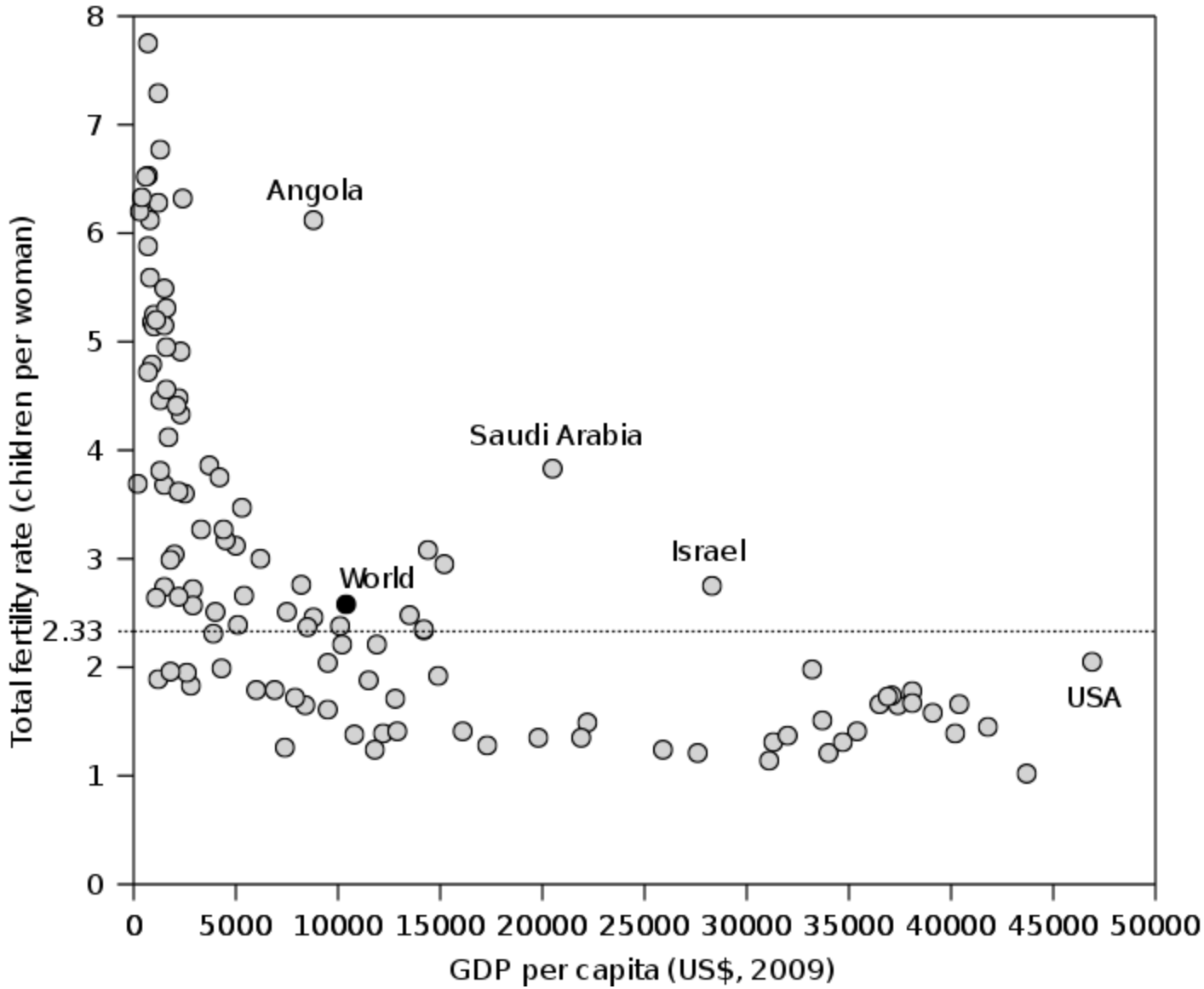
Wes
MAURITANIA
MALI
NIGER
SENEGAL
GAMBIA
GUINEA-
BISSAU
GUINEA
MALI
Niger
Bamako
BURKINA
FASO
Ouagadougou
Niamey
Niger
Black Volta
Volta
BENIN
TOGO
GHANA
NIGERIA
Abuja
Lagos
Niger
Conakry
SIERRA
LEONE
Freetown
LIBERIA
Monrovia
CÔTE
d'IVOIRE
Yamoussoukro
Abidjan
Accra
Lomé
Porto-Novo
Malabo
Gulf of Guinea
Libreville
N


Upper East
Upper West
Northern
Brong-Ahafo
Ashanti
Eastern
Volta
Western
Central
Greater Accra


10000
5000
2000
1000
500
200
100
50
20
10
1950
1960
1970
1980
1990
2000
2010
2020
2030
2040
2050
World
Asia
Europe
Africa
Latin America
Northern America
Oceania


% of population undernourished
35%
20 - 34%
5 - 19%
2.5 - 4%
<2.5%
no data


2006 12 17


Total fertility rate (children per woman)
GDP per capita (US$, 2009)
Angola
Saudi Arabia
Israel
World
USA
2.33
0
1
2
3
4
5
6
7
8
0
5000
10000
15000
20000
25000
30000
35000
40000
45000
50000


AMINATA
SERVICE STATION
K.B.S

Neighborhoods as Building Blocks for Social Research

- Conceptualization
- Motivations for delineating neighborhoods
  - Making sense of complex data
  - Spatial sampling
  - Targeted policy initiatives
- Problems with available data

Problems with Qualitatively Delimited Neighborhoods

- Individual biases; simplified images
- Institutional biases; governance, planning, convenience
- Official neighborhoods
- Views of the world
- Agreement
- Scale

Quantitative Approaches

- Goal: To find statistically significant spatially contiguous aggregations of spatial units
- Made possible by the development of methods for finding statistically significant spatial clusters
- The idea of local statistics

Approaches Used in Our Studies

- Many types of neighborhoods found
- Vernacular
- Vernacular with remotely sensed and ground verification and modifiction
- Local Statistics

    AMOEBA (A Multidirectional Optimum Ecotope-Based Algorithm)

    LOSH (Local Spatial Heterogeneity)

Introduction to LOSH

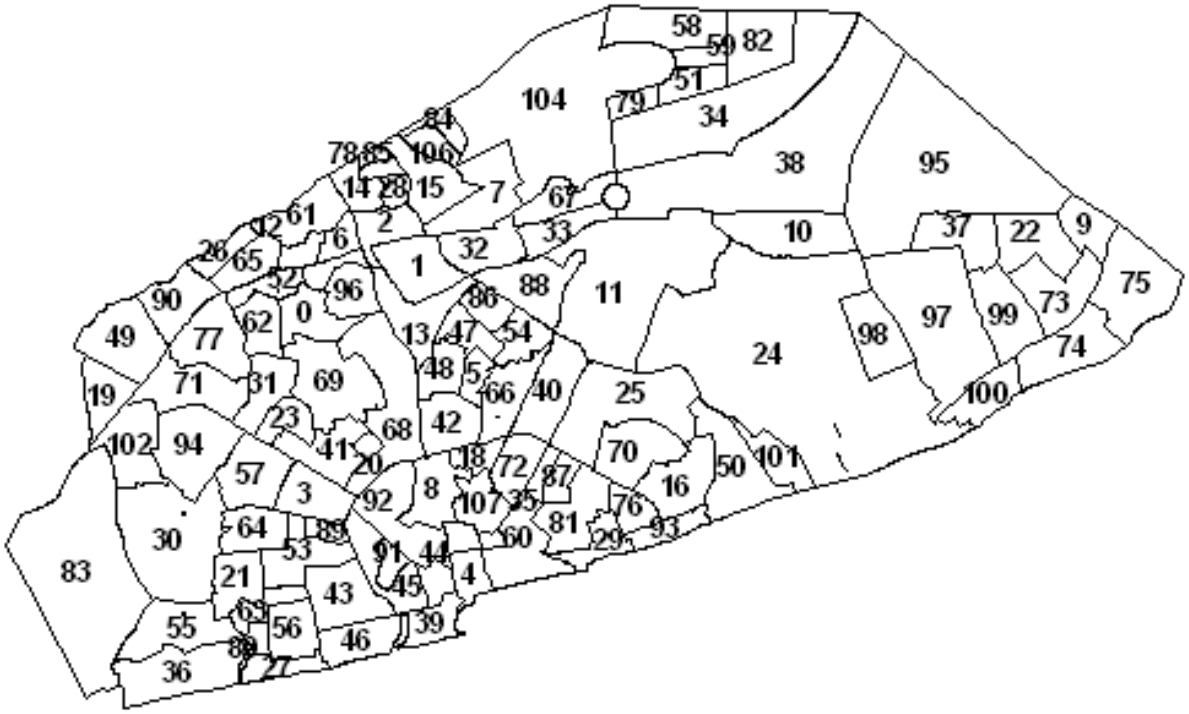
- Focus on a site *i* having a variable value *x*
- Consider the *j* surrounding places
- *G_i allows for tests on high or low variable values taken as a group around some site i*
- ***H_i allows for tests on cluster heterogeneity and homogeneity around some site i***

Uses of H_i

- Explore differential rates (such as disease rates within a cluster)
- Find degree of heterogeneity or homogeneity within an already delimited cluster
- Identify temporal trends in heterogeneity and homogeneity
- Identify boundaries and test for the existence of boundaries between districts
- Study the residuals of a spatial regression surrounding a site *i*
- Define weights for generalized least squares

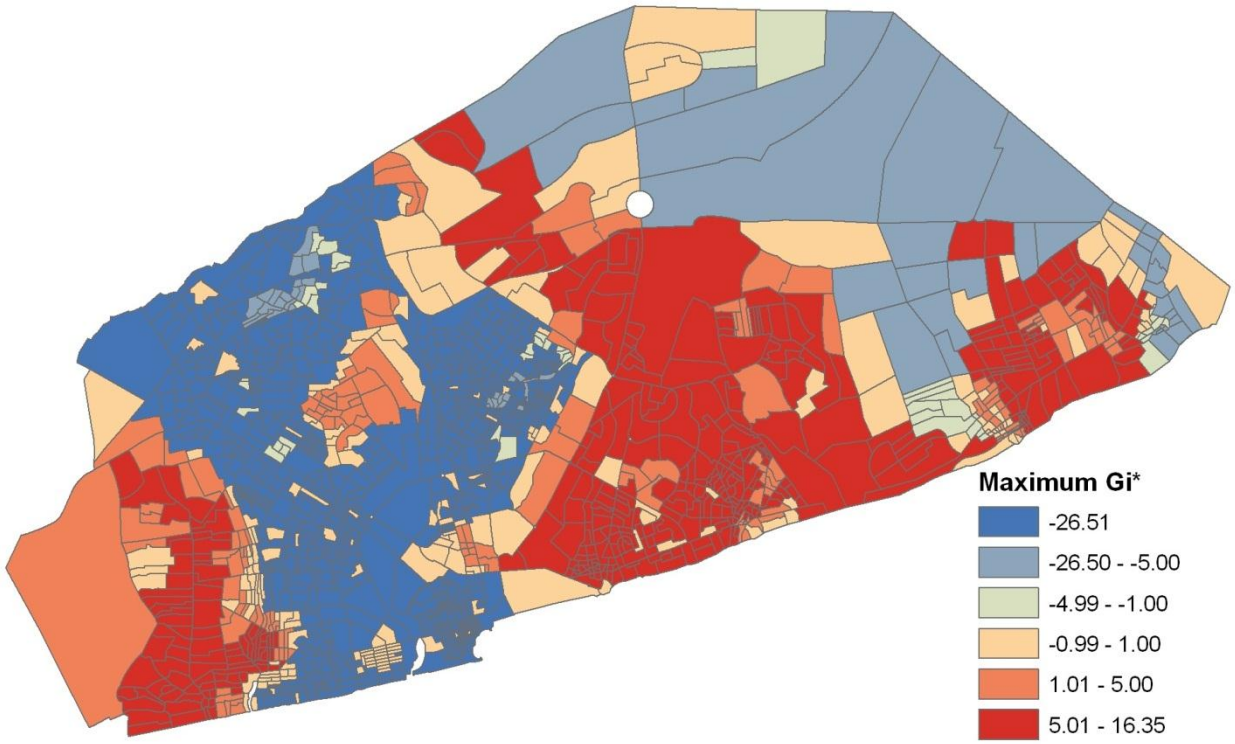
Vernacular Neighborhoods of Accra, Ghana

Vernacular = locally understood

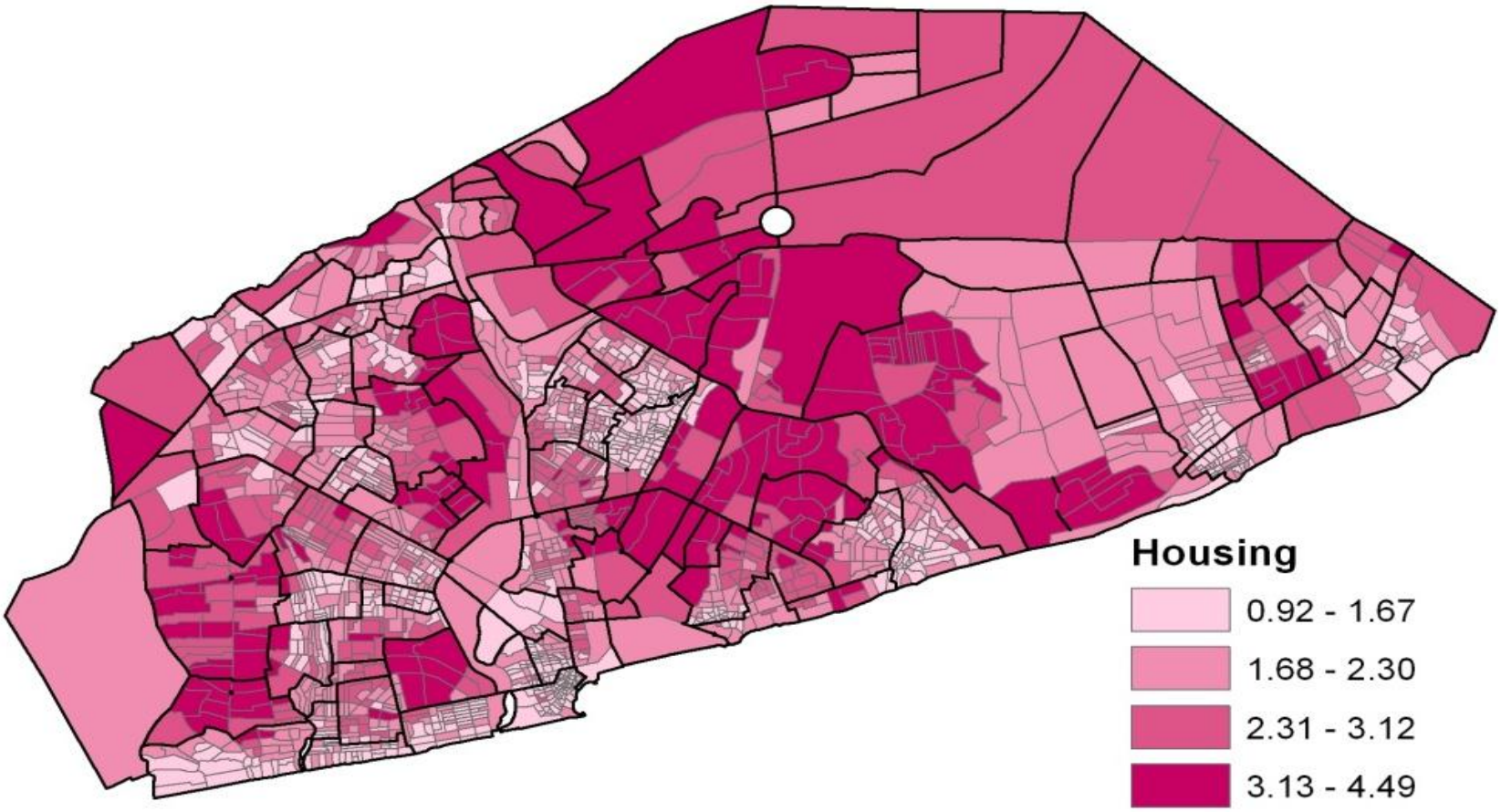


House Quality

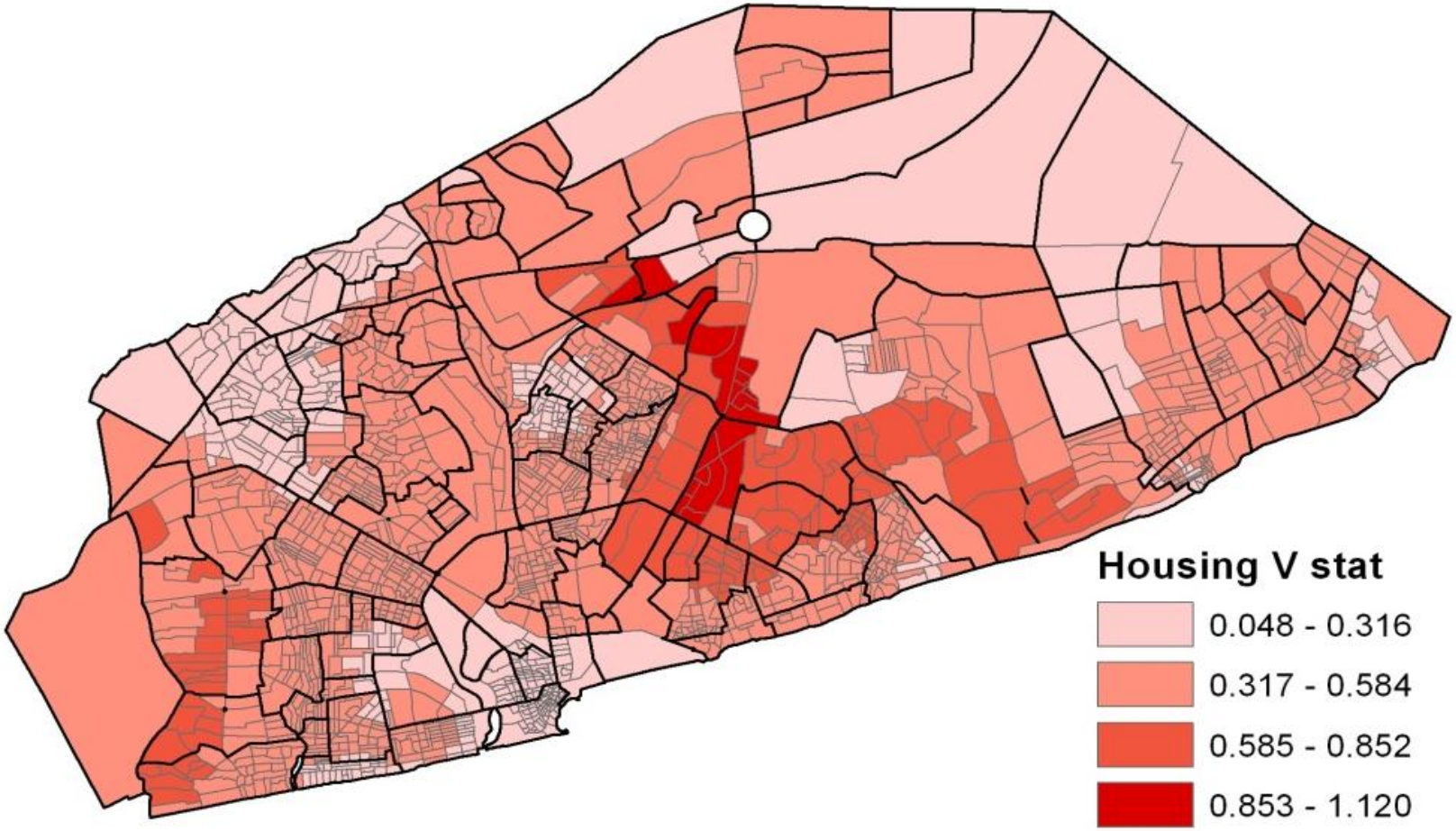
Maximum G_i*



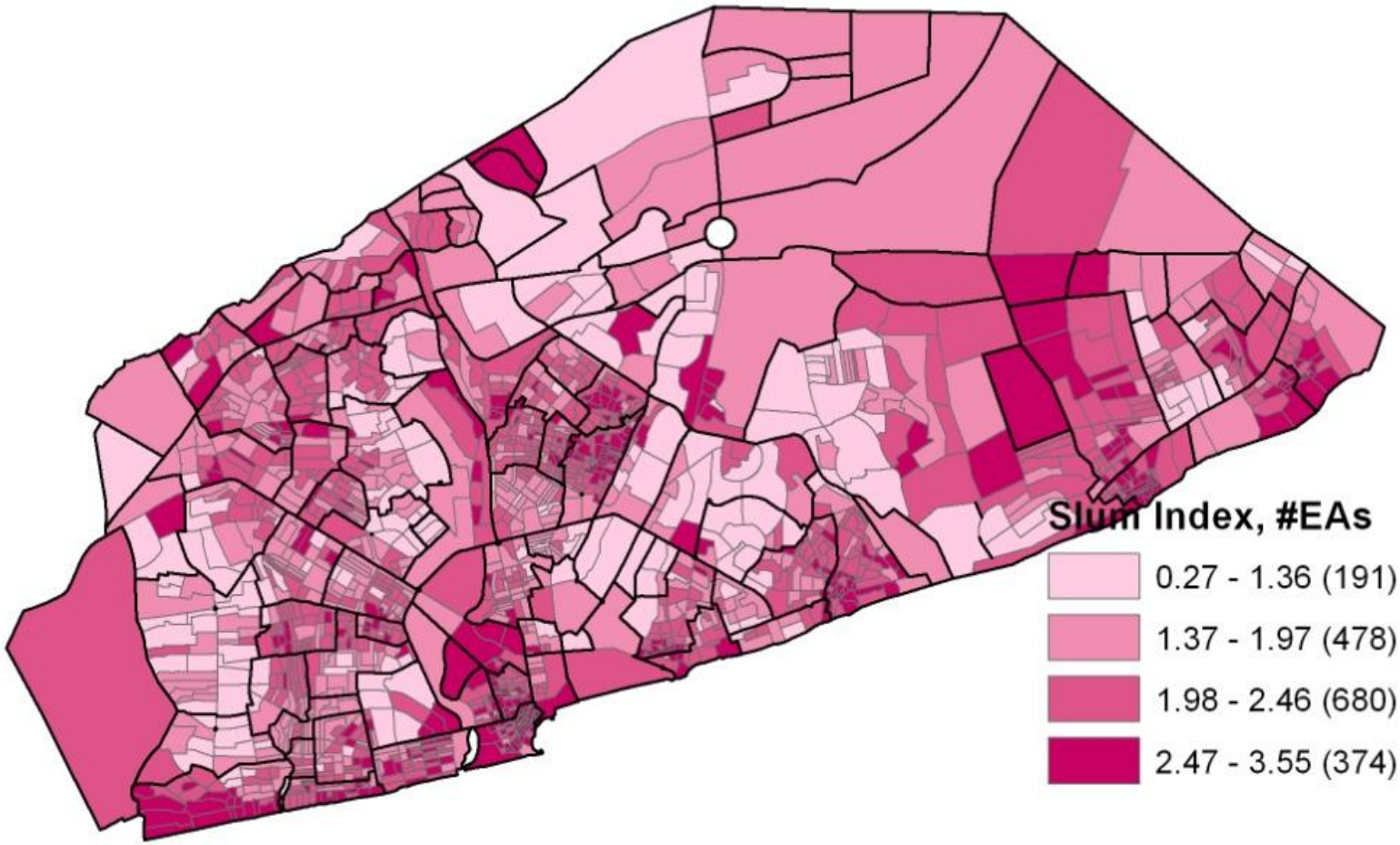
Housing Quality



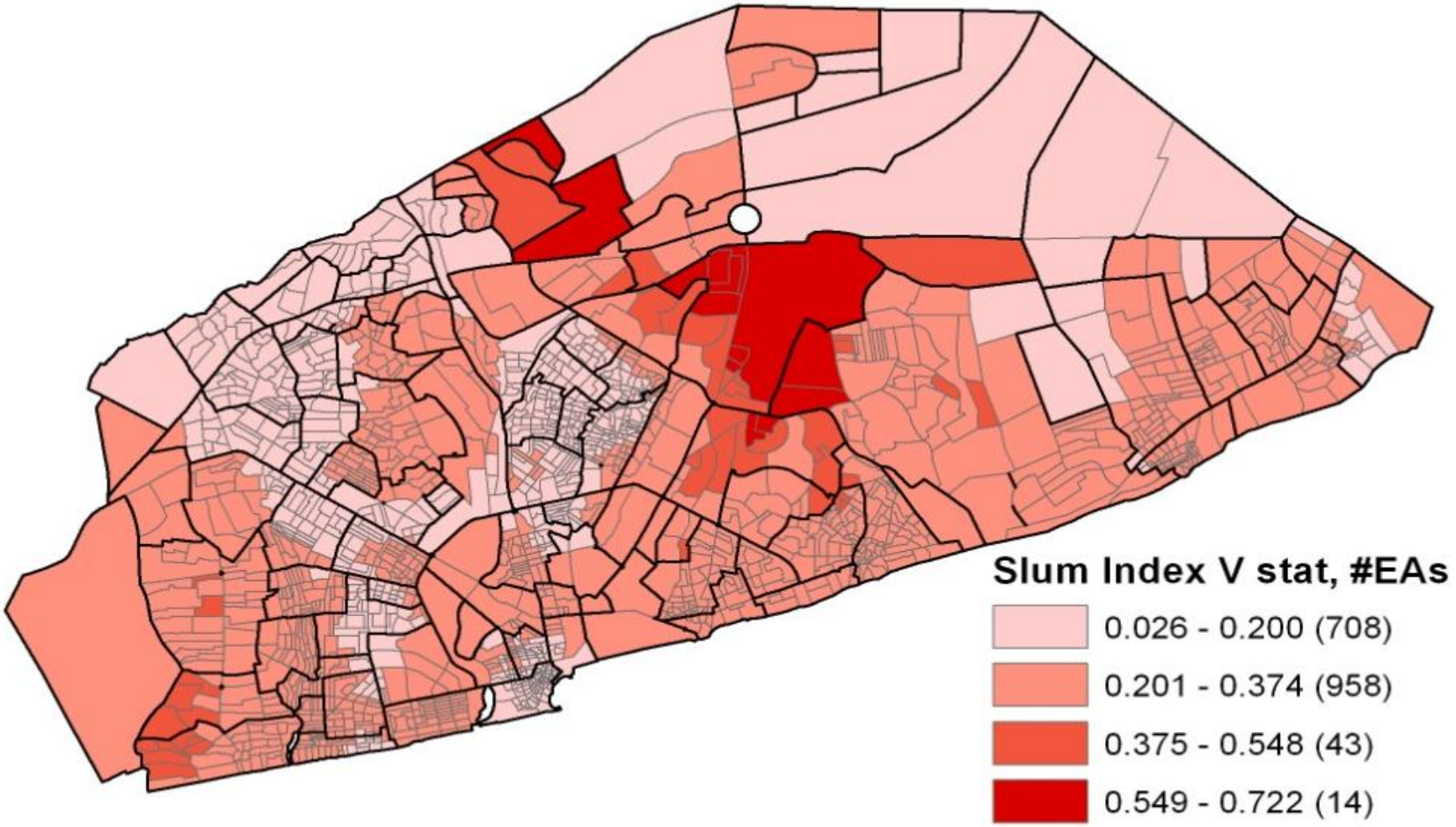
Hi for Housing Quality



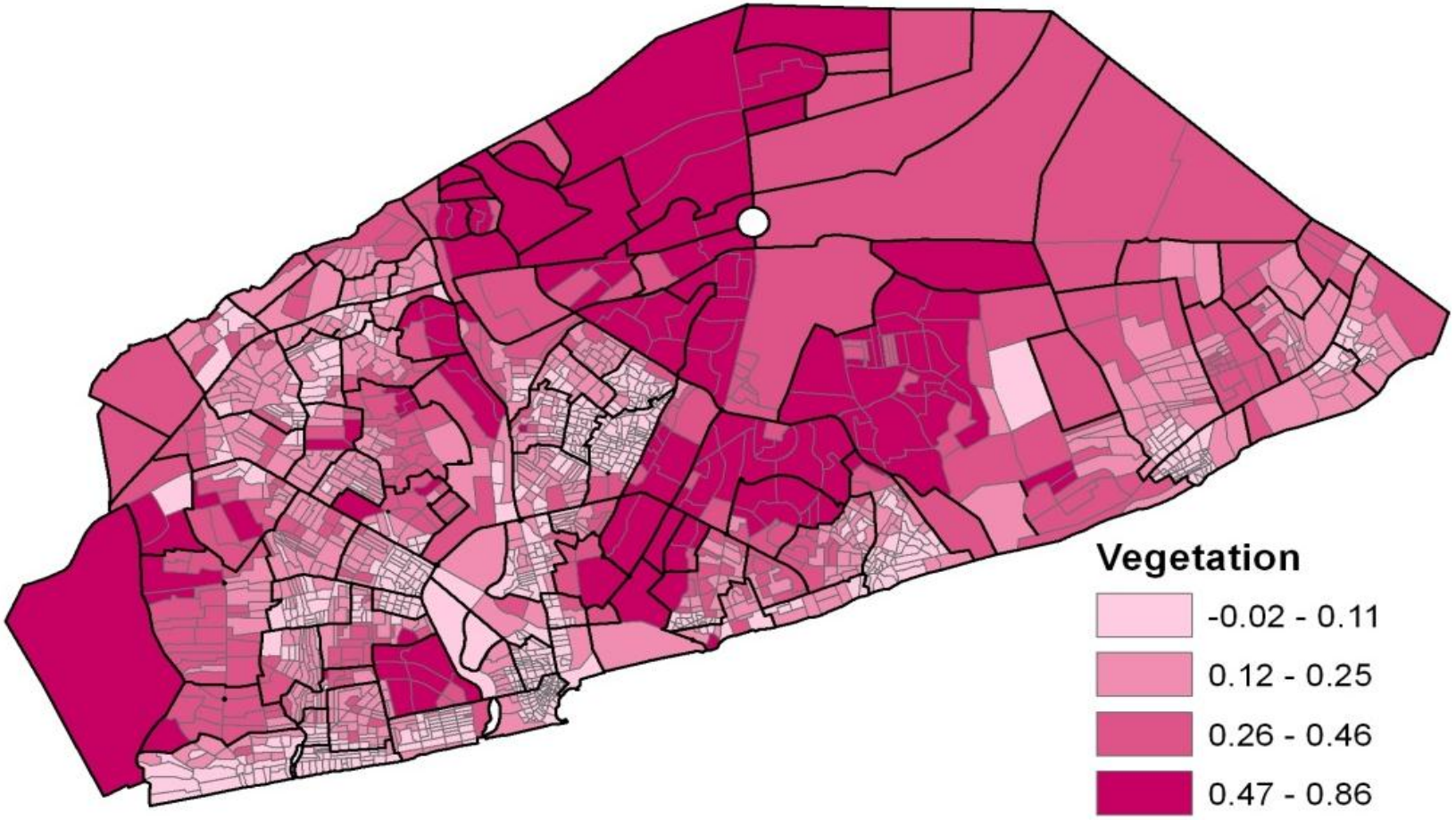
Slum Index



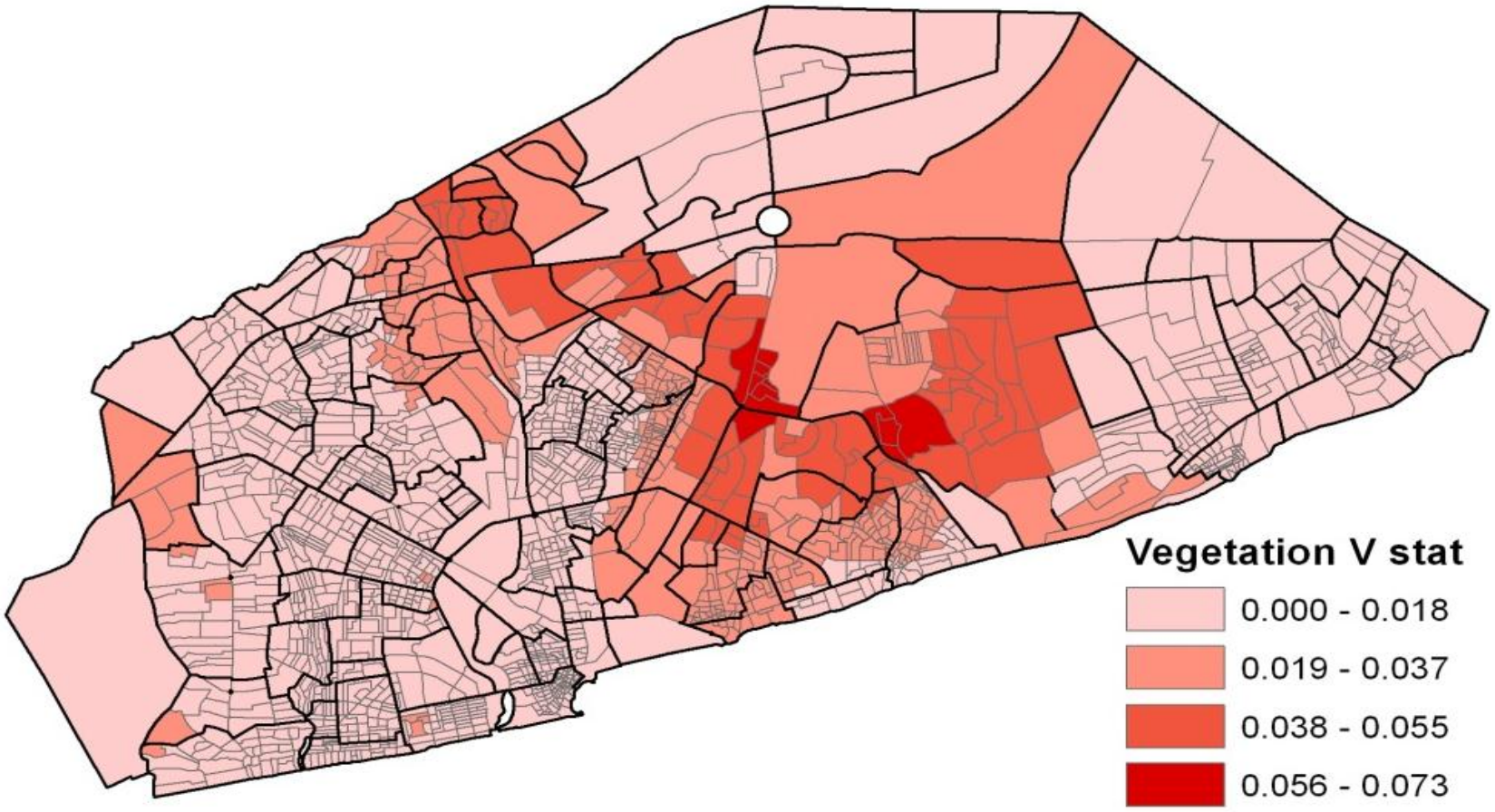
Hi for Slum Index



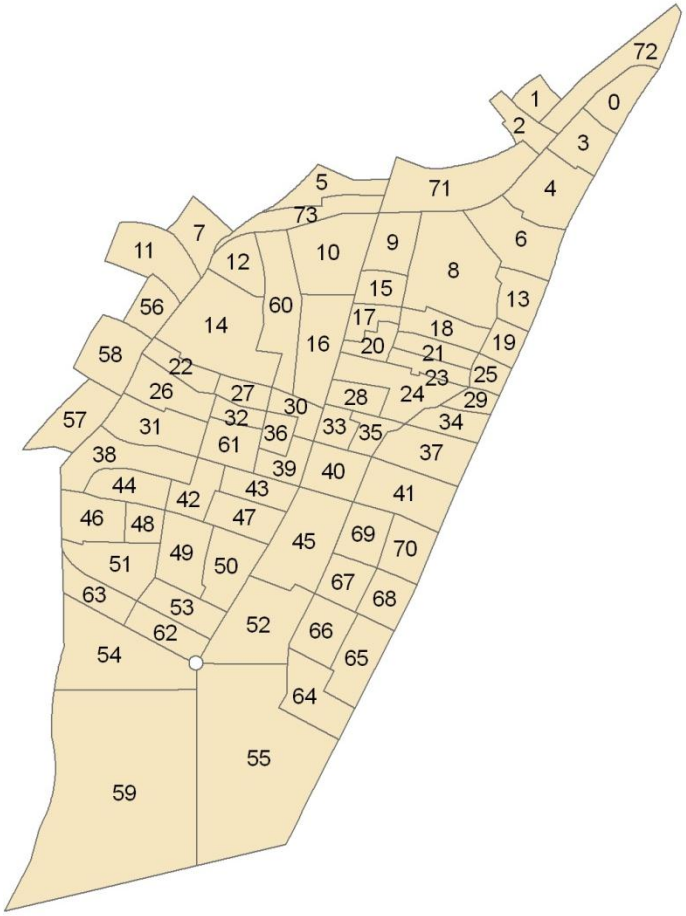
Remotely Sensed Vegetation Values

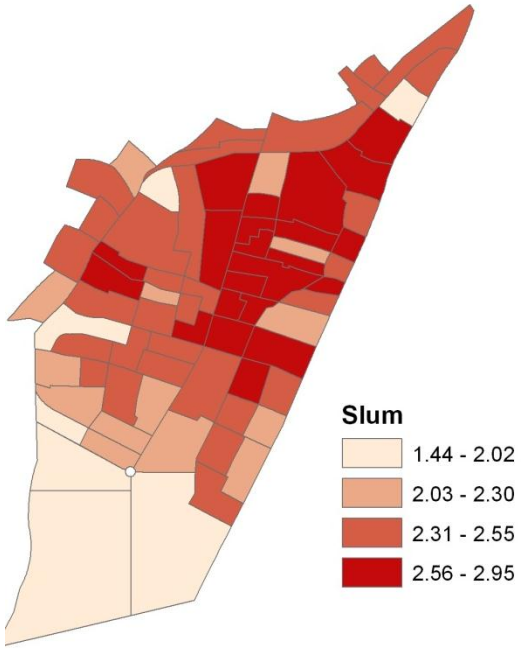


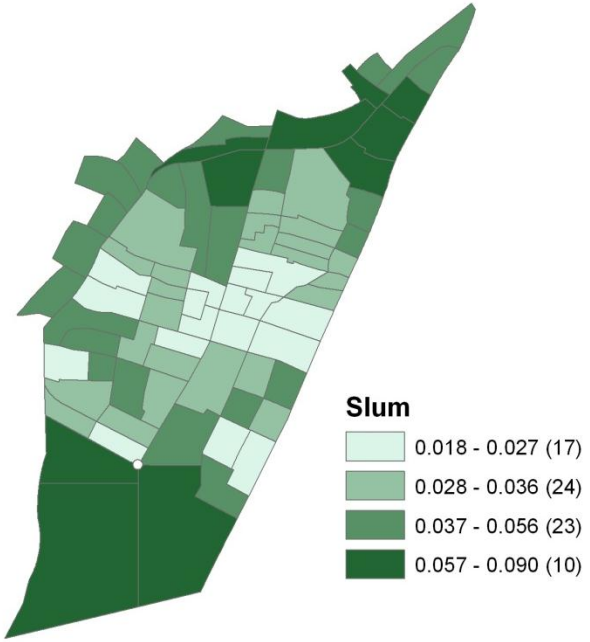
Hi for Remotely Sensed Vegetation

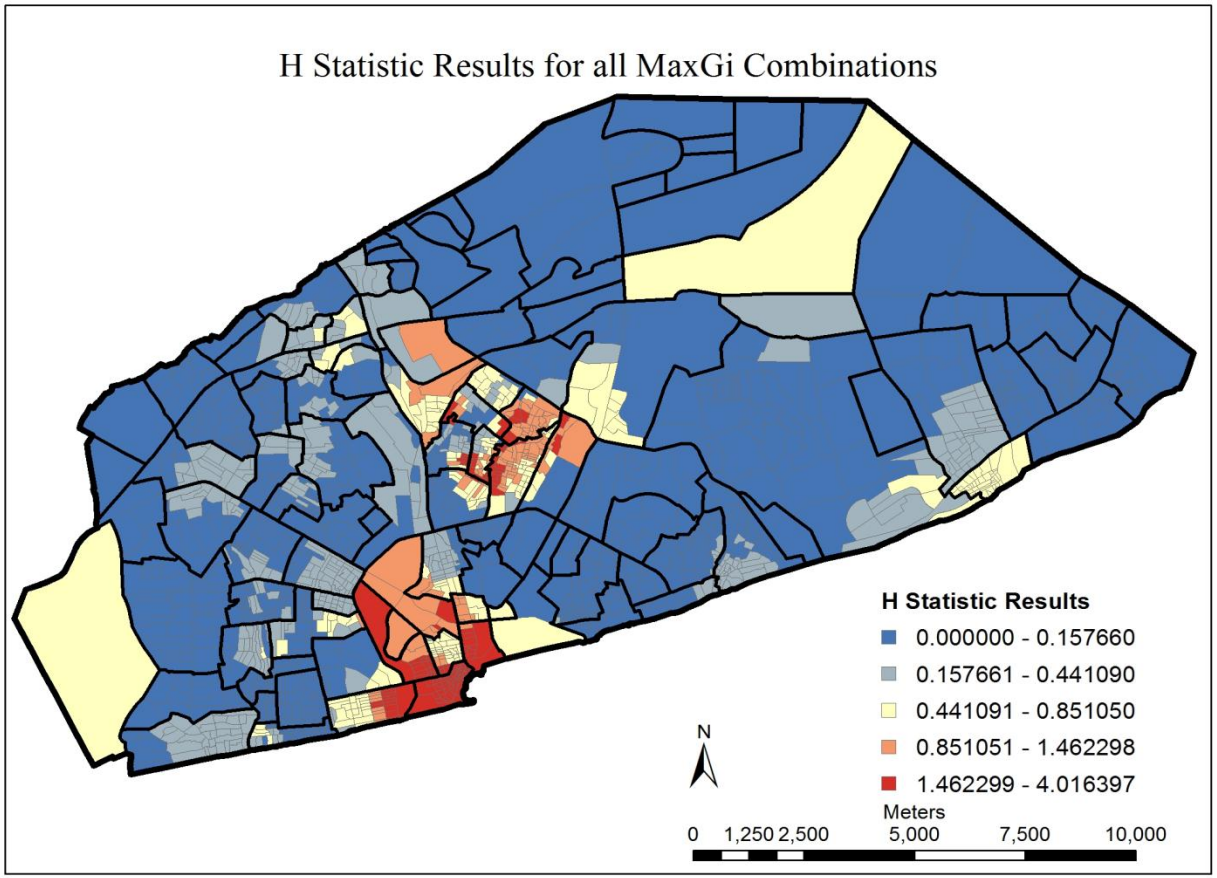


Example Vernacular Neighborhood: Nima








H Statistic Results for all MaxGi Combinations
H Statistic Results
0.000000 - 0.157660
0.157661 - 0.441090
0.441091 - 0.851050
0.851051 - 1.462298
1.462299 - 4.016397
N
Meters
0 1,250 2,500 5,000 7,500 10,000

Closing Comments and Suggestions

LOSH:

- Identifies transitional regions
- Directs attention toward boundary demarcation
- Shows degree of heterogeneity/homogeneity within clusters
- Suggestion 1: Use as a further test on residuals of regression for identifying spatial outliers
- Suggestion 2: Use for tests on coefficients in GWR

Figure 7 - Slum Sum: Amoeba-clustered EAs at the 95% Confidence Level

Figure 8 - Chest Pain: Amoeba-clustered EAs at the 95% Confidence Level

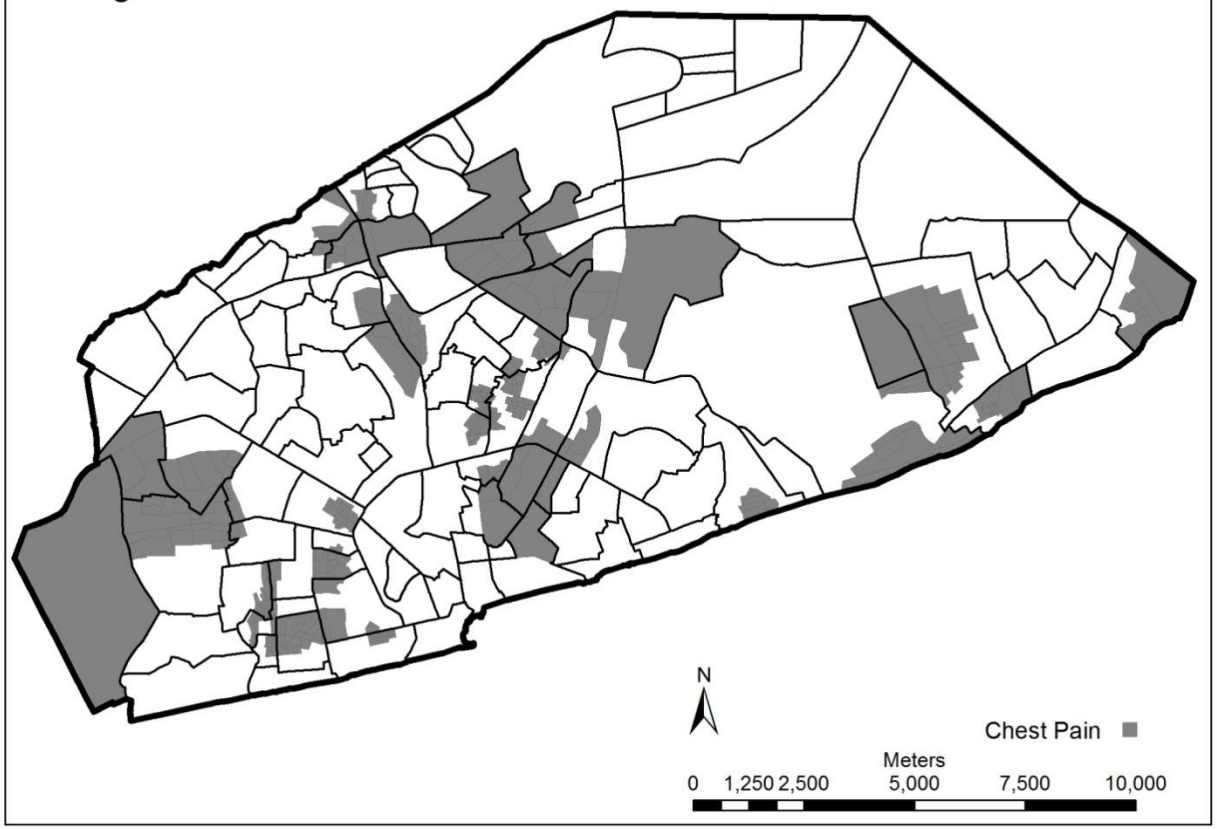


Figure 9 - Illiteracy

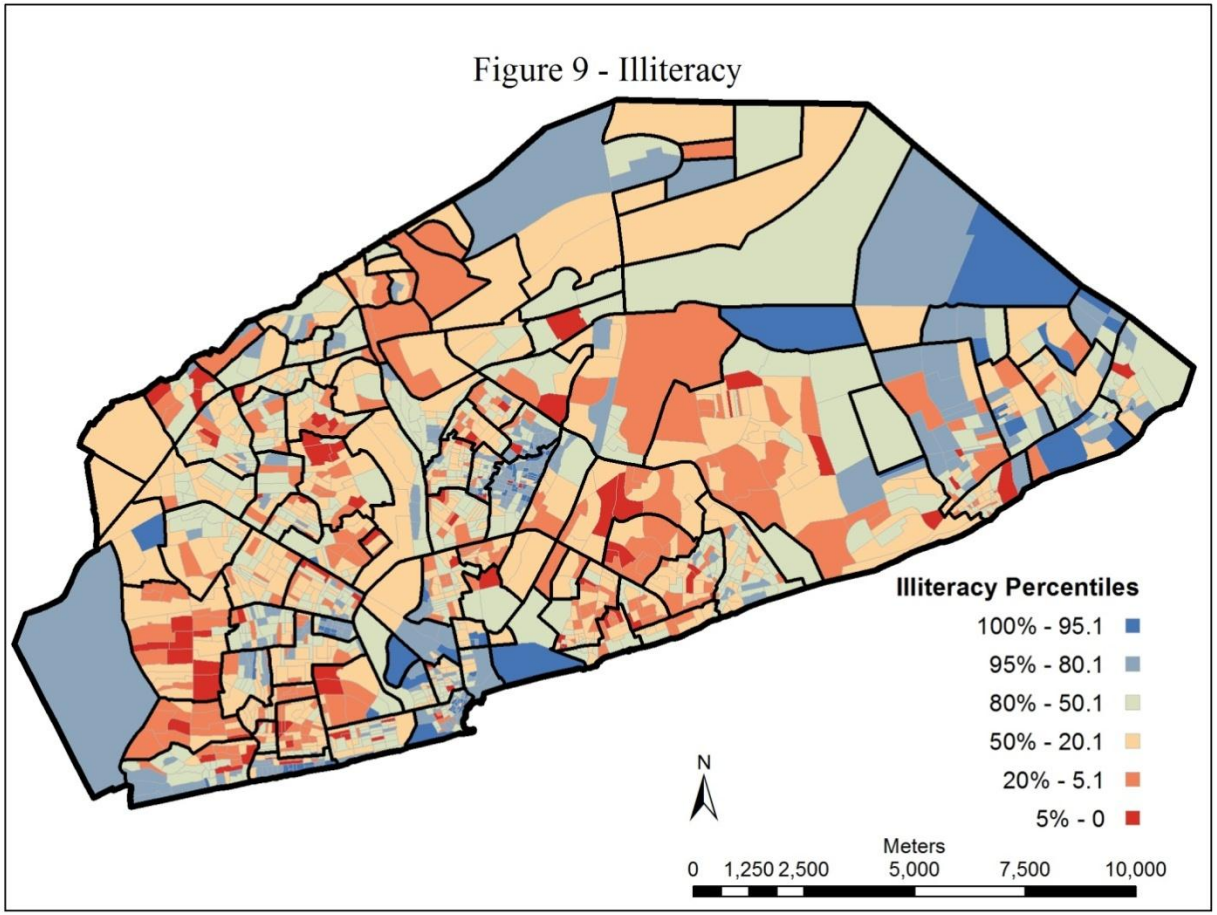


Figure 10 - The Intersection of Amoeba-clustered EAs from Figures 7 & 8

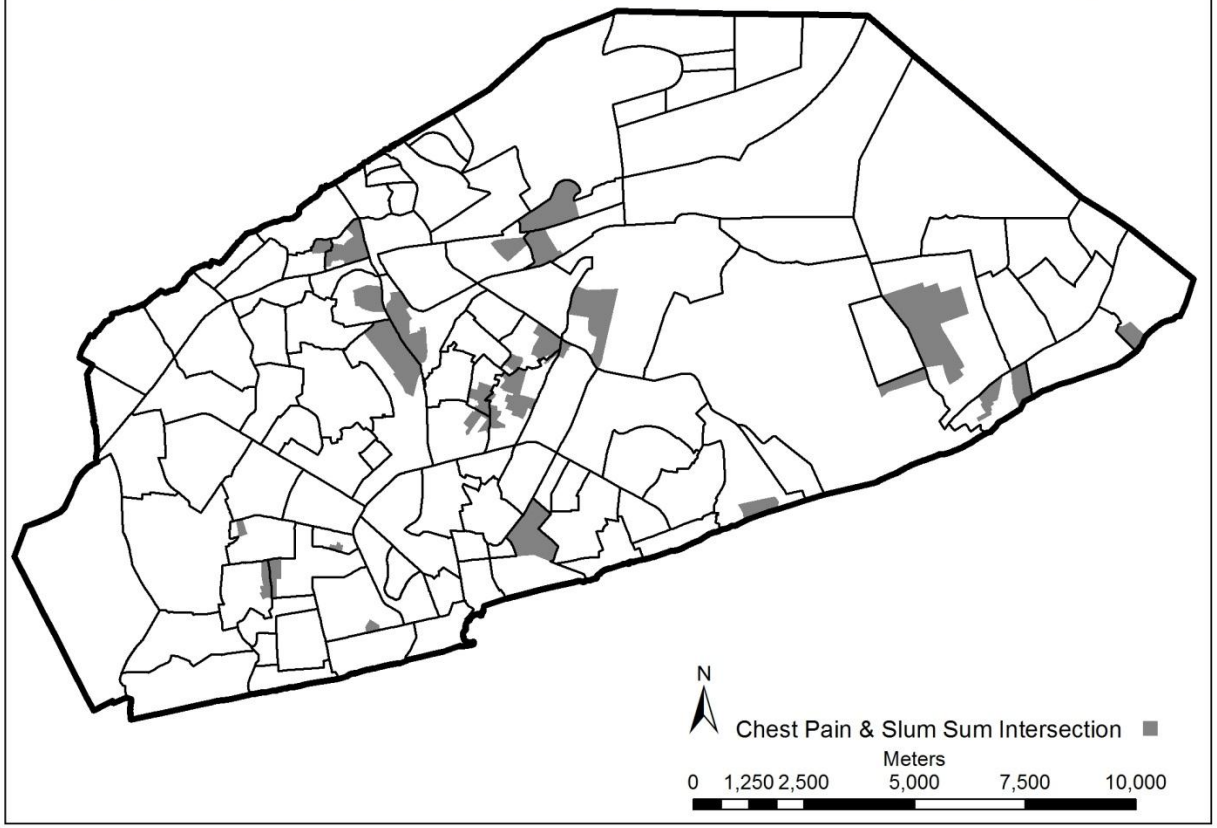


Figure 11 -
Illiteracy rates in the intersection of Amoeba-clustered EAs from Figures 7 & 8

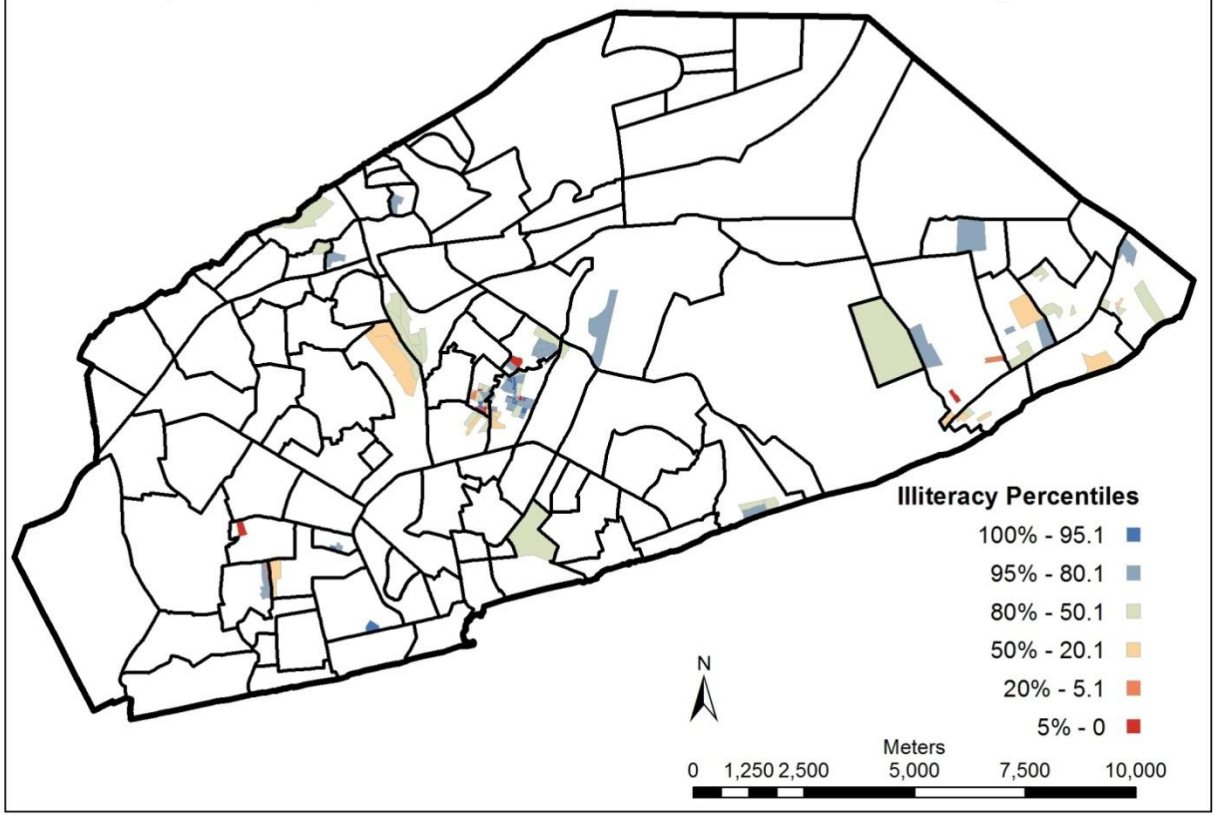
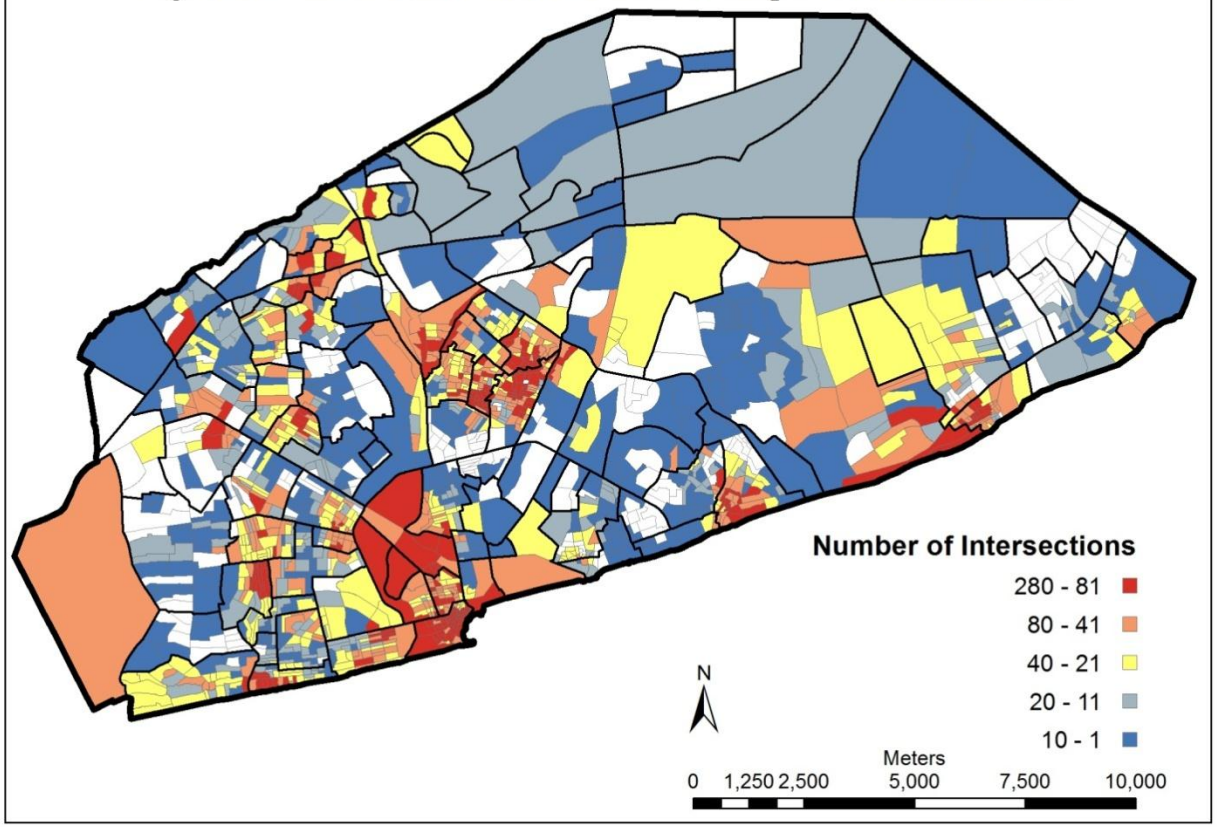
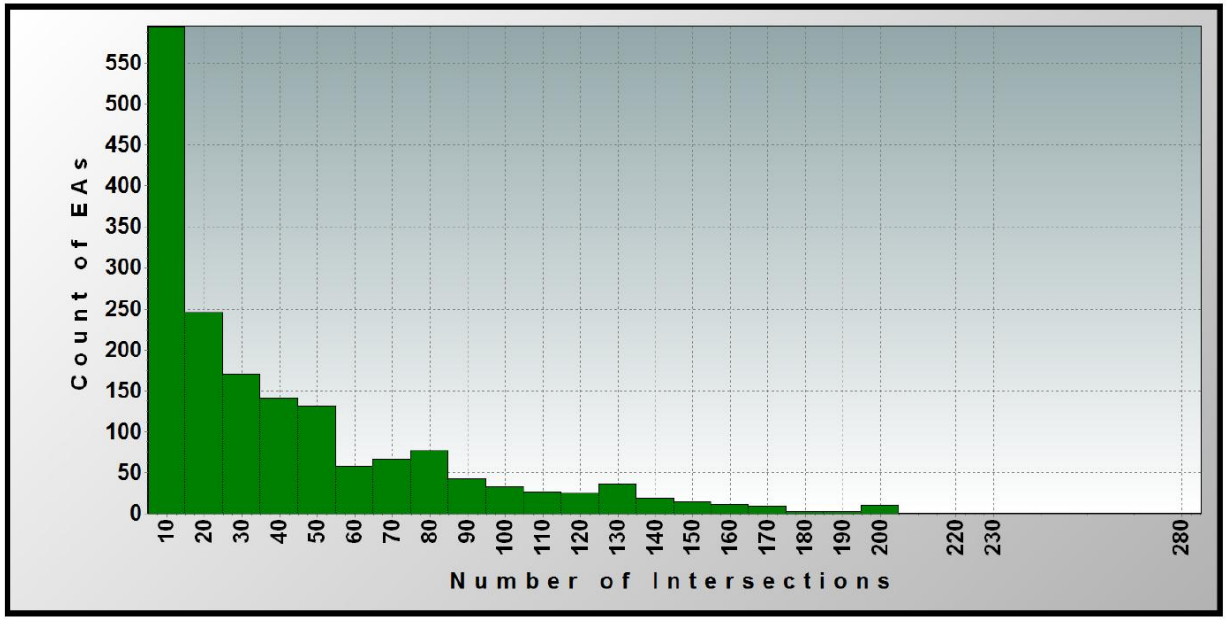


Figure 12 - Number of E and H Intersections per Enumeration Area




Count of EAs
550
500
450
400
350
300
250
200
150
100
50
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
150
160
170
180
190
200
220
230
280
Number of Intersections


ASUO
CHEMISTS GHANA

Figure 1a - Field Modified Vernacular Neighborhoods

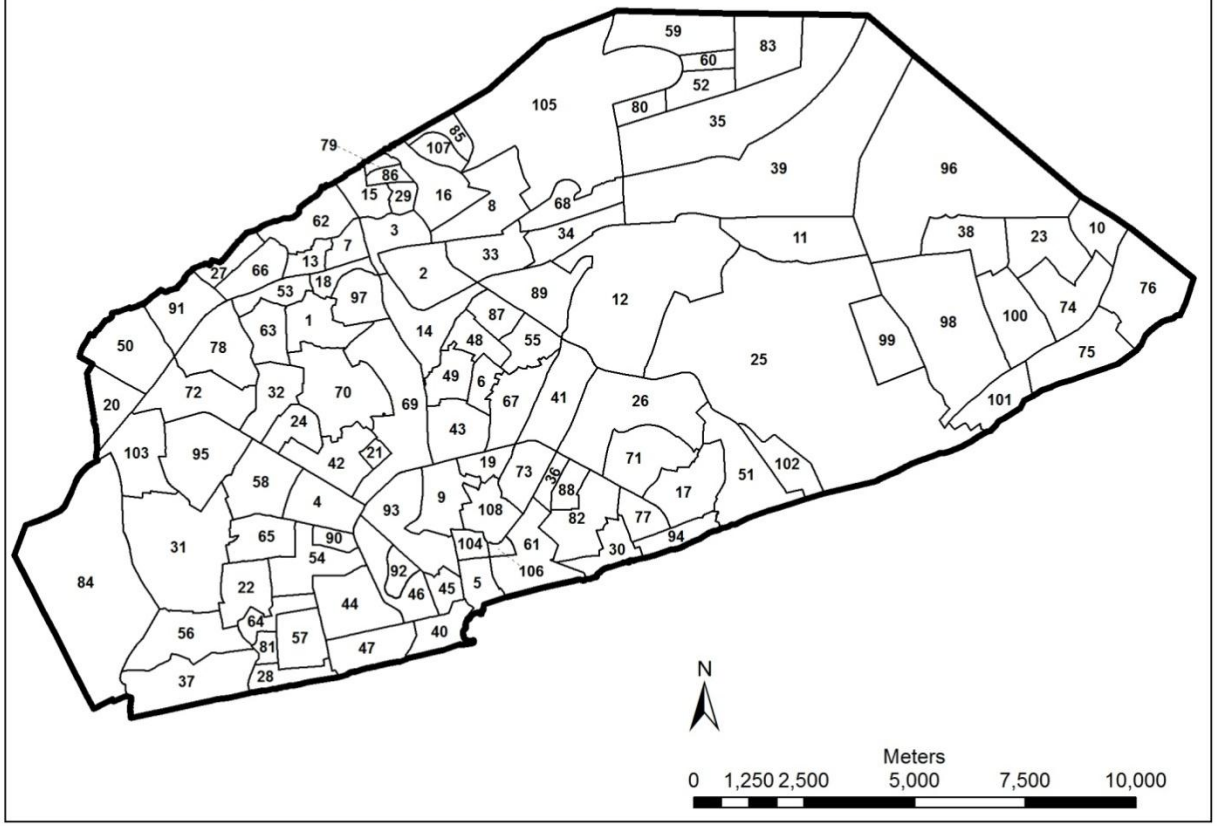


Figure 1b - Field Modified Vernacular Neighborhoods

Number	Name	Number	Name	Number	Name
1	Abeka	39	Industrial Area	77	Nyanbia Estates
2	Abelemkpe	40	Jamestown	78	Official Town
3	Abofu	41	Kanda Estate	79	Okoman
4	Abossey Okai	42	Kaneshie	80	Okponglo
5	Accra Central	43	Kokomlemle	81	Old Damsoman
6	Accra New Town	44	Korle Bu Hospital	82	Osu
7	Achimota	45	Korle Dudor	83	Otinshie
8	Achimota Forest	46	Korle Lagoon Area	84	Pambros Salt Ponds
9	Adabraka	47	KorleGonno	85	Papao
10	Addogonno	48	Kotobabi	86	Parakuo Estate
11	Airport Hills Residential Area	49	Kpehe	87	Pig Farm
12	Airport Residential Area	50	Kwashieman	88	Ringway Estate
13	Akweteyman	51	La	89	Roman Ridge
14	Alajo	52	La Bawalshie	90	Sabon Zongo
15	Algoboshie	53	Lapaz	91	Santa Maria
16	Anumle	54	Lartebiokorshi	92	Sodom & Gomorah
17	Apapa	55	Mamobi	93	South Industrial Area
18	Apenkwa	56	Mamponse	94	South La Estate
19	Asylum Down	57	Mamprobi	95	South Ordokor
20	Awoshie	58	Mataheko	96	Spintex Road
21	Awudome Estate	59	Medina Estates	97	Tesano
22	Banana Inn	60	Mepeasm	98	Teshie
23	Buade	61	Ministries	99	Teshie Manheam
24	Bubiashie	62	New Achimota	100	Teshie Nungua Estates
25	Burma Camp	63	New Fadama	101	Teshie Old Town
26	Cantonments	64	New Mamprobi	102	Trade Center
27	Chantan	65	New Russia	103	Tsabaa
28	Chorkor	66	Niiboye Town	104	Tudu
29	Christian Village	67	Nima	105	University Of Ghana
30	Christianborg	68	North Dzorwulu Residential Area	106	Victoriaborg
31	Dansoman Estate	69	North Industrial Area	107	West legon Residential
32	Darkuman	70	North kaneshie	108	West Ridge
33	Dzorwulu Residential Area	71	North labone Estate		
34	East Dzorwulu Residential Area	72	North Ordokor		
35	East Legon Residential	73	North Ridge		
36	East Ridge	74	Nungua		
37	Gbegbeyise	75	Nungua Old Town		
38	Greda Estates	76	Nungua Salem		

Figure 1b - Field Modified Vernacular Neighborhoods

Number	Name	Number	Name	Number	Name
1	Abeka	39	Industrial Area	77	Nyanbia Estates
2	Abelemkpe	40	Jamestown	78	Official Town
3	Abofu	41	Kanda Estate	79	Okoman
4	Abossey Okai	42	Kaneshie	80	Okponglo
5	Accra Central	43	Kokomlemle	81	Old Damsoman
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9	Adabraka	47	KorleGonno	85	Papao
10	Addogonno	48	Kotobabi	86	Parakuo Estate
11	Airport Hills Residential Area	49	Kpehe	87	Pig Farm
12	Airport Residential Area	50	Kwashieman	88	Ringway Estate
13	Akweteyman	51	La	89	Roman Ridge
14	Alajo	52	La Bawalshie	90	Sabon Zongo
15	Algoboshie	53	Lapaz	91	Santa Maria
16	Anumle	54	Lartebiokorshi	92	Sodom & Gomorah
17	Apapa	55	Mamobi	93	South Industrial Area
18	Apenkwa	56	Mamponse	94	South La Estate
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22	Banana Inn	60	Mepeasm	98	Teshie
23	Buade	61	Ministries	99	Teshie Manheam
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25	Burma Camp	63	New Fadama	101	Teshie Old Town
26	Cantonments	64	New Mamprobi	102	Trade Center
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28	Chorkor	66	Niiboye Town	104	Tudu
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36	East Ridge	74	Nungua		
37	Gbegbeyise	75	Nungua Old Town		
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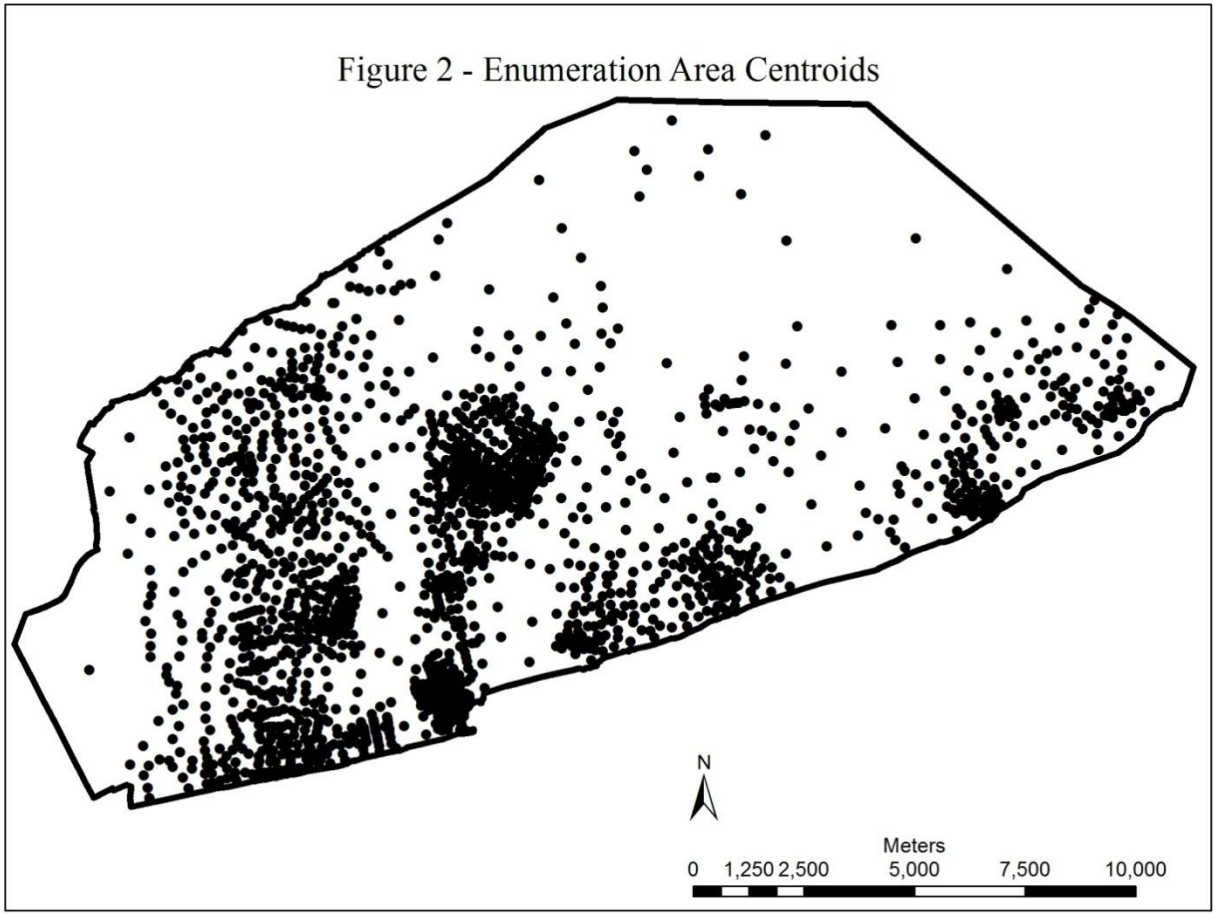
Figure 2 - Enumeration Area Centroids



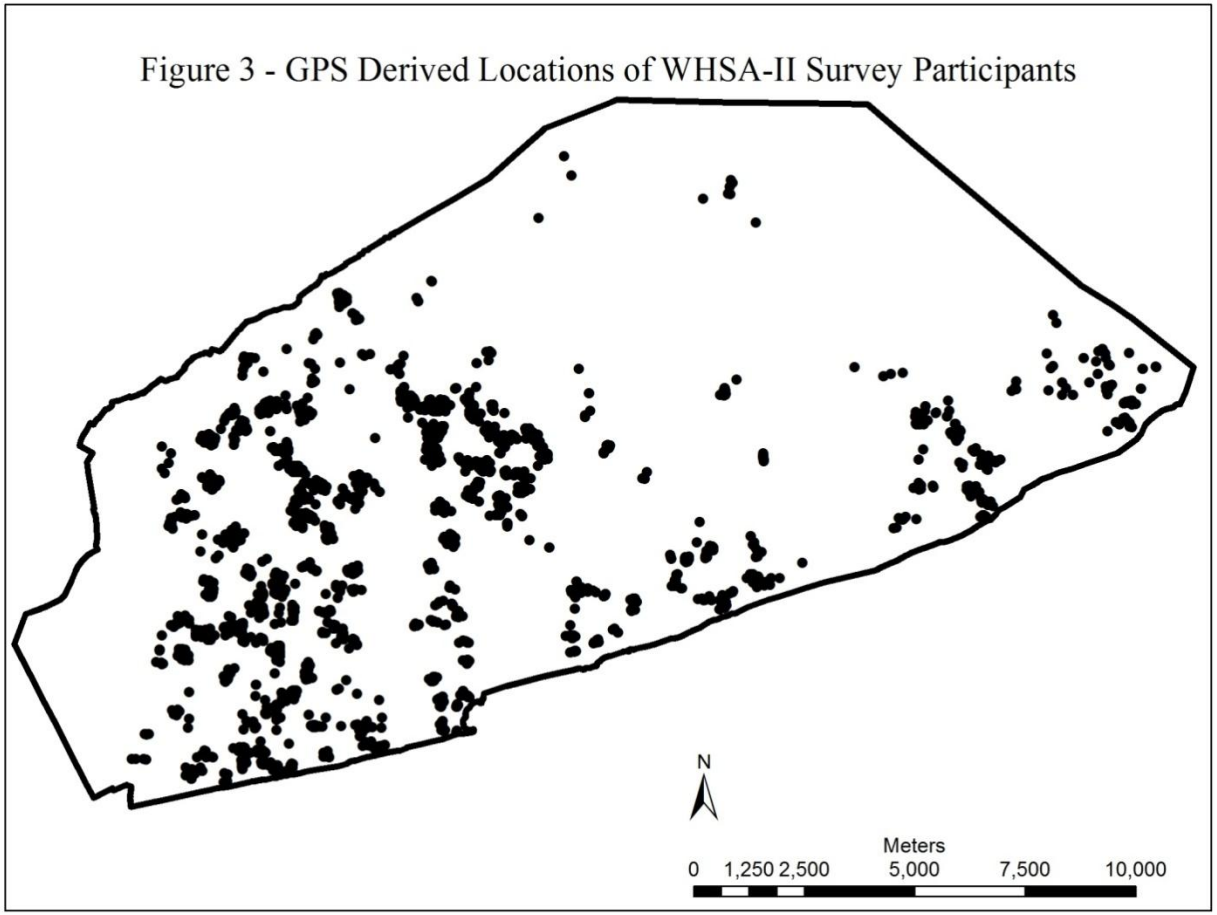


Figure 3 - GPS Derived Locations of WHSA-II Survey Participants
N
Meters
0 1,250 2,500 5,000 7,500 10,000

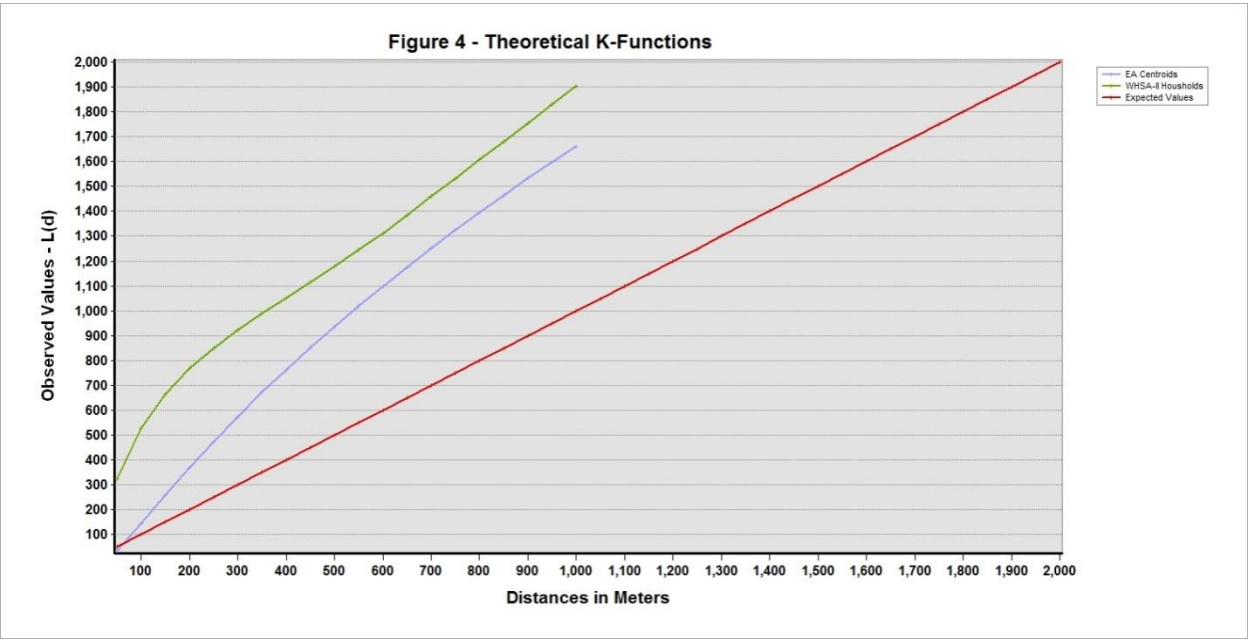


Figure 4 - Theoretical K-Functions
Observed Values - L(d)
2,000
1,900
1,800
1,700
1,600
1,500
1,400
1,300
1,200
1,100
1,000
900
800
700
600
500
400
300
200
100
100 200 300 400 500 600 700 800 900 1,000 1,100 1,200 1,300 1,400 1,500 1,600 1,700 1,800 1,900 2,000
Distances in Meters
EA Centroids
WHSA-II Housholds
Expected Values

Spatial Variance

- Focus and tests: On equality of spatial variance

Literature:

- F-test, Bartlett test (requires normal distributions):
  sensitive to non-normality
- Box (1953) corrected for non-normality
- Levene (1960) replaced each observation by a scale
  variable e.g., an absolute deviation;
  but not georeferenced variables

Data Analysis

- For each cell/area define the neighborhood as for the *G* or *I* statistic
- Compute the *G* and *H* statistics for each cell.
- Generate the *G*-map and the *H* map.

Variation in region to distance *d*

We define the average of the absolute (or squared) errors to be:

$$h_1(d) = \sum_{i=1}^{n} | e_i(d) |^{a} \ / n$$

α = 1 (represents the mean absolute error)

= 2 (represents the mean variation)

For entire study area (n)

Scaled H_i

- h_1 is the mean of absolute errors in entire study area

$$H_i(d) = \frac{\sum_j w_{ij}(d)\,|\,e_j(d)\,|^a}{h_1(d)\sum_j w_{ij}(d)}$$

- This scales the local area *j* to error values in the entire area

The Variance of H_i

K for number of equally weighted neighbors

h_1 is mean of absolute errors in entire study area

h_2 is mean squared residuals in entire study area

$$Var_P(H_i) = \left(\frac{1}{(n-1)Kh_1^2} \right)(h_2 - h_1^2)[n-K]$$

Practical Test on H_i for Squared Errors

- *Chi-square distribution with v degrees of freedom has mean v and variance 2v*

$$Z_i = 2H_i / V_i$$

- With *2/V_i df*

- *Z is standard normal variate*
- *V_i can be mean variance*

CASE 1:
p values for H_i for random x's

0.85	0.18	0.42	**0.07**	0.47	0.28	0.46	0.54	0.20	0.33
0.68	**0.08**	0.37	**0.03**	0.36	0.24	0.47	0.51	0.18	0.29
0.68	**0.08**	0.21	**0.09**	0.78	0.63	0.11	**0.10**	**0.01**	0.20
0.85	0.15	0.21	**0.01**	0.32	0.14	0.24	0.29	0.43	1.00
0.74	0.20	0.42	**0.02**	0.21	0.13	0.25	0.44	0.15	0.69
0.93	0.56	0.87	**0.10**	0.13	**0.10**	0.25	0.44	0.18	0.59
0.91	0.31	0.50	0.46	0.90	0.62	0.21	0.44	0.09	0.50
0.99	0.56	0.69	0.52	0.79	0.52	0.12	0.12	**0.03**	0.32
0.88	0.28	0.68	0.52	0.91	0.96	0.44	0.14	**0.02**	0.19
0.97	0.82	0.97	0.92	0.92	0.94	0.90	0.55	0.21	0.40

- **Bold** = statistically significant at ≤ 0.10

CASE 2
p values for bump in x's in middle 4x4

0.35	0.15	0.50	0.27	0.58	0.47	0.63	0.68	0.53	0.62
0.31	0.13	0.56	0.24	0.55	0.47	0.61	0.64	0.43	0.54
0.73	0.33	0.20	**0.06**	**0.04**	**0.05**	**0.08**	0.25	0.14	0.41
0.83	0.40	0.11	**0.09**	**0.10**	0.14	**0.04**	**0.08**	0.59	0.90
0.73	0.45	0.18	0.26	0.45	0.38	**0.01**	**0.02**	0.40	0.66
0.86	0.66	**0.07**	**0.02**	0.38	0.35	0.20	**0.08**	0.43	0.61
0.81	0.52	**0.03**	**0.00**	**0.08**	0.15	**0.05**	0.16	0.34	0.54
0.94	0.66	0.12	**0.02**	0.16	0.46	0.32	0.32	0.25	0.50
0.86	0.50	0.72	0.64	0.86	0.91	0.60	0.39	0.22	0.44
0.97	0.79	0.88	0.85	0.88	0.92	0.81	0.69	0.46	0.66

- **Bold** = statistically significant at ≤ 0.10

A Spatial Cluster Again

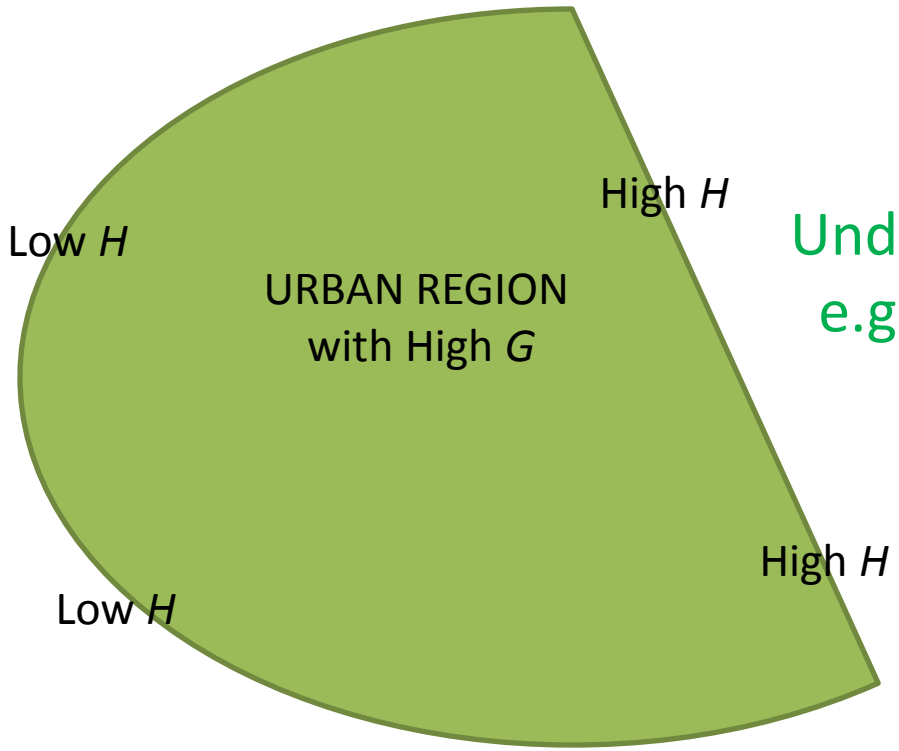
0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0
0	0	0	1	1	1	1	0	0	0
0	0	0	1	1	1	1	0	0	0
0	0	0	1	1	1	1	0	0	0
0	0	0	1	1	1	1	0	0	0
0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0	0

CASE 3
p values for H_i for binary (0,1) x's

0.76	0.77	0.77	0.77	0.77	0.77	0.77	0.77	0.77	0.76
0.77	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.77
0.77	1.00	0.23	0.11	**0.07**	**0.07**	0.11	0.23	1.00	0.77
0.77	1.00	0.11	**0.06**	**0.07**	**0.07**	**0.06**	0.11	1.00	0.77
0.77	1.00	**0.07**	**0.07**	1.00	1.00	**0.07**	**0.07**	1.00	0.77
0.77	1.00	**0.07**	**0.07**	1.00	1.00	**0.07**	**0.07**	1.00	0.77
0.77	1.00	0.11	**0.06**	**0.07**	**0.07**	**0.06**	0.11	1.00	0.77
0.77	1.00	0.23	0.11	**0.07**	**0.07**	0.11	0.23	1.00	0.77
0.77	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.77
0.76	0.77	0.77	0.77	0.77	0.77	0.77	0.77	0.77	0.76

Bold = statistically significant at ≤ 0.10

Evaluation of Boundary of Cluster Defined by High *G*



Undeveloped Land,
e.g., a Flood Plain

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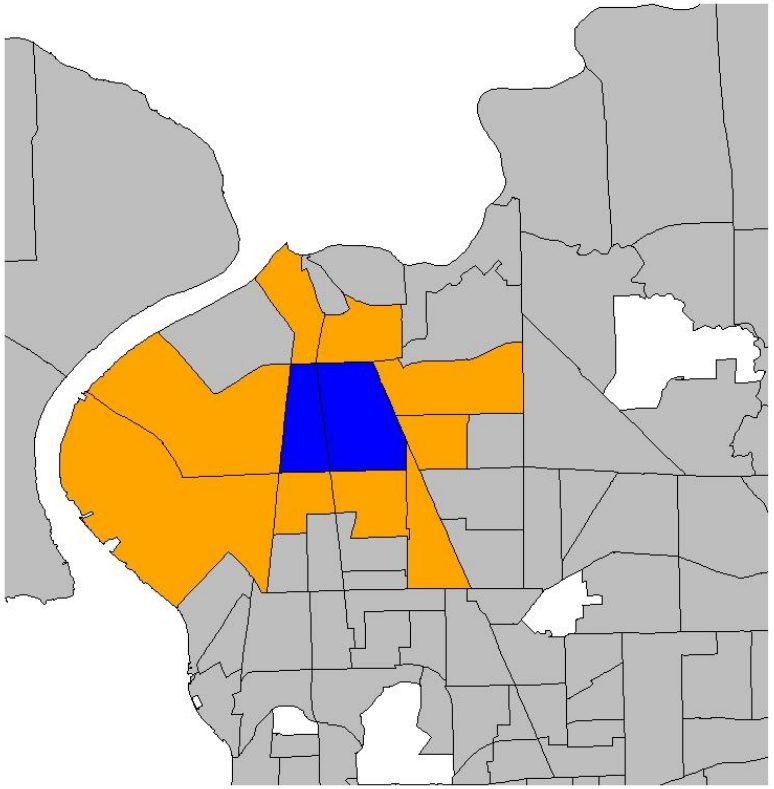
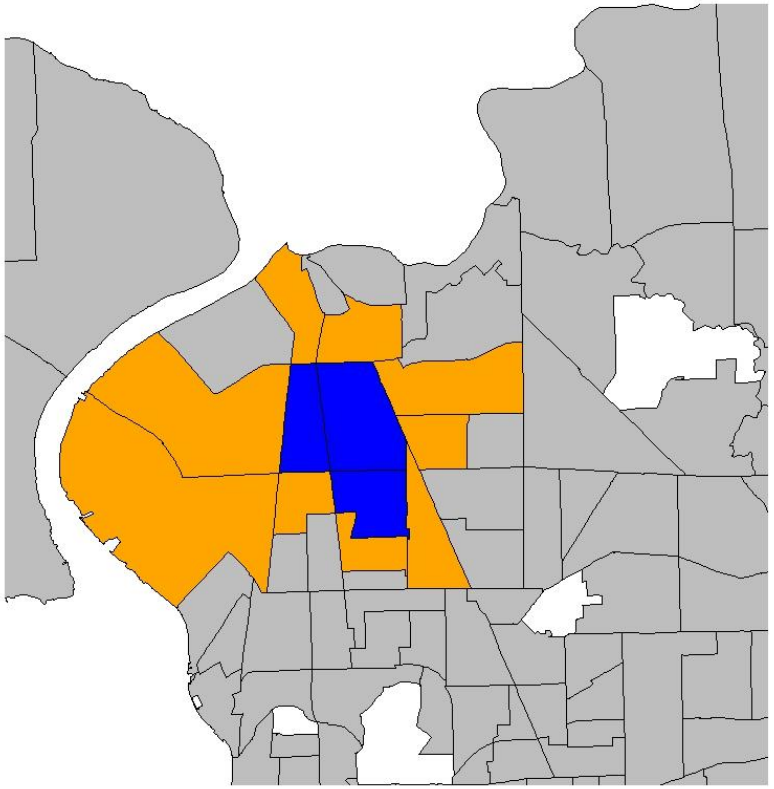
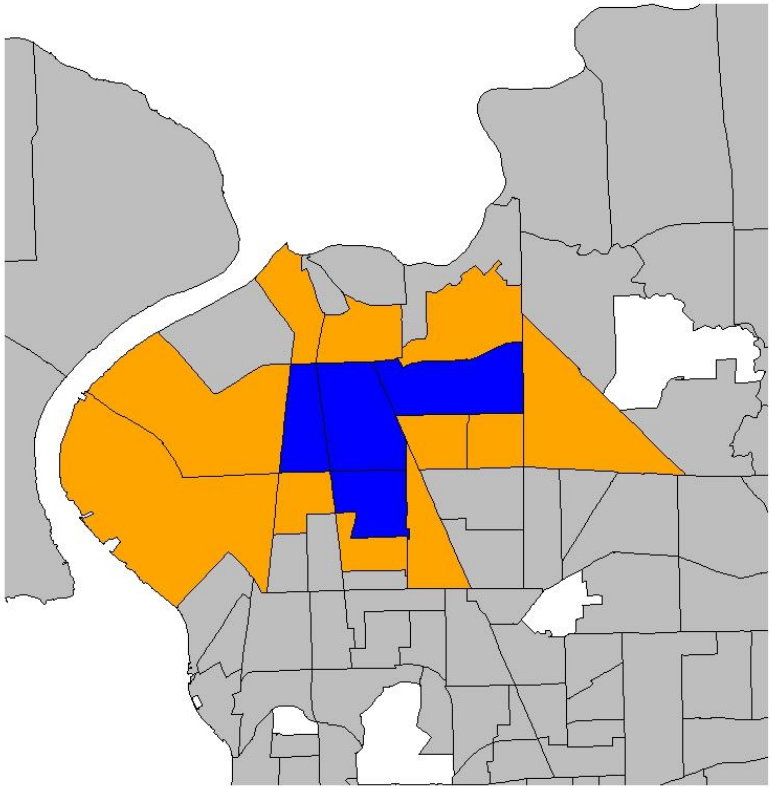
- Step 2
- Consider contiguous census tracts
- Highest G_i^* when blue region is *i*
- G_i^* higher than in Step 1



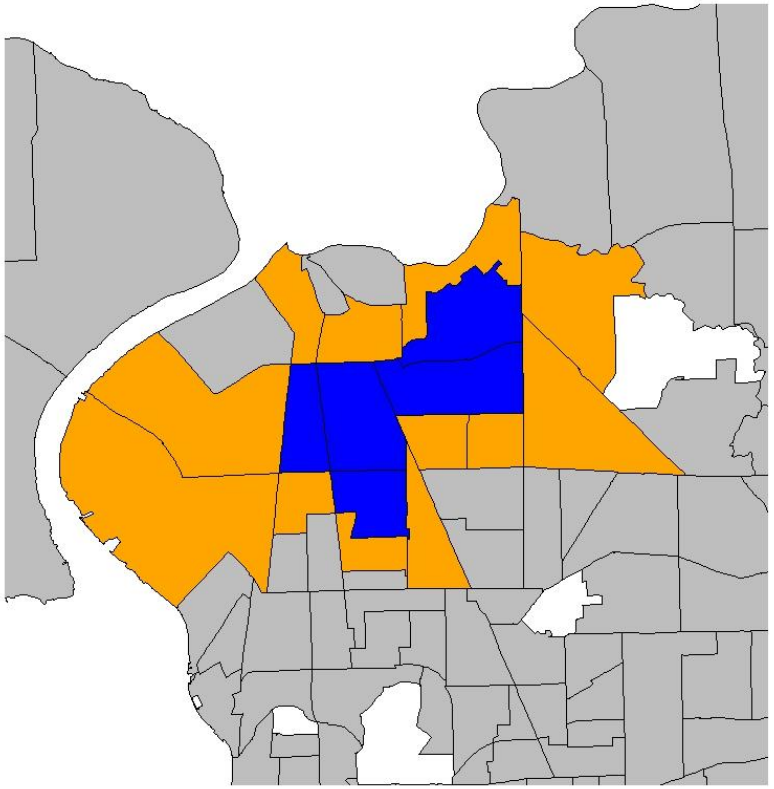
- Step 3
- G_i* still increasing (in blue)



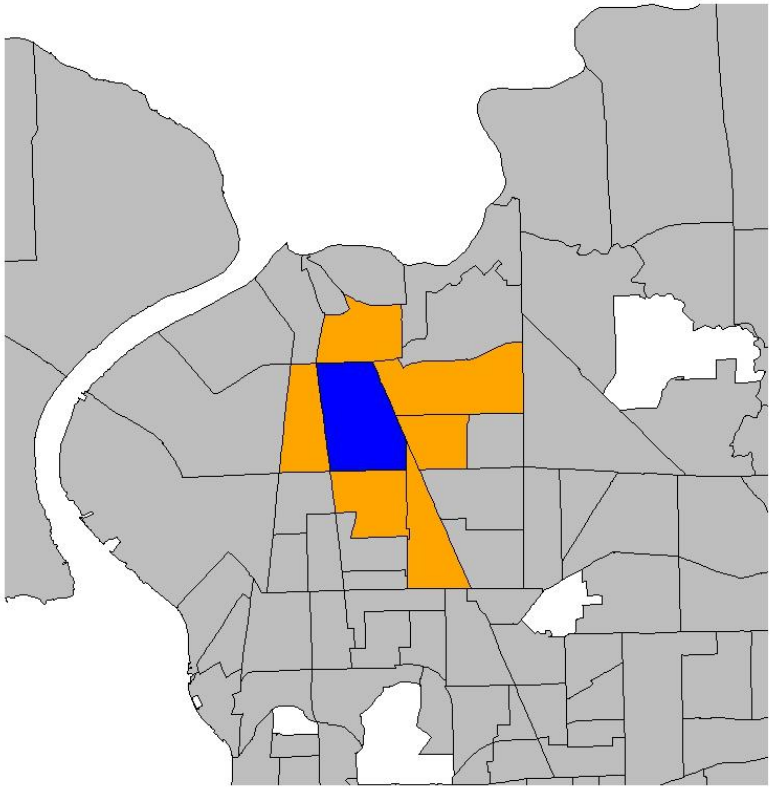
- Step 4



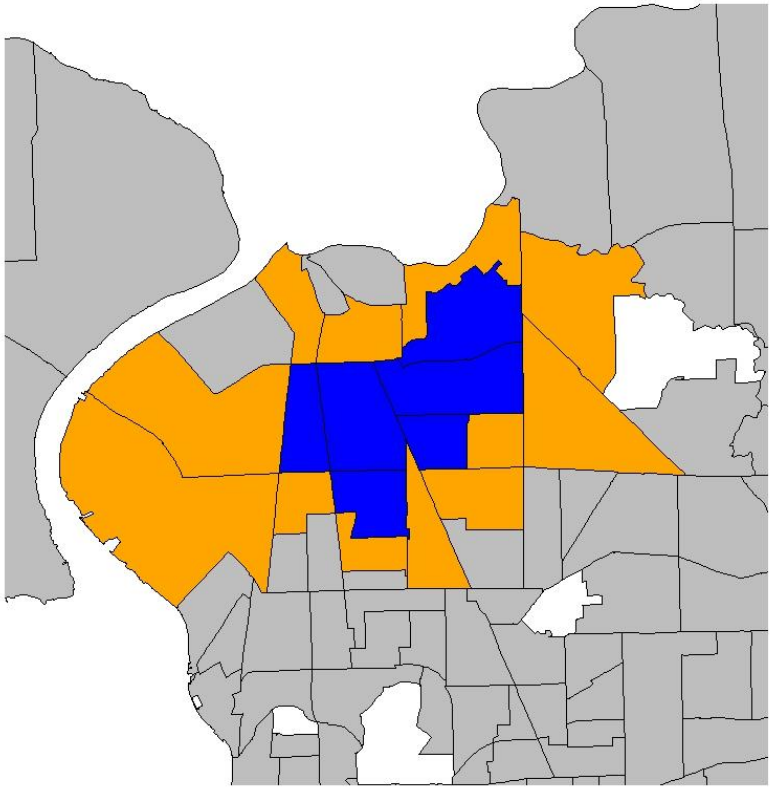
- Step 5



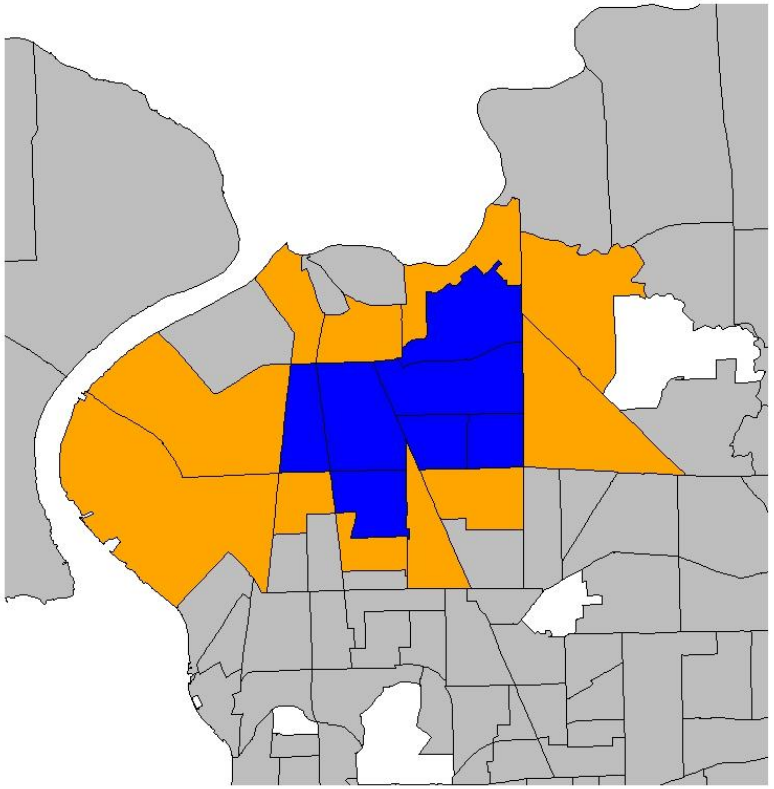
- AMOEBA
- House quality variable
- Step 1 (Maximum of Maxima G_i^*)



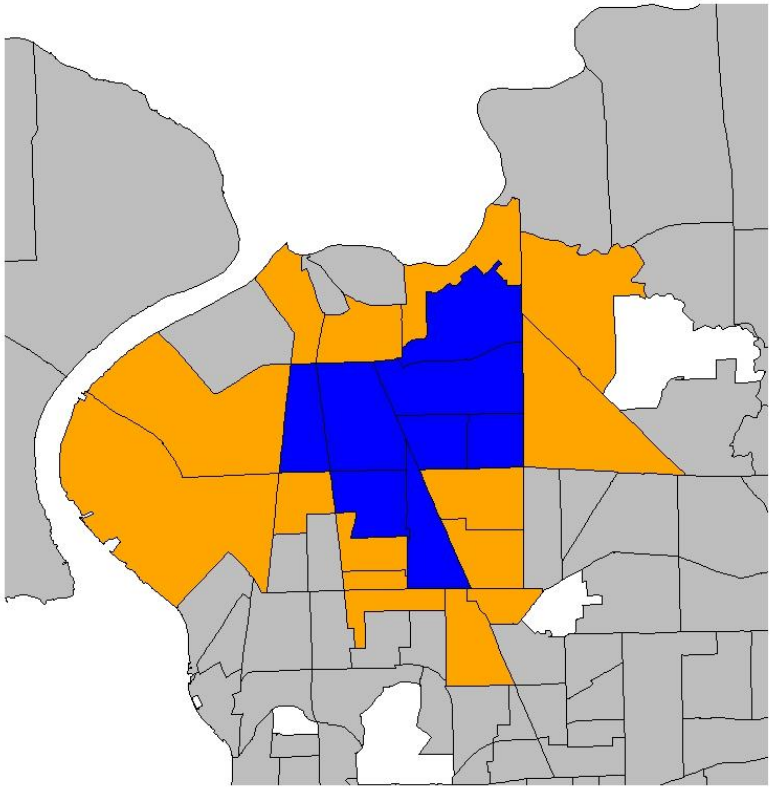
- Step 6



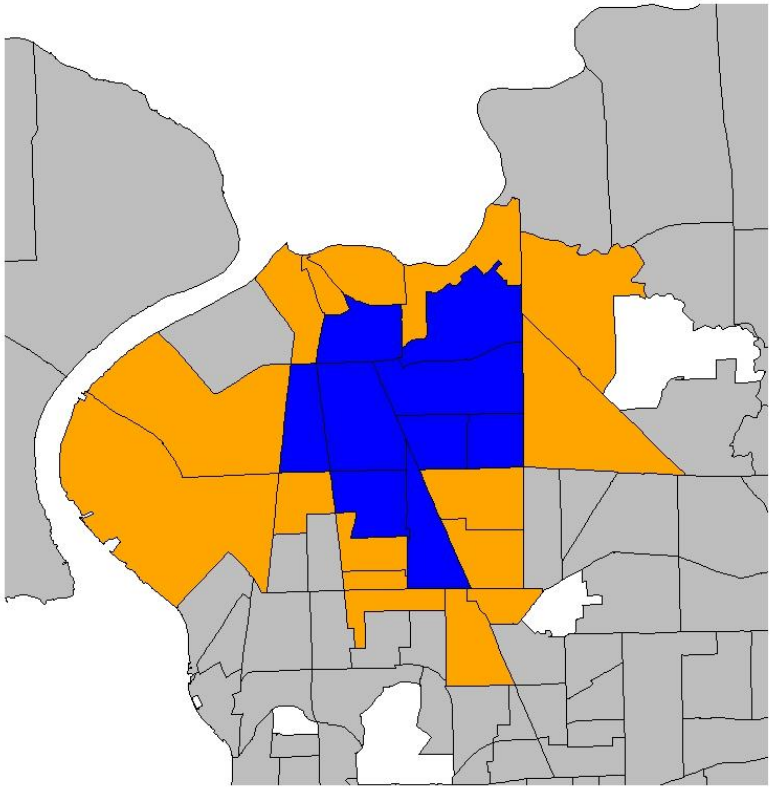
- Step 7



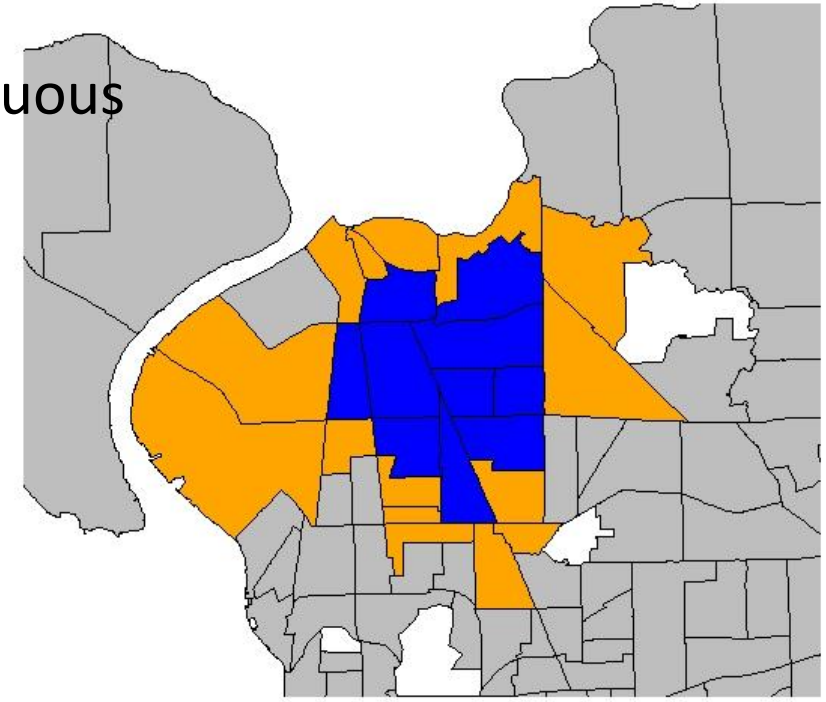
- Step 8



- Step 9



- Step 10
- Finally, by adding in other contiguous census tracts G_i^* decreases (or stays the same) instead of increasing



Interpretations

Mean/Variance	**High *H***	**Low *H***
High |*G*|	**Hot spot: Heterogeneous local conditions**	**Hot Spot: Homogeneous**
Low |*G*|	Uneven local	Homogeneous

Example 1: Traditional cluster (homogeneity) = High *G*, Low *H*

Example 2: High *H* at cluster boundary indicates well-defined neighborhood

Interpretation

High G_i, High H_i

A hot spot with heterogeneous local conditions

High G_i, Low H_i

A hot spot with similar surrounding areas; the map would indicate whether the affected region is larger than the single 'cell'

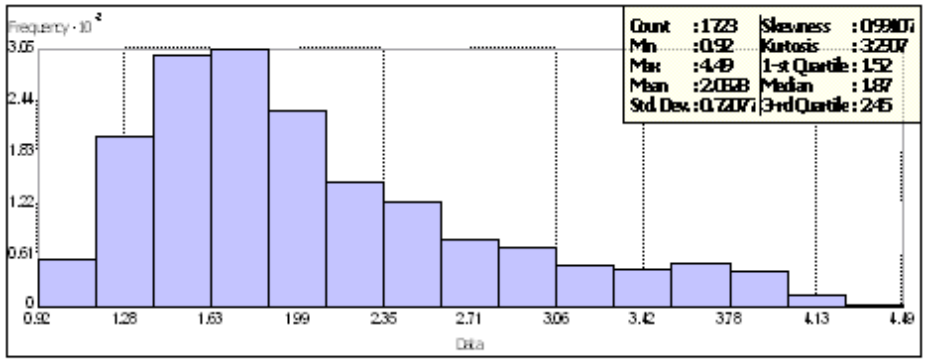
Low G_i, High H_i

Heterogeneous local conditions but at a low average level (an unlikely event)

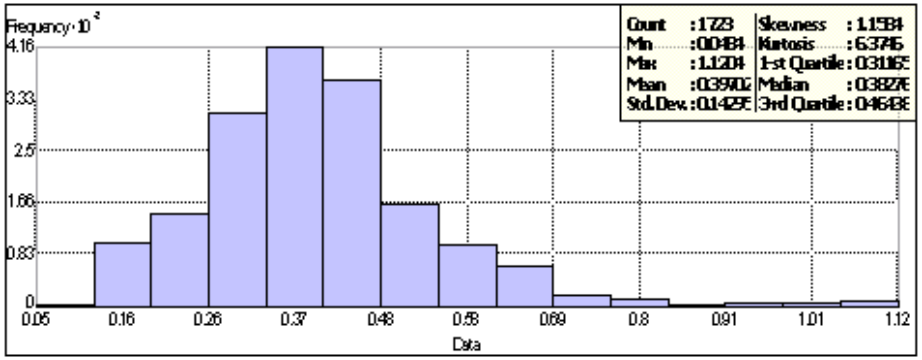
Low G_i, Low H_i

Homogeneous local conditions and a low average level

Housing Quality and *Hi* Frequency Distributions

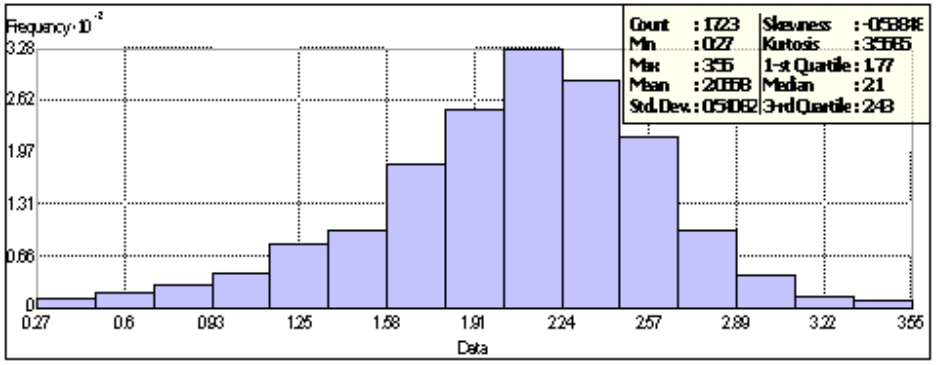


Data Source: Attribute: Housing

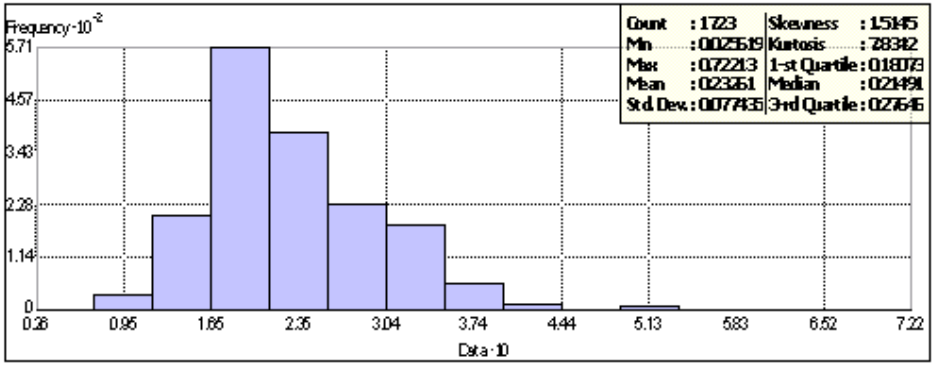


Data Source: Attribute: result

Slum Index and *Hi* Frequency Distributions

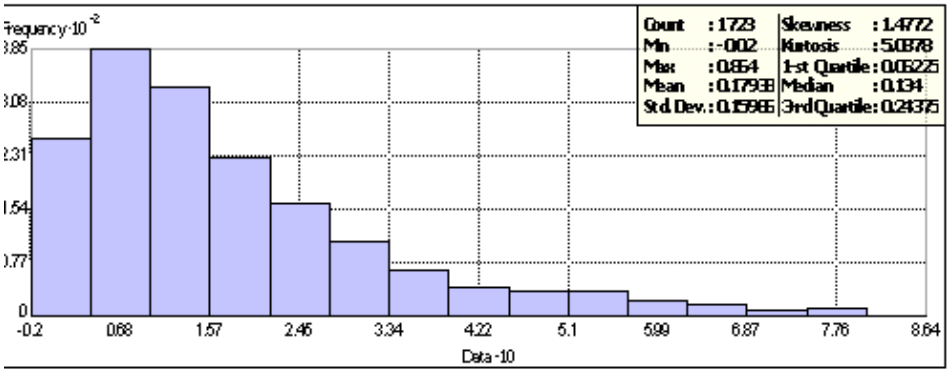


Data Source: Attribute: Slum

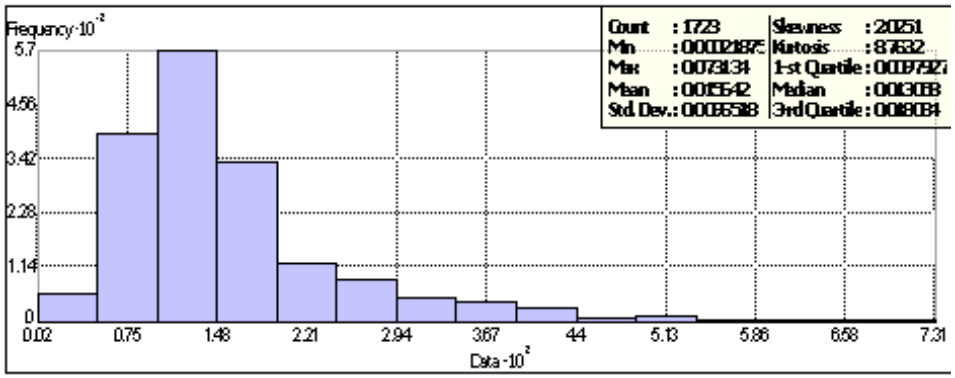


Data Source: Attribute: result

Vegetation and *Hi* Distributions



Data Source: Attribute: HybridVeg



Data Source: Attribute: result