Next Steps:

Scaling Up Ecosystem Accounts to The Nation

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Austin Troy

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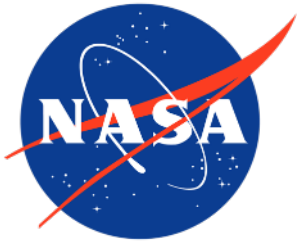
NASA: Group on Earth Observation

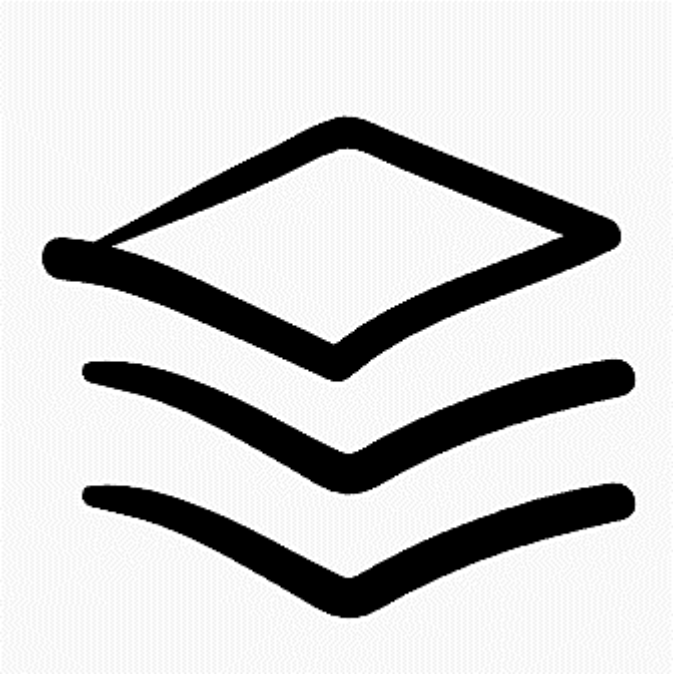
Earth Observation for U.S. Ecosystem Accounting (EO4EA)



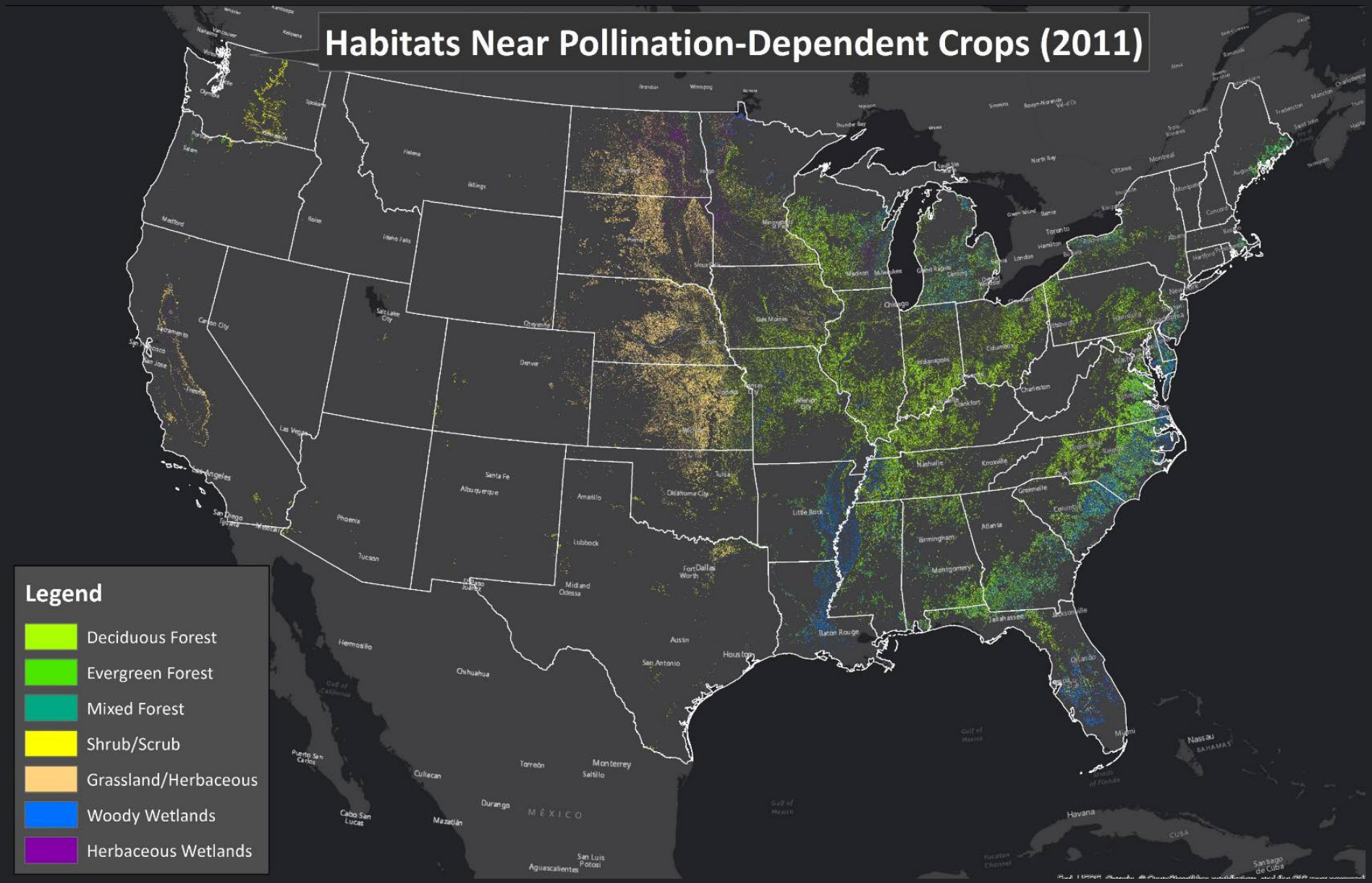
In this presentation:

Challenges in scaling up

Urban Ecosystem Accounts

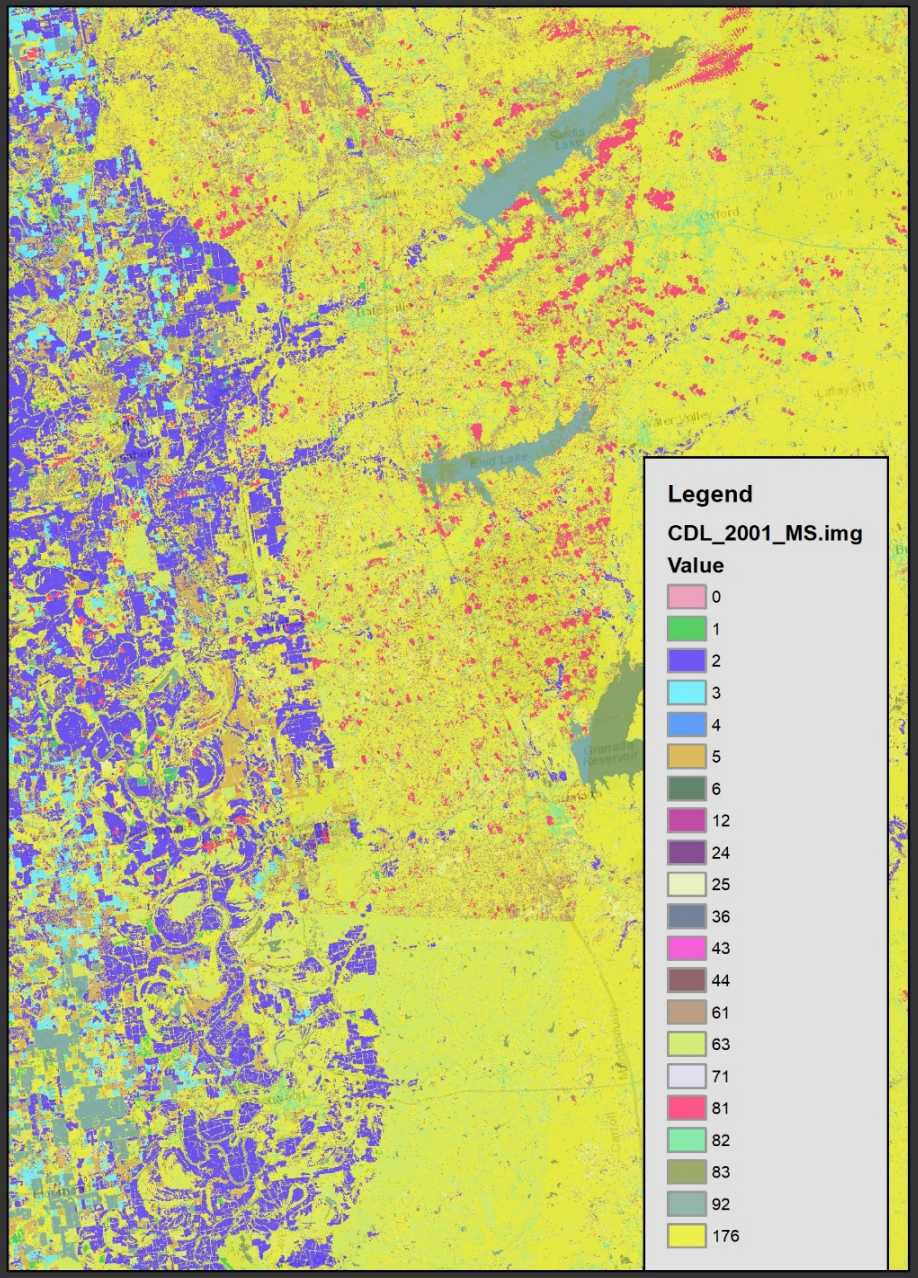


Data Challenges

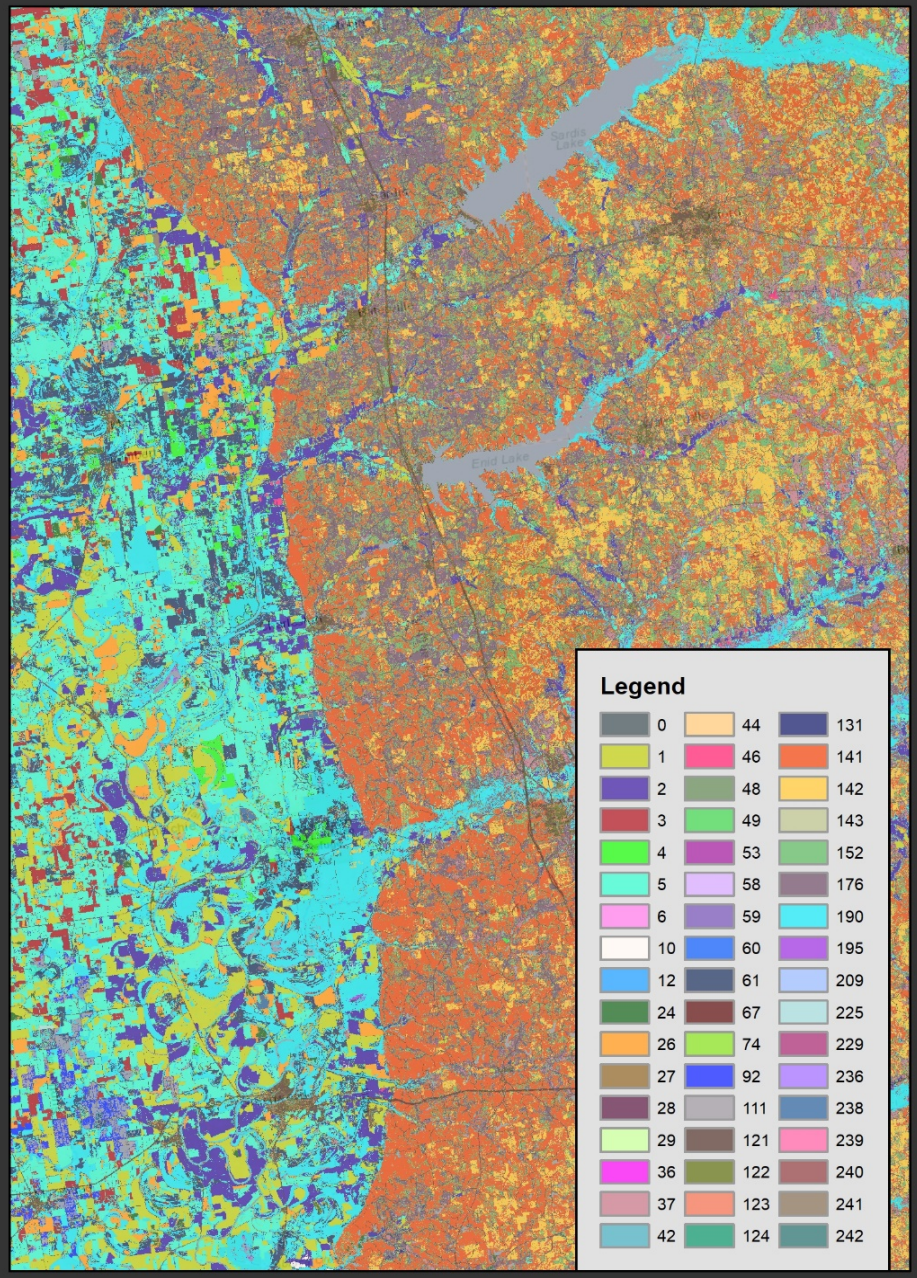

Habitats Near Pollination-Dependent Crops (2011)
Legend
Deciduous Forest
Evergreen Forest
Mixed Forest
Shrub/Scrub
Grassland/Herbaceous
Woody Wetlands
Herbaceous Wetlands
MÉXICO
CUBA

Longitudinal Gap

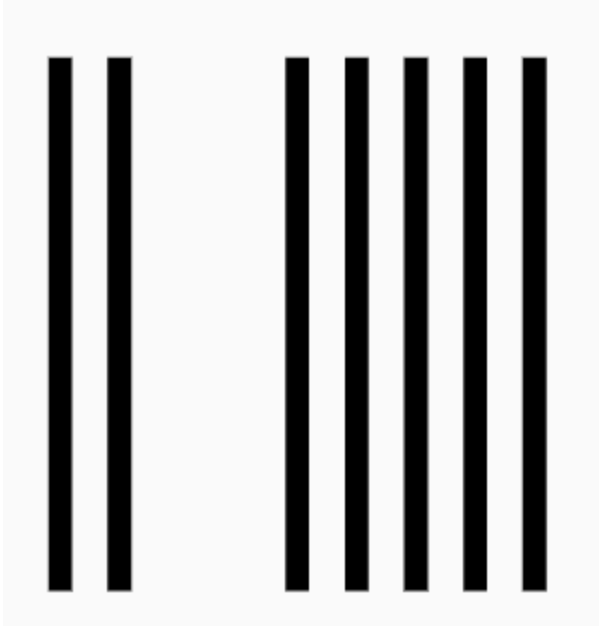
Crop Land Dataset 2001 for Mississippi

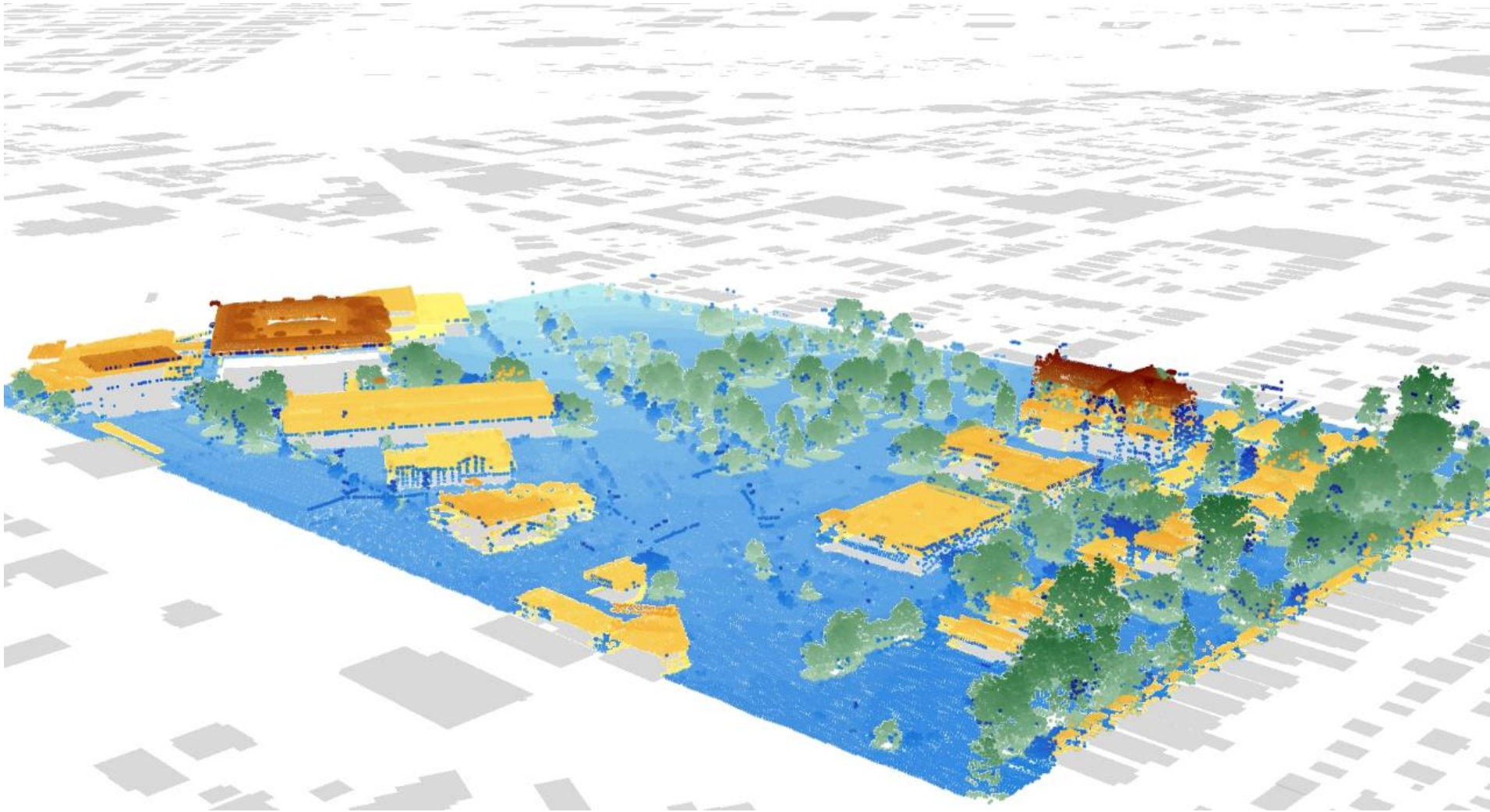


Crop Land Dataset 2011 for Mississippi

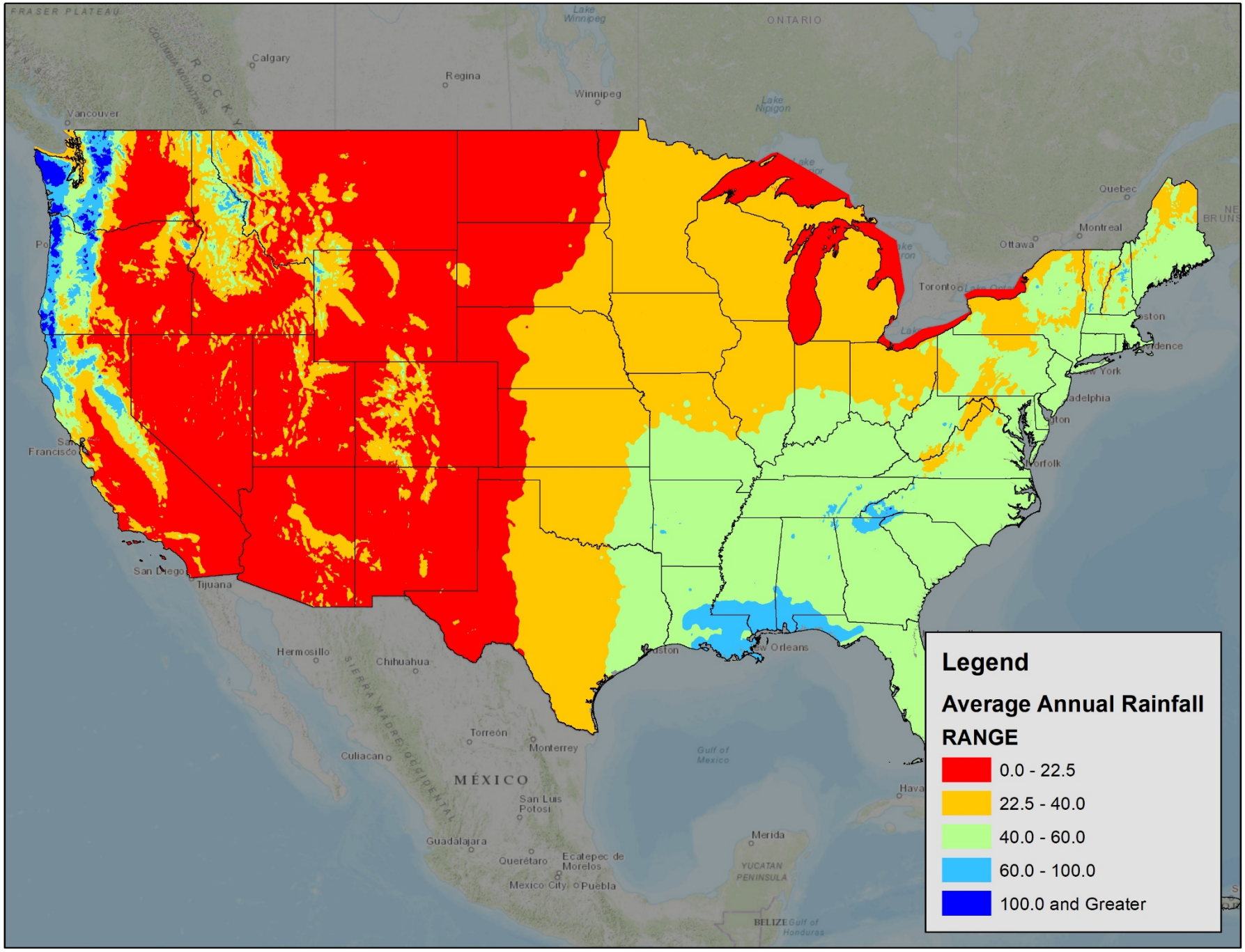


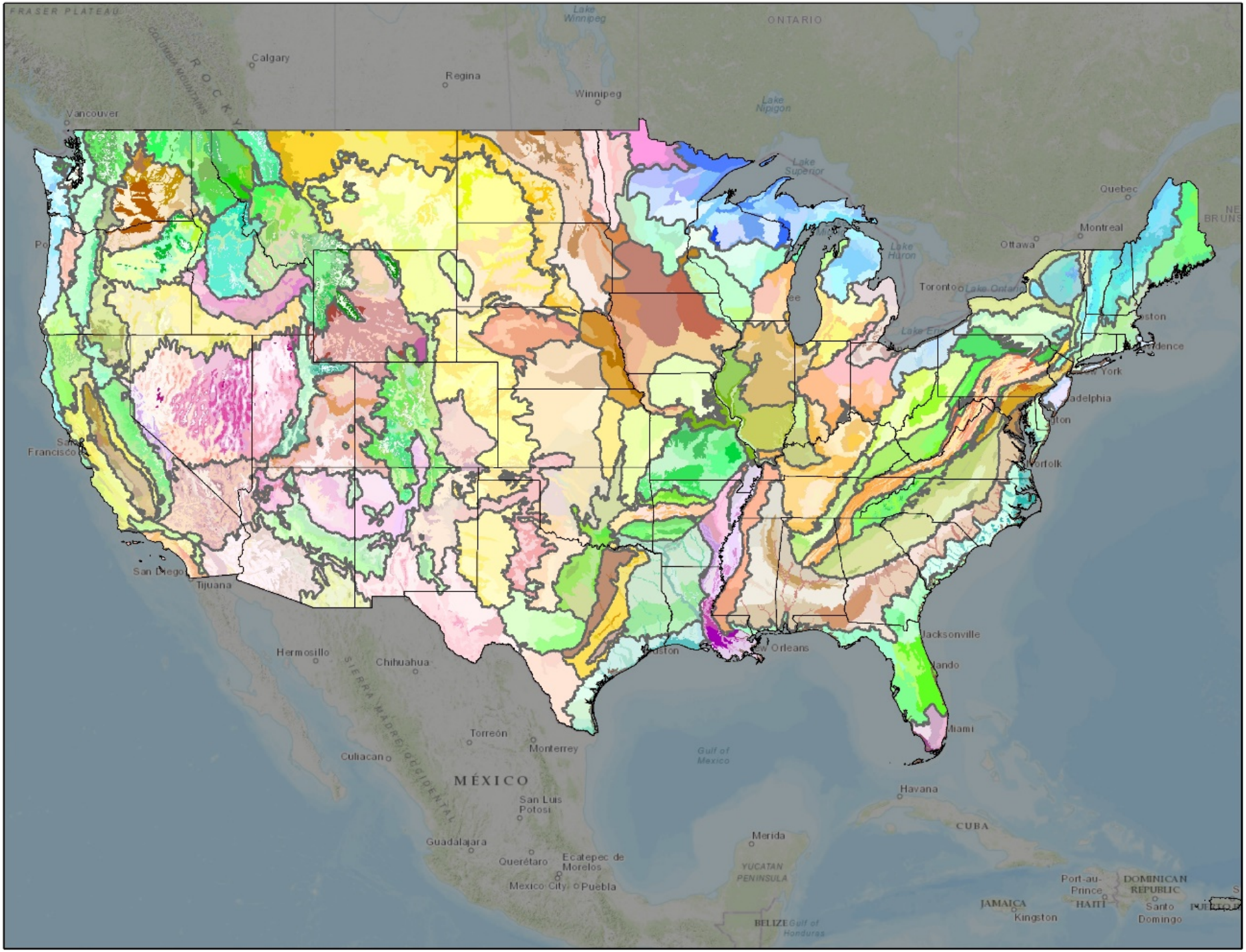
Spatial Gap





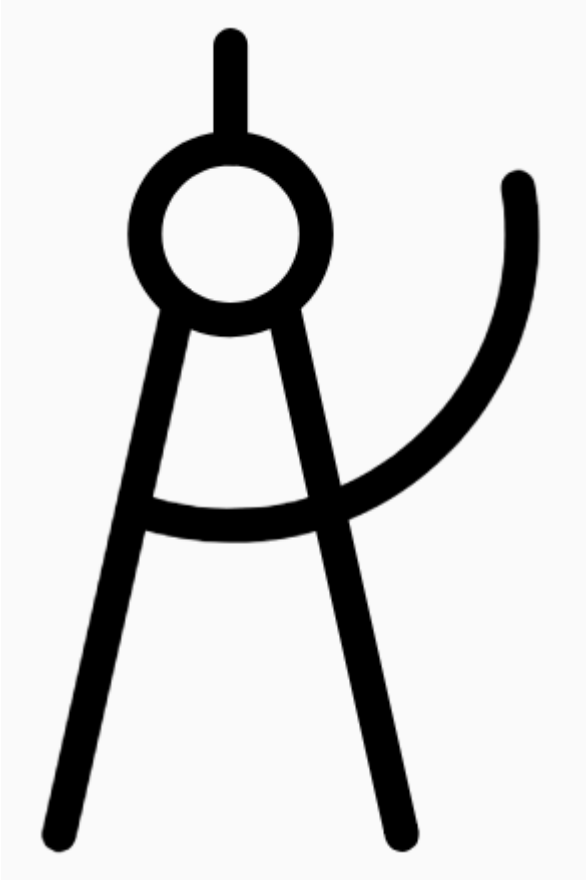
Climate Disparities

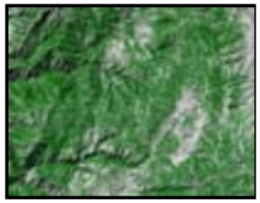

Legend
Average Annual Rainfall
RANGE
0.0 - 22.5
22.5 - 40.0
40.0 - 60.0
60.0 - 100.0
100.0 and Greater
FRASER PLATEAU
ONTARIO
Calgary
Regina
Winnipeg
Vancouver
Quebec
Montreal
Ottawa
Toronto
San Francisco
San Diego
Tijuana
Hermosillo
Chihuahua
Torreón
Monterrey
Culiacan
MÉXICO
San Luis Potosi
Guadalajara
Querétaro
Ecatepec de Morelos
Mexico City
Puebla
Merida
YUCATAN PENINSULA
BELIZE
Gulf of Mexico
Gulf of Honduras
New Orleans


FRASER PLATEAU
COLUMBIA MOUNTAINS
ROCKY
Lake Winnipeg
ONTARIO
Calgary
Regina
Winnipeg
Vancouver
Lake Nipigon
Lake Superior
Quebec
Montreal
Ottawa
Lake Huron
Toronto
Lake Ontario
Lake Erie
San Francisco
San Diego
Tijuana
Hermosillo
Chihuahua
SIERRA MADRE OCCIDENTAL
Orleans
Jacksonville
Torreón
Monterrey
Culiacan
Gulf of Mexico
MÉXICO
Havana
CUBA
San Luis Potosí
Guadalajara
Querétaro
Ecatepec de Morelos
Mexico City
Puebla
Merida
YUCATAN PENINSULA
Port-au-Prince
HAITI
DOMINICAN REPUBLIC
Santo Domingo
JAMAICA
Kingston
BELIZE
Gulf of Honduras


CANADA
James Bay
Winnipeg
Regina
Ottawa
Montreal
Quebec
Toronto
Buffalo
Detroit
Cleveland
Chicago
Milwaukee
Minneapolis
Salt Lake City
Denver
Kansas City
Indianapolis
Cincinnati
Pittsburgh
Philadelphia
Richmond
Nashville
Memphis
Atlanta
Jacksonville
Dallas
Houston
San Antonio
Phoenix
Tucson
El Paso
Las Vegas
Fresno
San Diego
Tijuana
Hermosillo
Chihuahua
Torreón
Monterrey
Culiacan
MÉXICO
San Luis Potosí
Gulf of Mexico
Havana

Accuracy Assessment

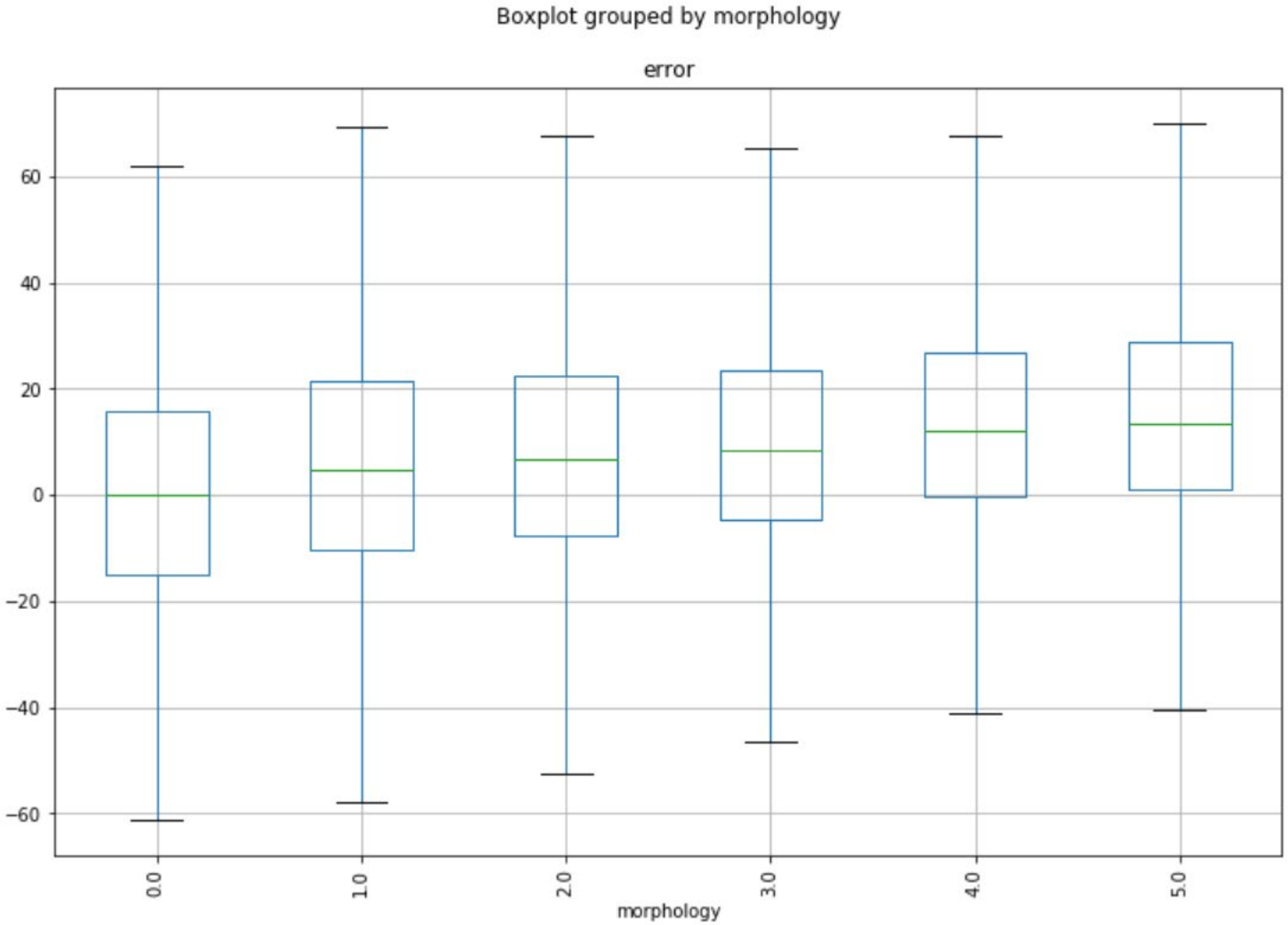




NLCD 2011 USFS Tree Canopy analytical (10.4 GB)

The U.S. Forest Service analytical canopy product is designed for users that require more ar standard error (layer two). For layer one, the percent tree canopy cover layer, the file pixel cell covered by tree canopy. No masking of obvious non-tree areas is performed for this pro individual value representing the standard error for the model in that 30m cell. The higher t canopy cover layer was produced using a Random Forests (trademarked by Leo Breiman an canopy cover estimates from the random forest regression trees. This mapping methodolog designed to be comparable to NLCD 2001 canopy for change detection.

1-m Landcover for 36 cities



Undeveloped Land

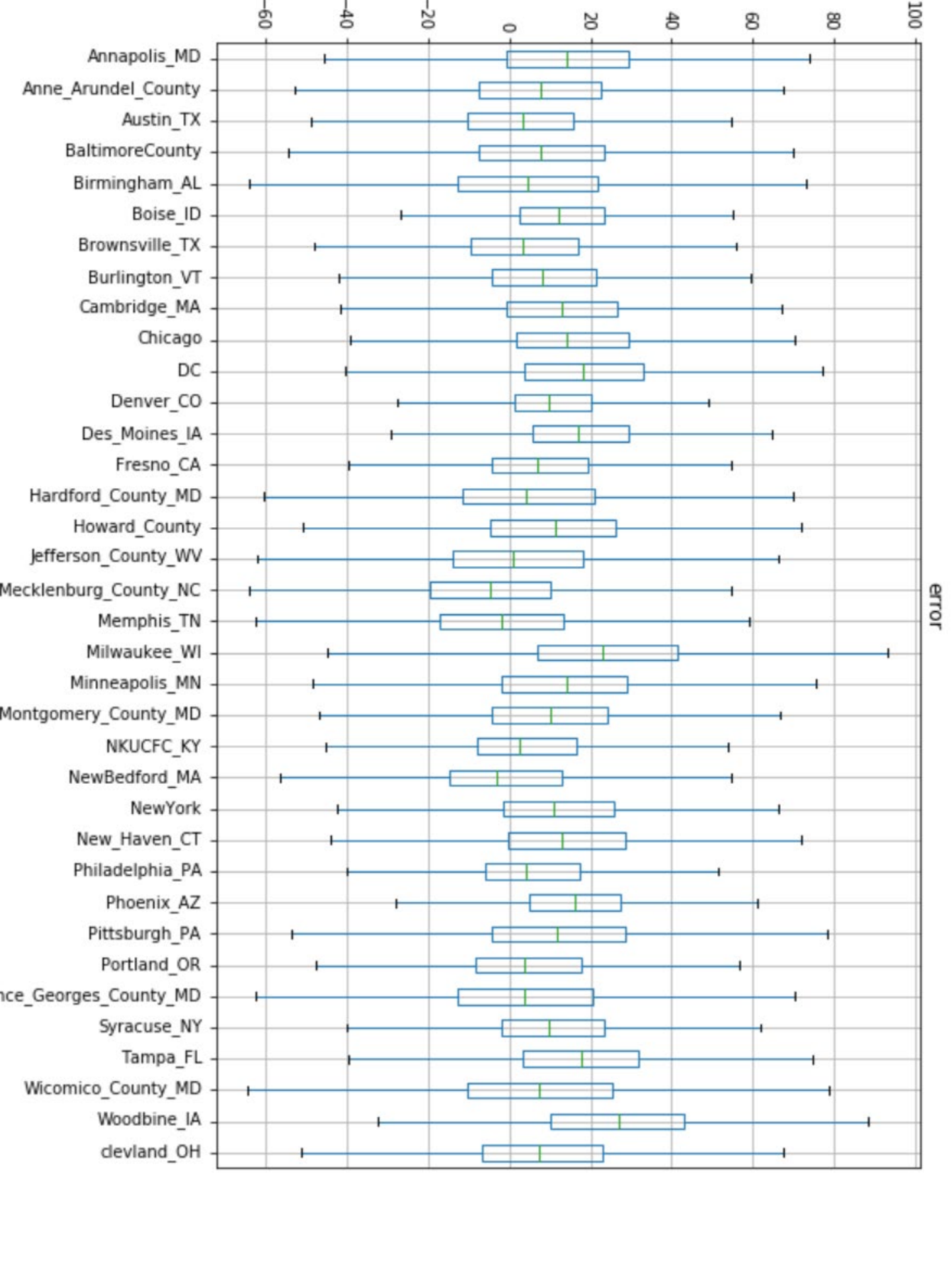
Suburbs

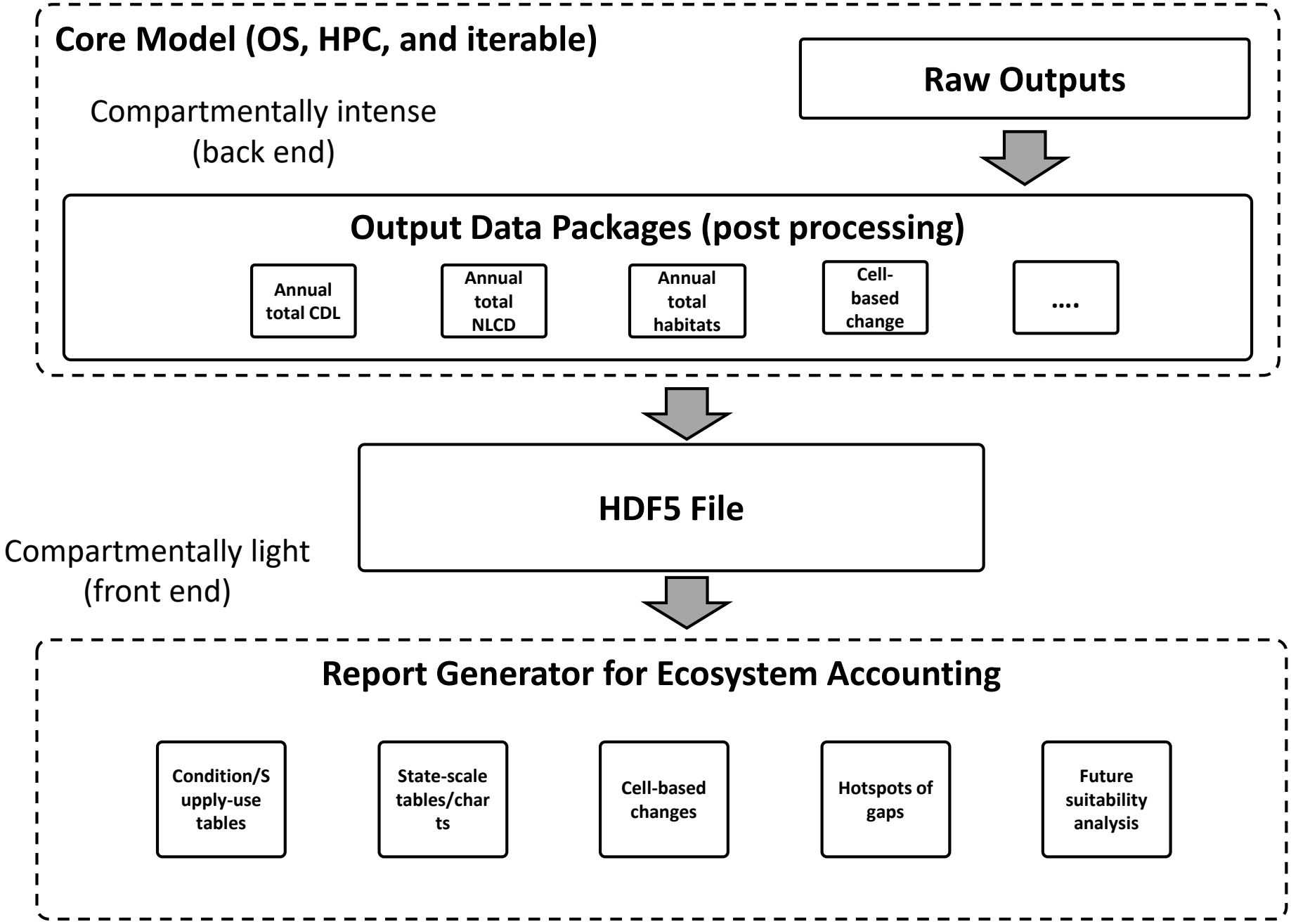
Urban Fringe

Low Den. Urban Area

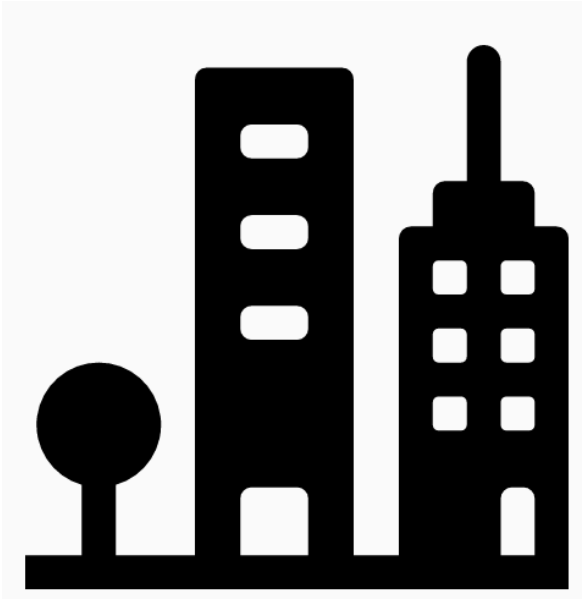
Med. Den. Urban Area

High Den. Urban Area


−60
−40
−20
0
20
40
60
80
100
error
Annapolis_MD
Anne_Arundel_County
Austin_TX
BaltimoreCounty
Birmingham_AL
Boise_ID
Brownsville_TX
Burlington_VT
Cambridge_MA
Chicago
DC
Denver_CO
Des_Moines_IA
Fresno_CA
Hardford_County_MD
Howard_County
Jefferson_County_WV
Mecklenburg_County_NC
Memphis_TN
Milwaukee_WI
Minneapolis_MN
Montgomery_County_MD
NKUCFC_KY
NewBedford_MA
NewYork
New_Haven_CT
Philadelphia_PA
Phoenix_AZ
Pittsburgh_PA
Portland_OR
nce_Georges_County_MD
Syracuse_NY
Tampa_FL
Wicomico_County_MD
Woodbine_IA
clevland_OH


Core Model (OS, HPC, and iterable)
Compartmentally intense
(back end)
Raw Outputs
Output Data Packages (post processing)
Annual total CDL
Annual total NLCD
Annual total habitats
Cell-based change
....
HDF5 File
Compartmentally light
(front end)
Report Generator for Ecosystem Accounting
Condition/Supply-use tables
State-scale tables/charts
Cell-based changes
Hotspots of gaps
Future suitability analysis

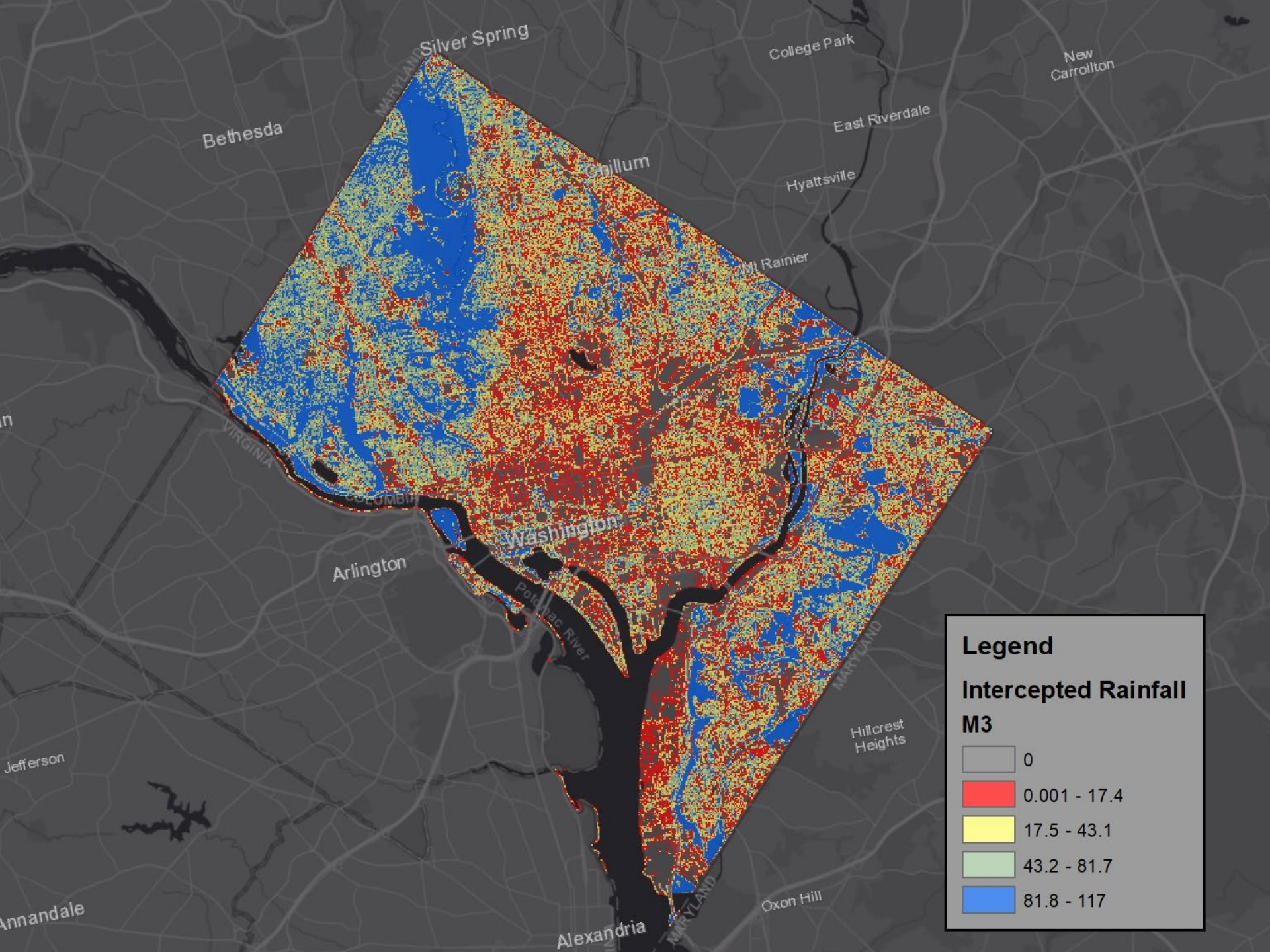
Urban Ecosystem Accounts

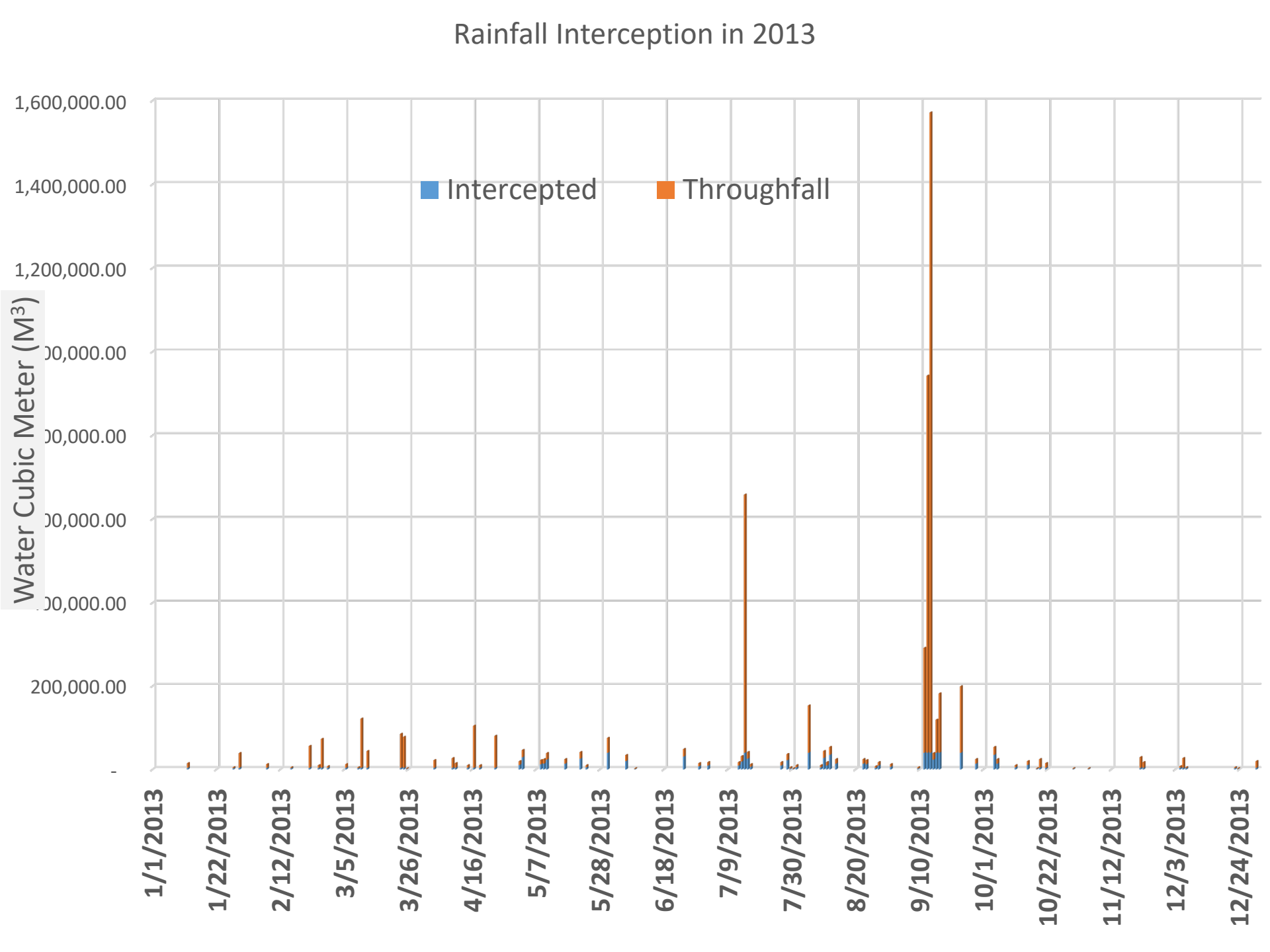


- Trees and rainfall interception
- Trees and urban heat mitigation

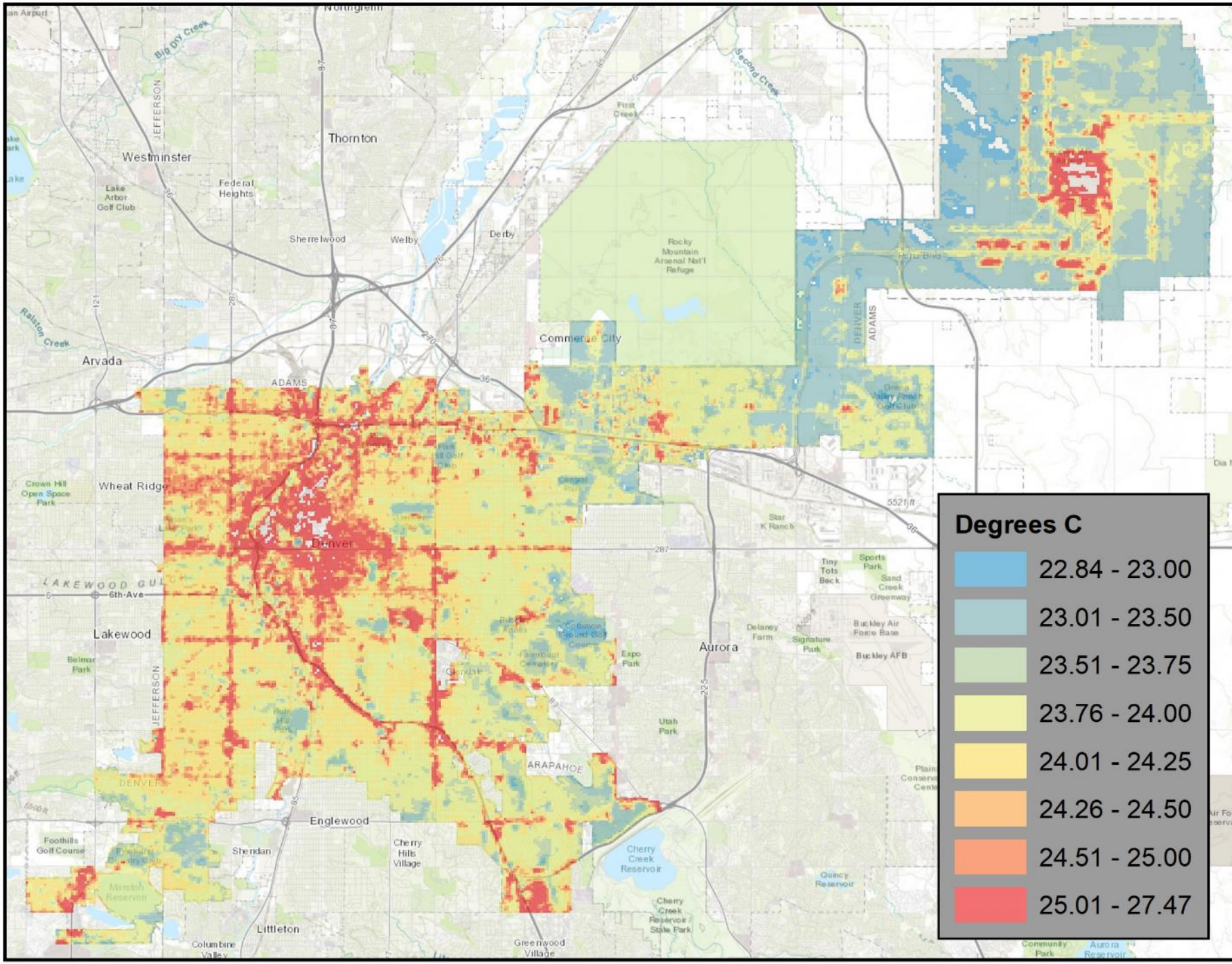
f (interception) = (Storm Length, Storm Intensity, Wind, Evaporation, LAI, Tree Size, surface type)

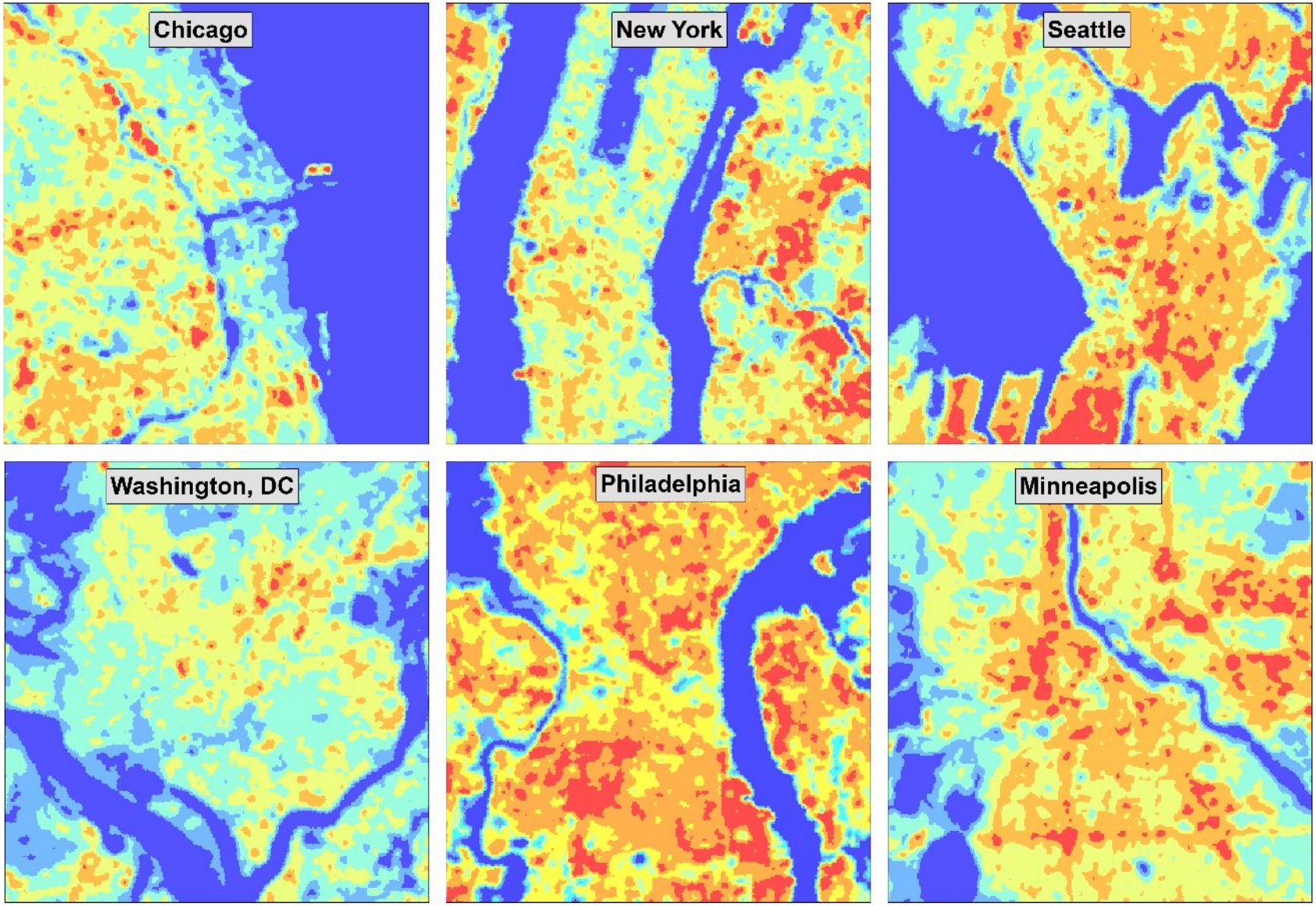
f (interception) = (Storm Size, Tree Cover)


Silver Spring
College Park
New Carrollton
Bethesda
East Riverdale
Chillum
Hyattsville
Mt Rainier
Washington
Arlington
Potomac River
Hillcrest Heights
Jefferson
Oxon Hill
Alexandria
Legend
Intercepted Rainfall M3
0
0.001 - 17.4
17.5 - 43.1
43.2 - 81.7
81.8 - 117


Rainfall Interception in 2013
Intercepted
Throughfall
Water Cubic Meter (M³)
1,600,000.00
1,400,000.00
1,200,000.00
200,000.00
-
1/1/2013
1/22/2013
2/12/2013
3/5/2013
3/26/2013
4/16/2013
5/7/2013
5/28/2013
6/18/2013
7/9/2013
7/30/2013
8/20/2013
9/10/2013
10/1/2013
10/22/2013
11/12/2013
12/3/2013
12/24/2013

Landcover	DC Intercepted_2001 (Cubic Million Meter)	DC Intercepted_2003 (Cubic Million Meter)	Denver Intercepted_2013 (Cubic Million Meter)
Rainfall	0.760 m (29.9 inch)	1.545 m (60 inch)	0.638 m (25.1)
Open Water	0.11	0.12	0.02
Developed, Open Space	7.18	7.77	1.76
Developed, Low Intensity	7.81	8.45	5.58
Developed, Medium Intensity	5.29	5.72	1.76
Developed, High Intensity	0.64	0.70	0.24
Deciduous Forest	6.31	6.83	0.00
Evergreen Forest	0.15	0.16	0.00
Mixed Forest	0.72	0.78	0.00
Shrub/Scrub	0.07	0.08	0.00
Grassland/Herbaceous	0.03	0.03	0.02
Pasture/Hay	0.01	0.01	0.00
Cultivated Crops	0.02	0.02	0.02
Woody Wetlands	0.64	0.69	0.12
Sum	28.98	31.36	9.54
Percentage of Rainfall That Hits only Trees that is intercepted	15.60%	8.31%	9.43%


Degrees C
22.84 - 23.00
23.01 - 23.50
23.51 - 23.75
23.76 - 24.00
24.01 - 24.25
24.26 - 24.50
24.51 - 25.00
25.01 - 27.47
Westminster
Thornton
Arvada
Wheat Ridge
Denver
Lakewood
Aurora
Englewood
Littleton
Commerce City
Federal Heights
Sherrelwood
Welby
Derby
Rocky Mountain Arsenal Nat'l Refuge
Lake Arbor Golf Club
Crown Hill Open Space Park
Belmar Park
Foothills Golf Course
Sheridan
Cherry Hills Village
Cherry Creek Reservoir
Cherry Creek Reservoir State Park
Quincy Reservoir
Marston Reservoir
Columbine Valley
Greenwood Village
Utah Park
Expo Park
Delaney Farm
Signature Park
Buckley Air Force Base
Buckley AFB
Tiny Tots Beck
Sports Park
Sand Creek Greenway
Star K Ranch
Big Dry Creek
Second Creek
First Creek
Ralston Creek
JEFFERSON
ADAMS
ARAPAHOE
DENVER
6th Ave
LAKEWOOD GU
5521 ft
6500 ft


Chicago
New York
Seattle
Washington, DC
Philadelphia
Minneapolis
Legend
Surface Temperature
°C
21.4 - 36.1
36.2 - 38.1
38.2 - 39.8
39.9 - 41.3
41.4 - 43.4
43.5 - 60.8
0
1
2
4
Miles

How Important Are Trees?

X=[Tree Coverage, Impervious Surface]

Y=[Daytime Surface Temperature]

OLS Regression Results

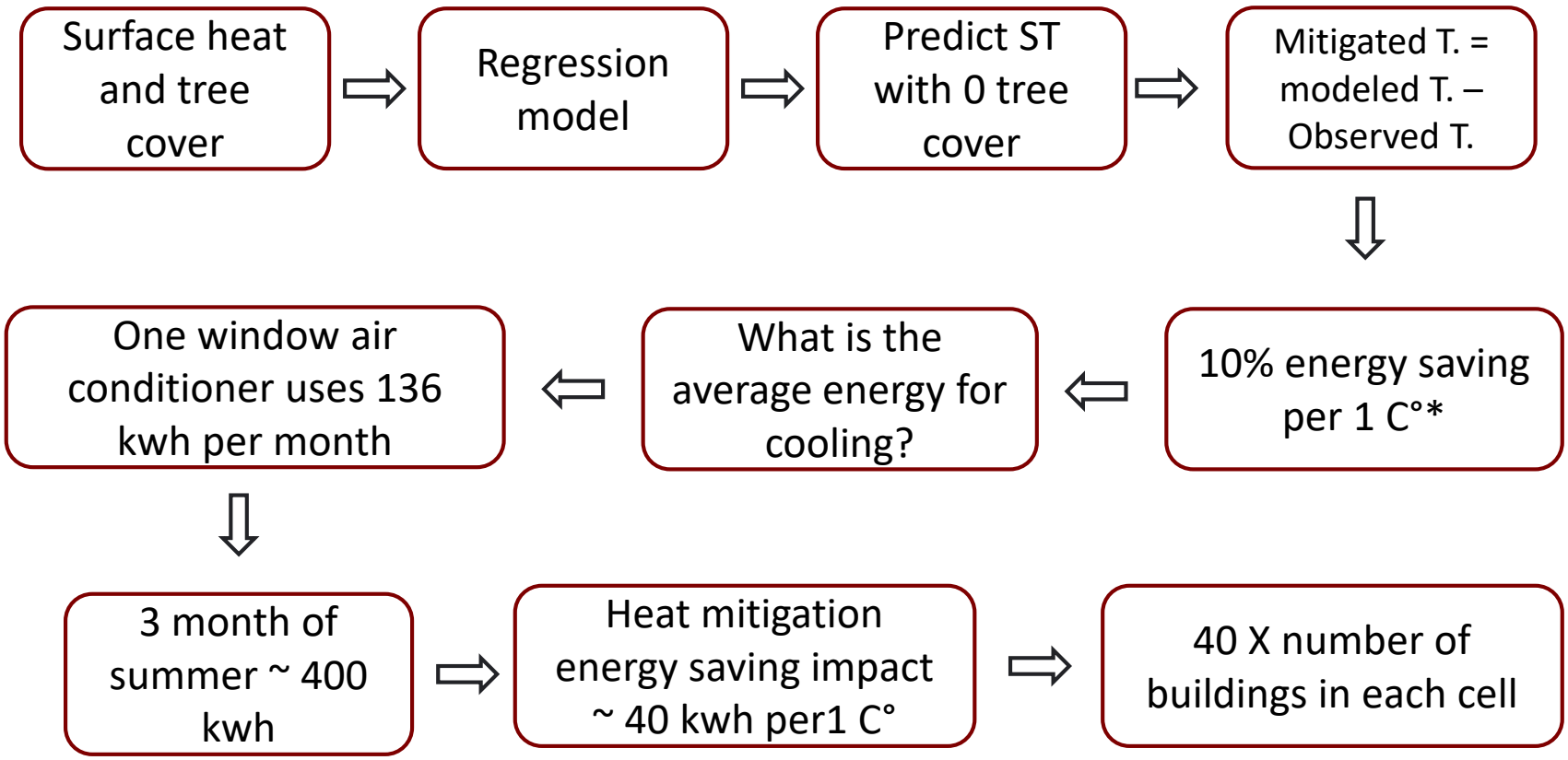
Dep. Variable:	surfTempD	**R-squared:**	0.245
Model:	OLS	**Adj. R-squared:**	0.245
Method:	Least Squares	**F-statistic:**	3.714e+04
Date:	Fri, 30 Nov 2018	**Prob (F-statistic):**	0.00
Time:	22:20:10	**Log-Likelihood:**	-4.4457e+05
No. Observations:	228636	**AIC:**	8.891e+05
Df Residuals:	228633	**BIC:**	8.892e+05
Df Model:	2		
Covariance Type:	nonrobust		

	coef	std err	t	P>|t|	[0.025	0.975]
const	44.0817	0.015	2896.081	0.000	44.052	44.111
LC_Tree	-0.0473	0.000	-183.553	0.000	-0.048	-0.047
LC_imp	0.0198	0.000	98.698	0.000	0.019	0.020

Omnibus:	1357.496	**Durbin-Watson:**	0.111
Prob(Omnibus):	0.000	**Jarque-Bera (JB):**	57873.353
Skew:	0.266	**Prob(JB):**	0.00
Kurtosis:	5.407	**Cond. No.**	292.

$$Modeled\ DST = 44.08 - 0.047 * TC + 0.019 * Imp$$

Some Assumptions for Running An Experimental Accounting



*Akbari, H., Pomerantz, M., & Taha, H. (2001). Cool surfaces and shade trees to reduce energy use and improve air quality in urban areas. *Solar energy*, *70*(3), 295-310.

Supply of Energy Savings by Trees

Landcover	Sum Megawatt hour energy saved
Developed, Open Space	239.31
Developed, Low Intensity	1281.44
Developed, Medium Intensity	243.24
Developed, High Intensity	77.21
Barren Land (Rock/Sand/Clay)	-0.06
Deciduous Forest	0.48
Evergreen Forest	0.03
Mixed Forest	0.02
Shrub/Scrub	-0.26
Grassland/Herbaceous	0.16
Pasture/Hay	0.01
Cultivated Crops	0.08
Woody Wetlands	0.93
Emergent Herbaceous Wetlands	0.15
Sum	1688.32

Use Table Est.s Energy Saving from Tree-Based Heat Mitigation

Landuse	Energy Saved (Megawatt)
BU Res. Urban (0.1 - 1 ac)	1273.59
BU Res. dense urba (>0.1 ac)	119.89
BU Res. Suburban (1 - 2.5 ac)	90.86
BU Comm. Office	51.73
BU Ind. Factory, plant	39.96
Rec Dev. Urban park	22.48
BU Comm. Retail/shopping	16.16
BU Res. Exurban (2.5 - 10 ac)	14.37
BU Inst. Schools (developed)	12.68
BU Trans. Airports	9.98
BU Inst. Military (developed)	7.12
Rec Dev. Golf course	6.08
BU Inst. Medical	5.02
BU Misc	4.08
BU Comm. Entertainment	3.86
BU Trans. Highways/railways	3.64
Sum	1681.51