Economy of Terrain and the Trajectory of Urban Renewal in Portland, OR

Richard Janssen

Are there any correlations between measures of terrain or vegetation and demographics? What visible impact has land development policy had on urban neighborhoods? How can imagery analysis be used to track changes in the urban landscape over time?

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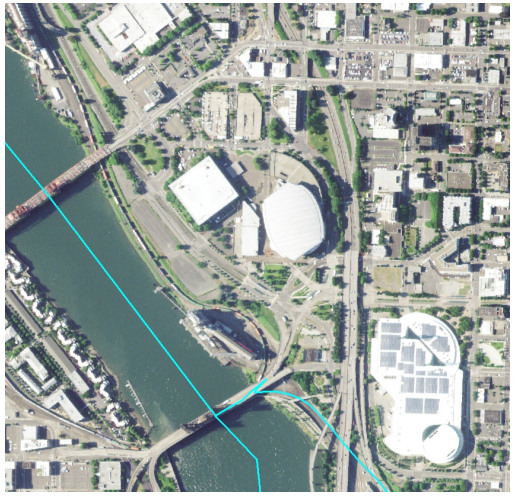
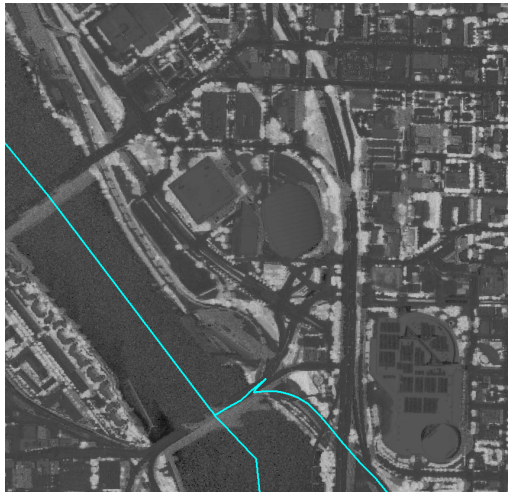
Abstract

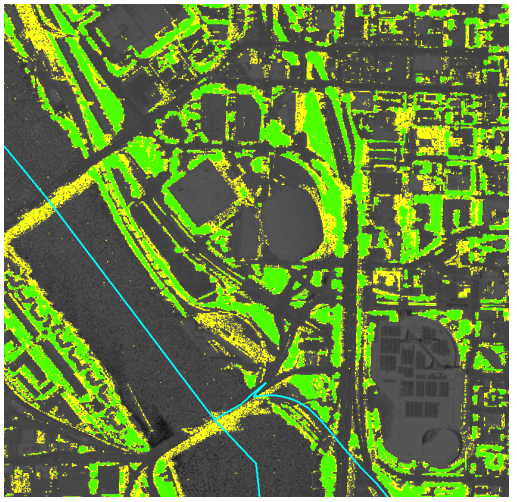
Urban Landscapes change at a rapid pace, we can see it happening every day from trees being cut to building new structures. These changes are often more evident in some areas than others. What is the nature of these changes and can they be reliably tracked on a city wide scale using public data? How are these changes being implemented with respect to neighborhood demographics? I studied a series of two aerial photograph mosaics for the Multnomah county area; 2009 Geoeye and 2016 NAIP images. The Normalized Differential Vegetation Index(NDVI) was calculated for each image set, as well a differential surface of the two years. The results are symbolized to show areas of potential vegetation loss or gain as well as new buildings and land use changes. QC of the NDVI change model is needed to assess the reliability of the output values, and this is undertaken somewhat by visual inspection of the 2009 and 2016 images against the NDVI layer. A number of issues arise at this point to create erroneous values in the NDVI change layer, such as perspective tilt directions of very tall buildings, areas that change from bare earth to building, dry vs wet years, and overly sensitive vegetation increases in non vegetated areas. A TIGER census tract layer and an Urban Renewal Area(URA) layer are overlayed onto the NDVI differential layer to delineate study areas and zonal statistics of slope and NDVI change are calculated within them. Census tracts that intersect the URAs are selected as the main study areas. Selection of tracts whose centroid falls within the URAs further refines the study areas. Census tract household income and race demographics as CSV were obtained and modified to show group proportions within each tract population and joined to the TIGER layer. Income group frequency within study areas are plotted against the NDVI differential mean in each tract. Frequency distributions of the mean slope and vegetation change statistics within each census tract and URA are also compared with the those of the county average. In lieu of advanced statistical analysis, urban renewal areas seem to be accumulating vegetation more slowly than other areas. Slope and vegetation statistics within census tracts do not seem to correlate with demographic variables.

Methods

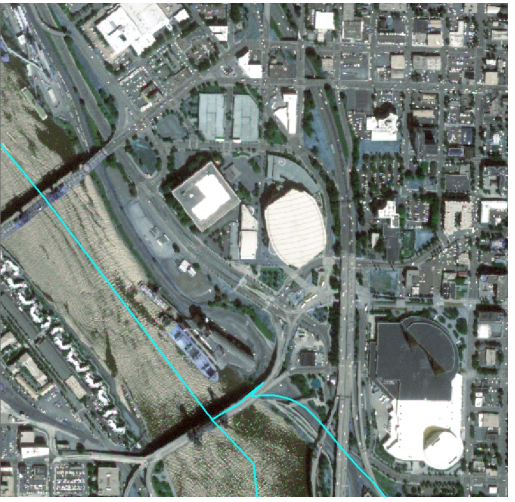
- - 2019 DEM > extract slope values in degrees.
- - 2009 PDX Geoeye images > mosaic to new raster > NDVI tool > Reclassify values 1 to 0.1, 0.1 to 0, and <0 as 1, 2, and 3 respectively
- - 2016 NAIP images from EROS> mosaic to new raster > resample to 2x2 meters to match 2009 geoeye > NDVI tool> Reclassify values of 1 to 0.1, 0.1 to 0, and <0 as 1, 2, and 3 respectively
- - import and reproject reclassified NDVI layers
- - Raster calculator on reclassed NDVI layers, (2016ndvi - 2009ndvi) = 5 year NDVI Change, scale -2 to 2 symbolize logically.
- - Visual inspection of model layer, "ground truthing", swipe tool image comparison of 2009/2016 aerials and NDVI change layer.
- - TIGER line files > project to NDVI datum
- - Census tract data(income and Demographics) > export as CSV for label making, data trimming, munging percentages > import to Arc and join w/ TIGER lines (GEOID<>geoid)
- - NDVI Change stats > zonal statistics as table MEAN/STD, using FIPS and URAs as zone > Join to TIGER (GEOID<>FIPS)
- - Urban Renewal Areas(URA) > import and reproject >> select from TIGER at URA intersection > Graph demographics in URA tracts vs mean NDVI Change > switch selection from TIGER at URA intersection> graph demographics in NON URA tracts vs mean NDVI change

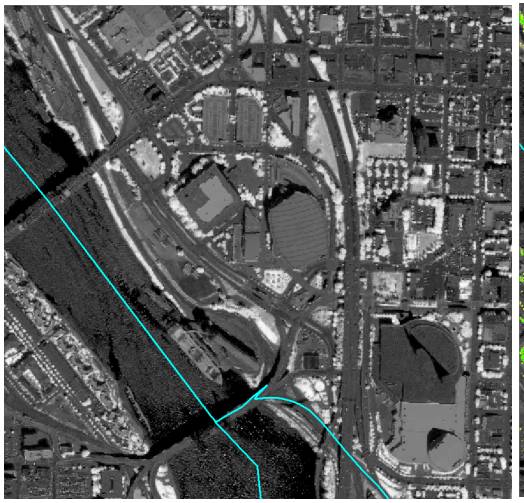


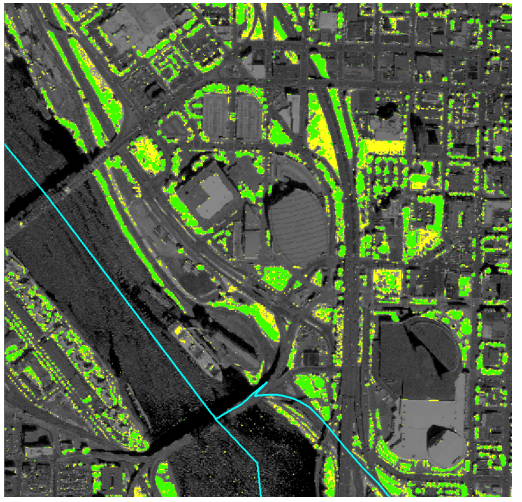




2016 NAIP
- NDVI tool yields the second image.
-Resample to 2x2M.
-Reclassify into 3 classes according to ESRI tool description:
Values 1 – 0.1 = 3 Canopy
Values .1 – 0 = 2 low veg
Values <0 = 1 no veg.





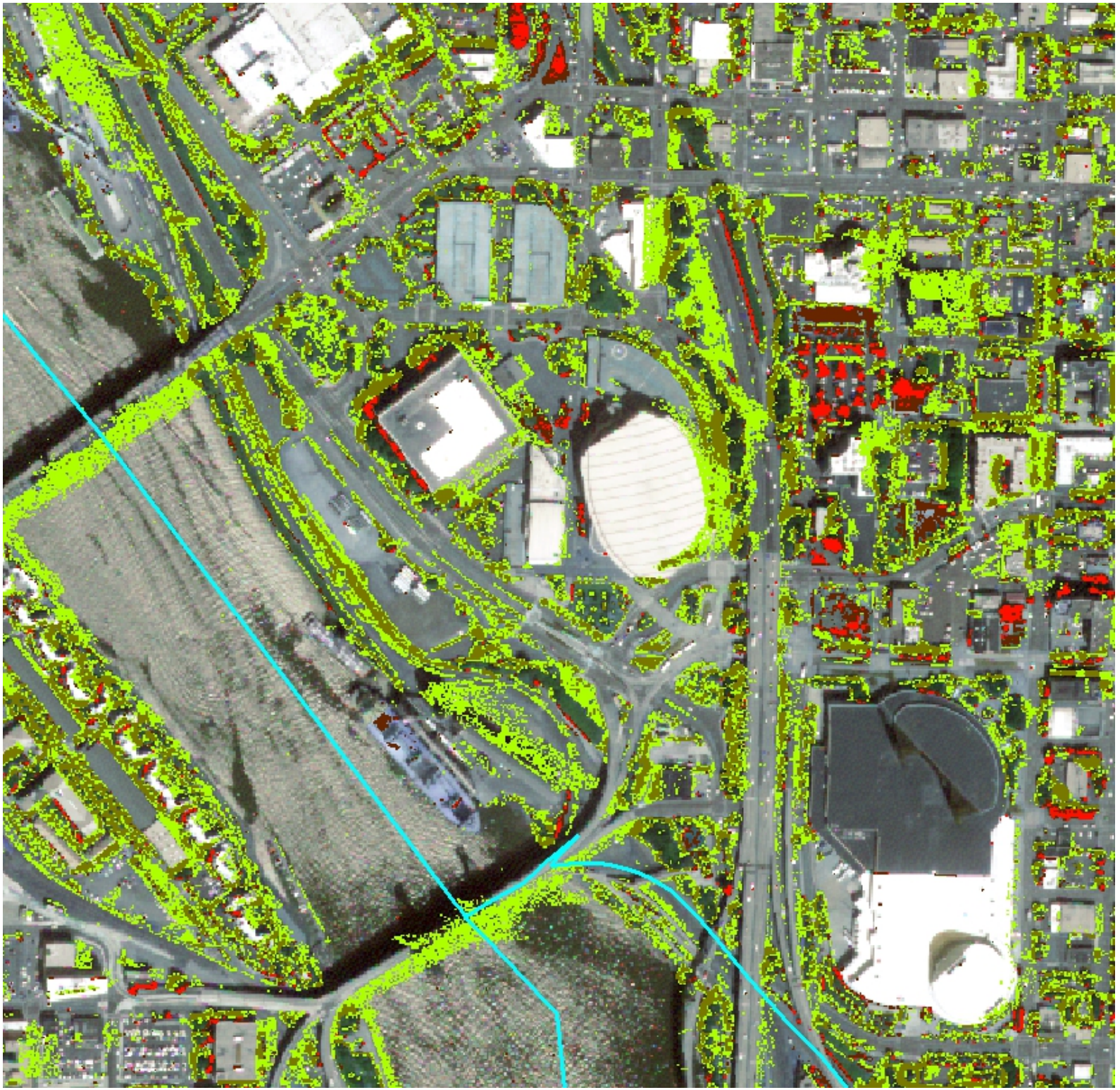


2009 Geoeye
-Same process w/o resample

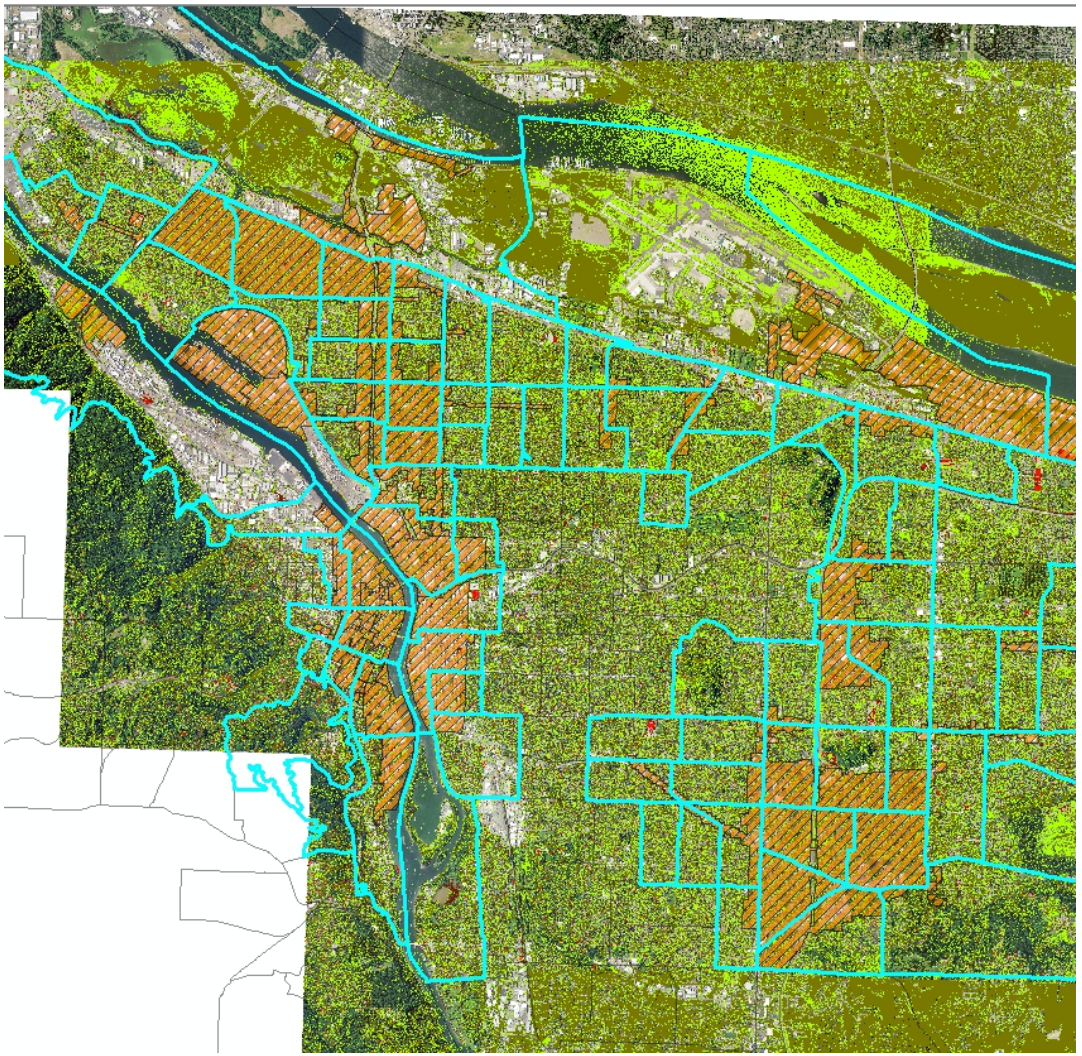
- Subtract 2009NDVI from 2016 NDVI to yield differential surface.

- Table shows subtraction matrix and resulting color code.
2 = canopy increase
1 = bare earth cover, or canopy gain
0 = no change(hollow)
-1 = pruning or building
-2 = canopy loss

NDVI	2016	1	2	3
2009				
1		0	1	2
2		-1	0	1
3		-2	-1	0



The study area. With some obvious problems.



-Selection is where URAs(orange stripes) intersect Census tracts

Problems

- -Forest growing all over NE industrial and River (GeoEye doesn't include this area.) Skewing positive of some tracts.
- - Misalignment of edges cutting into certain tracts.
- - Larger scale; changes in relief of large buildings

Next steps:

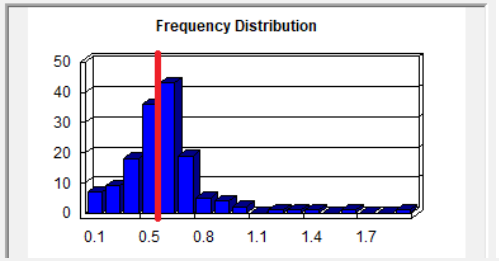
- - Zonal Stats of NDVI change on URA/Non URA selections
- - Graph comparisons of NDVI and Income statistics

NDVI

All Tracts

Field: MEAN

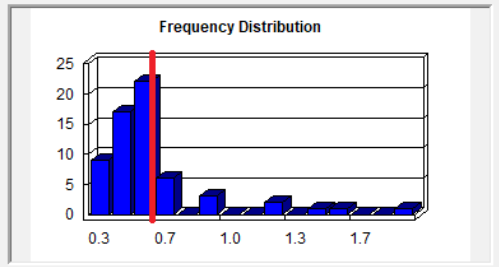
Statistics:
Count: 148
Minimum: 0.144748
Maximum: 1.986111
Sum: 88.000827
Mean: 0.5946
Standard Deviation: 0.242829
Nulls: 0



Non URA Tracts

Field: MEAN

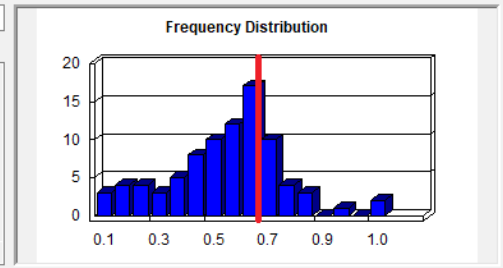
Statistics:
Count: 62
Minimum: 0.320204
Maximum: 1.986111
Sum: 39.627152
Mean: 0.639148
Standard Deviation: 0.303071
Nulls: 0



Tracts Intersecting URAs

Field: MEAN

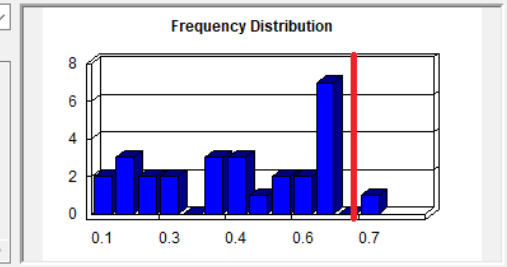
Statistics:
Count: 86
Minimum: 0.144748
Maximum: 1.074068
Sum: 48.373675
Mean: 0.562485
Standard Deviation: 0.181095
Nulls: 0



Centroid w/in URA

Field: MEAN

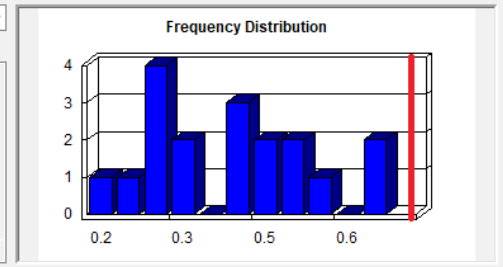
Statistics:
Count: 28
Minimum: 0.144748
Maximum: 0.704084
Sum: 12.547689
Mean: 0.448132
Standard Deviation: 0.169409
Nulls: 0



URAs

Field: MEAN

Statistics:
Count: 18
Minimum: 0.155086
Maximum: 0.731982
Sum: 7.789884
Mean: 0.432771
Standard Deviation: 0.161382
Nulls: 0

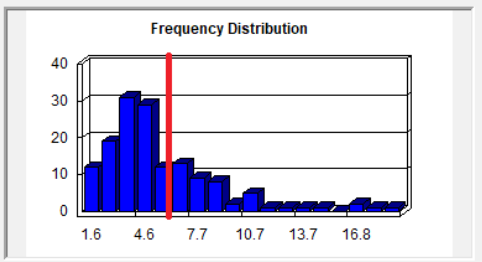


Slope

All Tracts

Field: MEAN

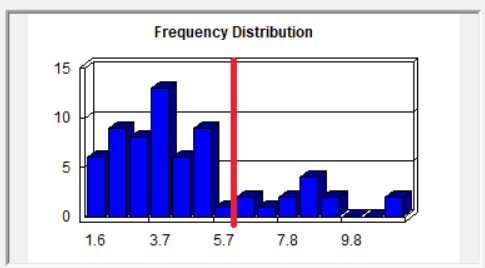
Statistics:
Count: 148
Minimum: 1.613448
Maximum: 19.412125
Sum: 882.070748
Mean: 5.959937
Standard Deviation: 3.301041
Nulls: 0



Non URA Tracts

Field: MEAN

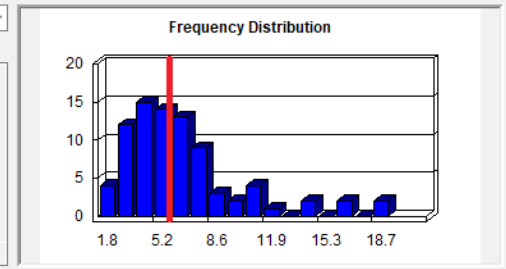
Statistics:
Count: 65
Minimum: 1.613448
Maximum: 11.80962
Sum: 313.110852
Mean: 4.81709
Standard Deviation: 2.337215
Nulls: 0



Tracts Intersecting URAs

Field: MEAN

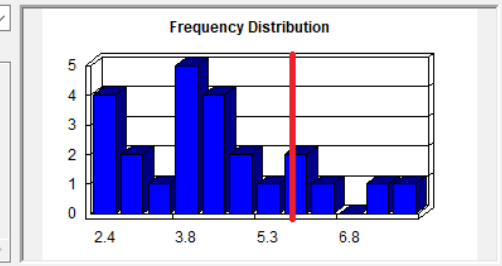
Statistics:
Count: 83
Minimum: 1.831928
Maximum: 19.412125
Sum: 568.959896
Mean: 6.854939
Standard Deviation: 3.650859
Nulls: 0



Centroid w/in URA

Field: MEAN

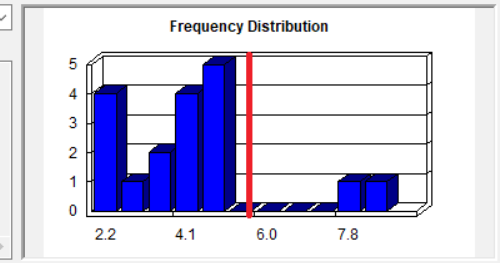
Statistics:
Count: 24
Minimum: 2.35815
Maximum: 8.102923
Sum: 110.310396
Mean: 4.596266
Standard Deviation: 1.489759
Nulls: 0



URAs

Field: MEAN

Statistics:
Count: 18
Minimum: 2.178284
Maximum: 8.857423
Sum: 80.400386
Mean: 4.466688
Standard Deviation: 1.699944
Nulls: 0



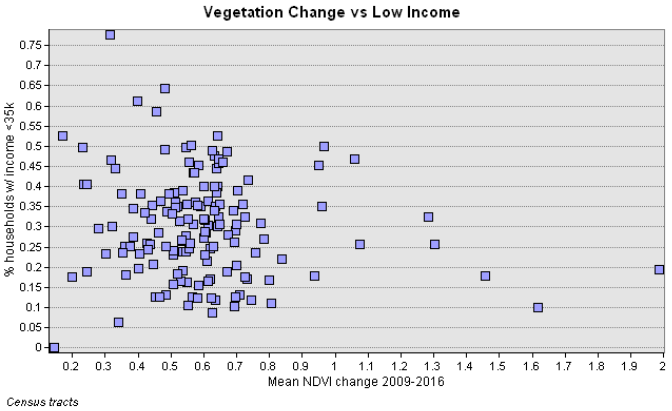
-Frequencies of mean slope and vegetation change values within census tracts.

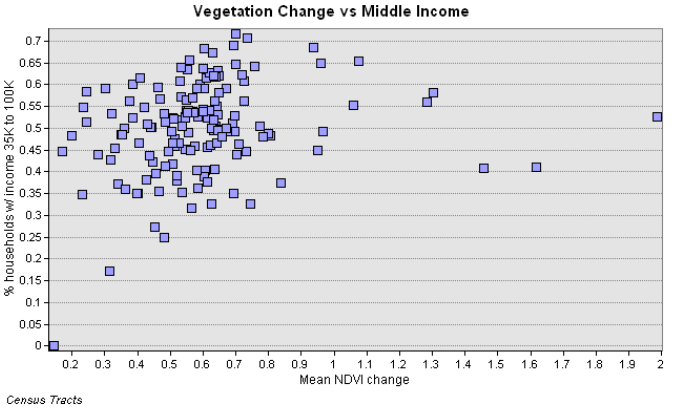
Y-axis = Tract Count
X-axis = NDVI change or Slope

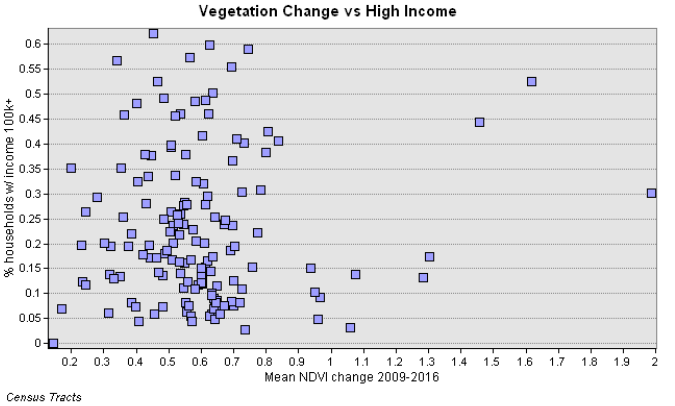
- The red line represents the mean NDVI change or Slope value of *all tracts*.

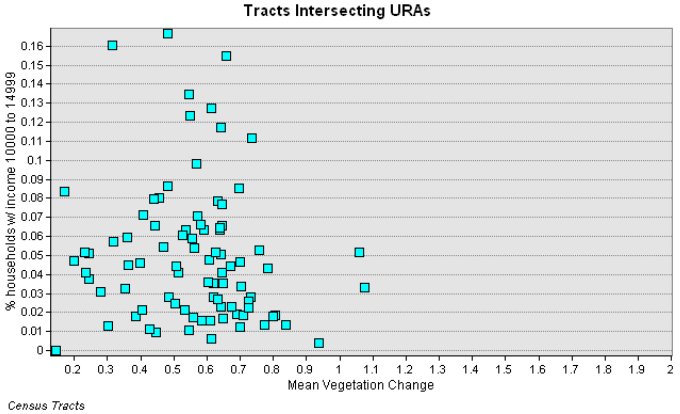
- Census tracts associated w/ URAs tend to have mean vegetation change that is lower than the average.

- Slope does not seem to change much with URA association



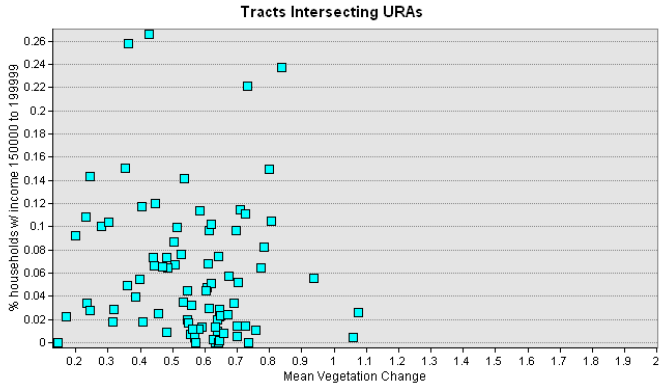


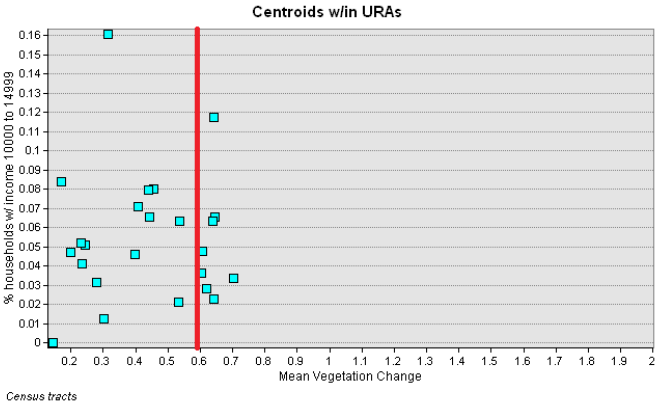


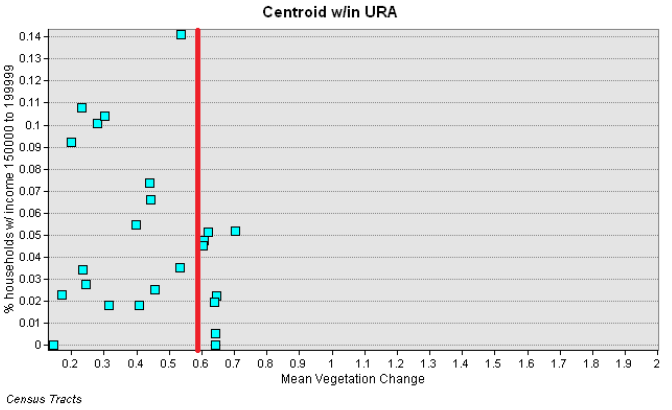


- Again there is movement below the mean as we focus on URAs

- Income group proportion w/in tracts exhibit some correlation w/ NDVI change.

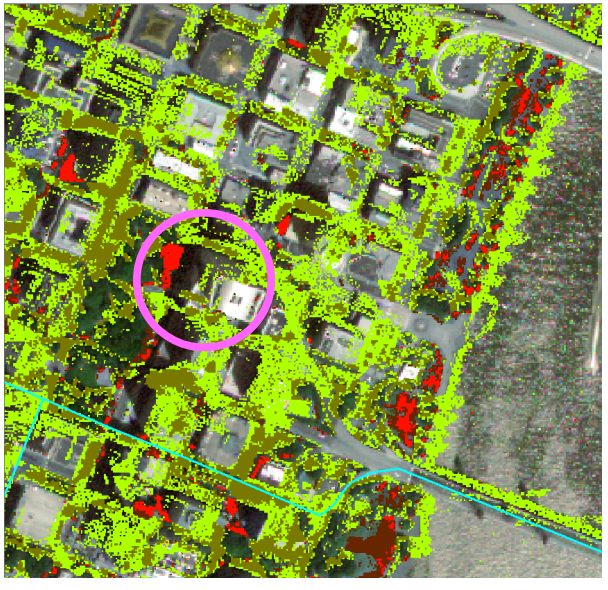


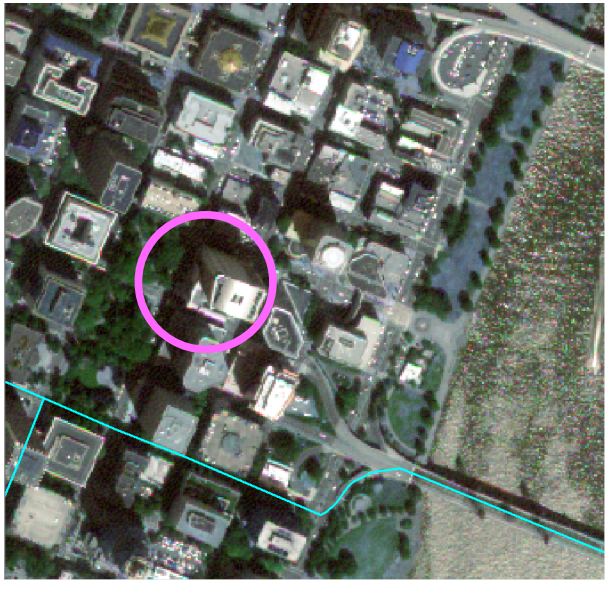


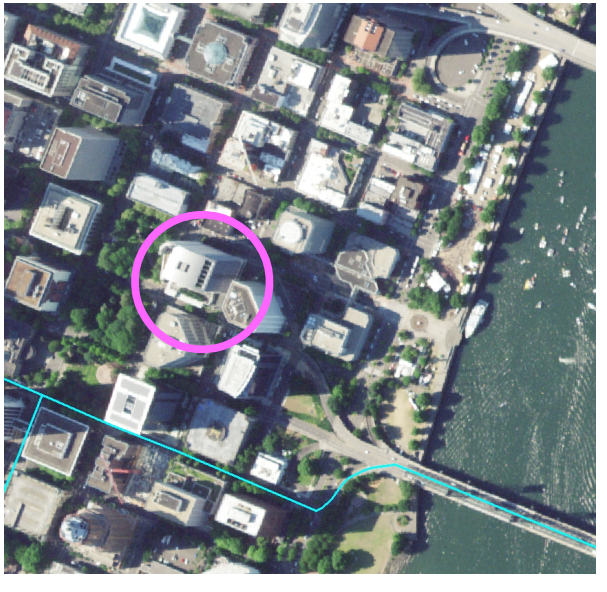


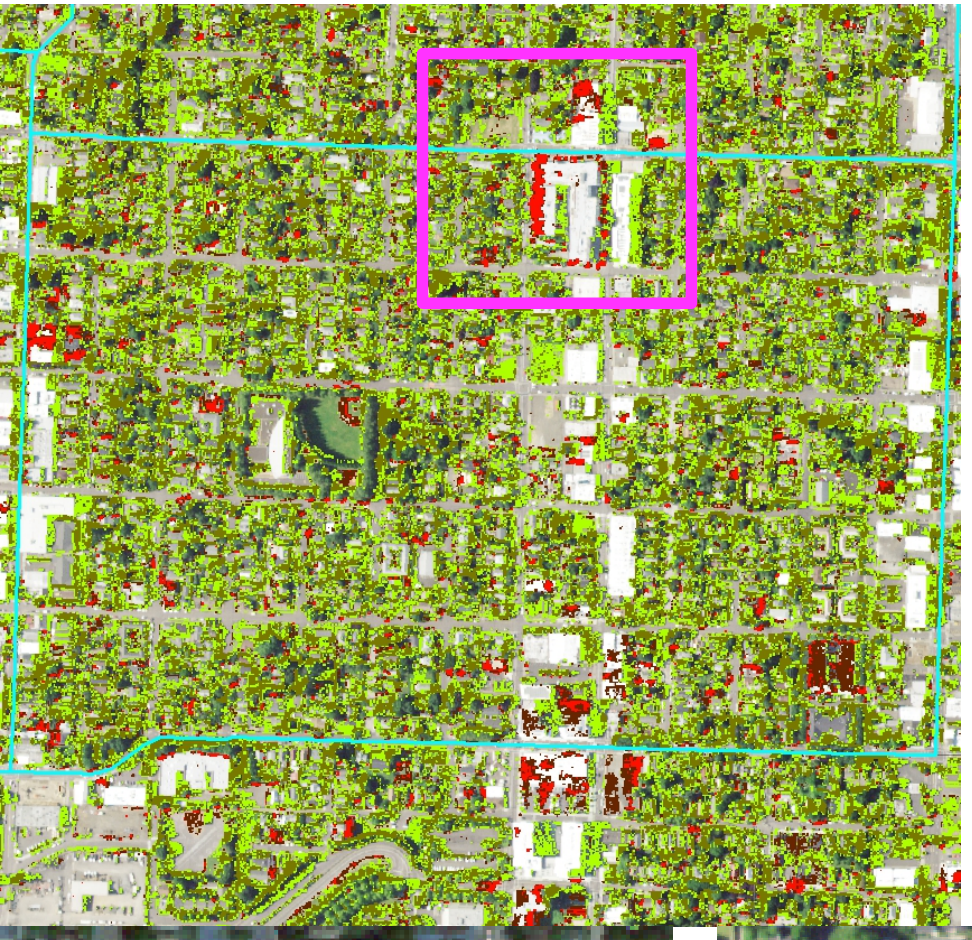
Census Tract 106, highest proportion of low income housing units. Mean NDVI Change = .32

2 = canopy increase
1 = bare earth cover, or canopy gain
0 = no change(hollow)
-1 = pruning or building
-2 = canopy loss









Census Tract 34.02, high proportion of high income housing units. Mean NDVI Change = .54

2 = canopy increase
1 = bare earth cover, or canopy gain
0 = no change(hollow)
-1 = pruning or building
-2 = canopy loss

Conclusions

- URAs seem to experience a slower rate of canopy accumulation from 2009 to 2016 relative to county average.
- It is possible and fairly easy to track neighborhood level changes in canopy and built environment using imagery and NDVI
- Proportion of low income households w/in tracts exhibits some negative correlation with NDVI change
- Proportion of Middle income households exhibits some positive correlation with NDV change
- Further data cleaning needed:
  - clipping edges and aligning images for a clean NDVI change surface
  - Refinement of NDVI change model to define outcomes of subtraction.
  - Inclusion of multiple image years to account for comparatively dry/wet season
  - Tightening of demographic groups and more advanced stats.