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Models, Social Media, & Gravity Theory: Relative Population Density

Census and National Statistics Organizations: Supporting Census with GIS

Date: Tuesday, June 28, 2016

Time 1:30 – 2:45PM

Room: Room 28D

Erin Goodnough, MGIS, GISP

erin.goodnough@mdaus.com

<http://mdaus.com/services/geospatial-modeling>

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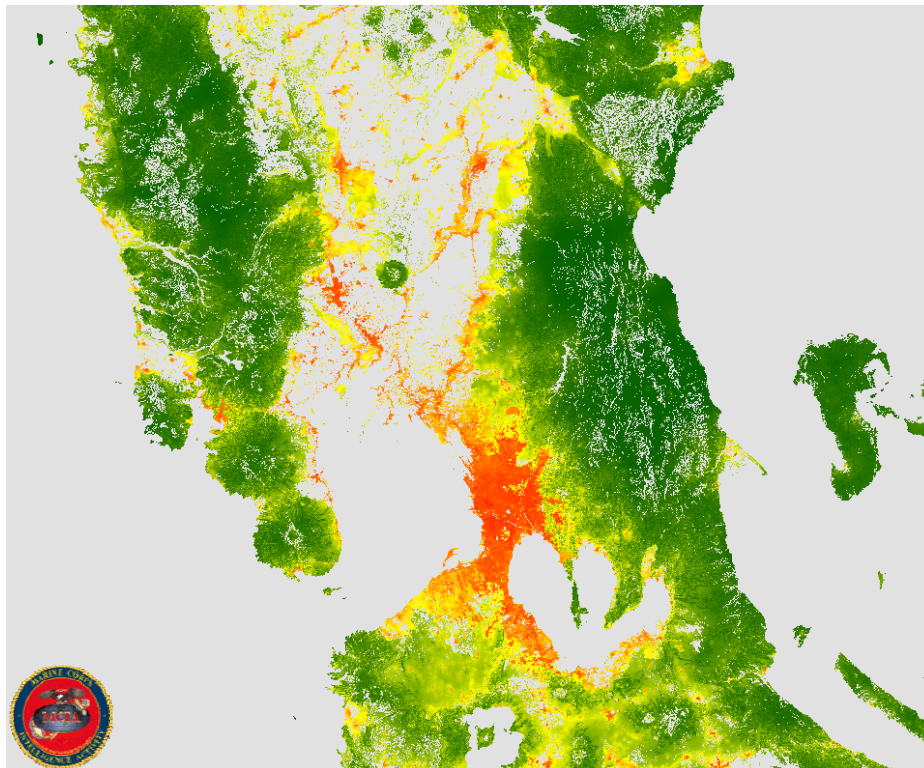
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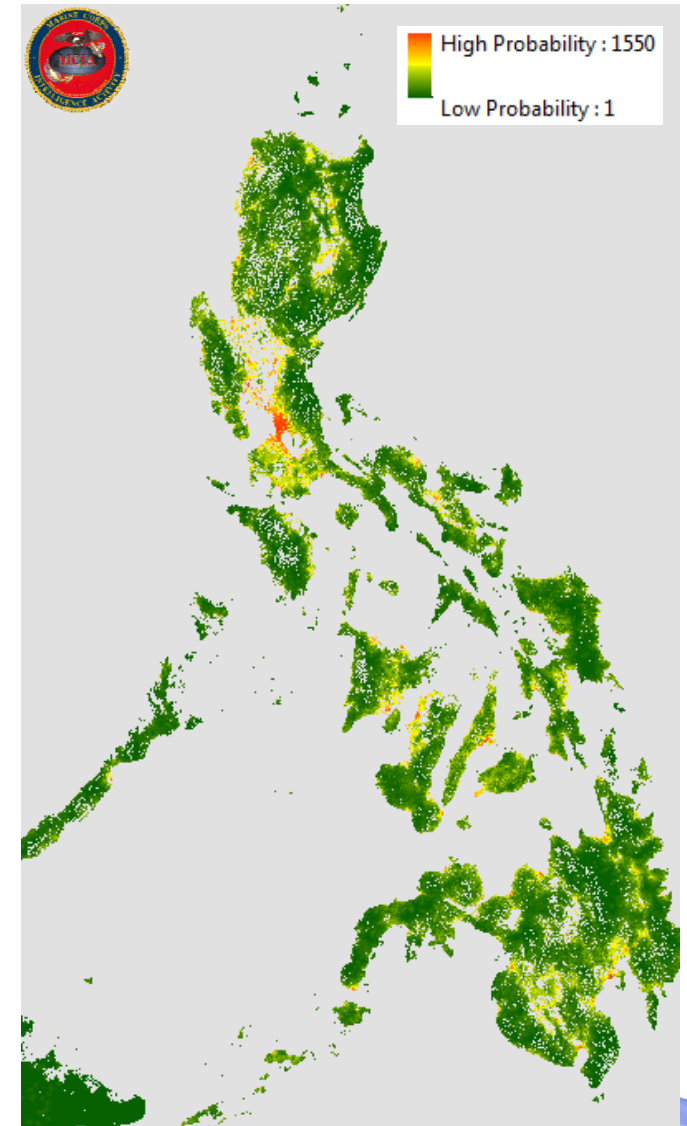
What is a Population Index?

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- 30m dataset
- illustrates the probability of population density



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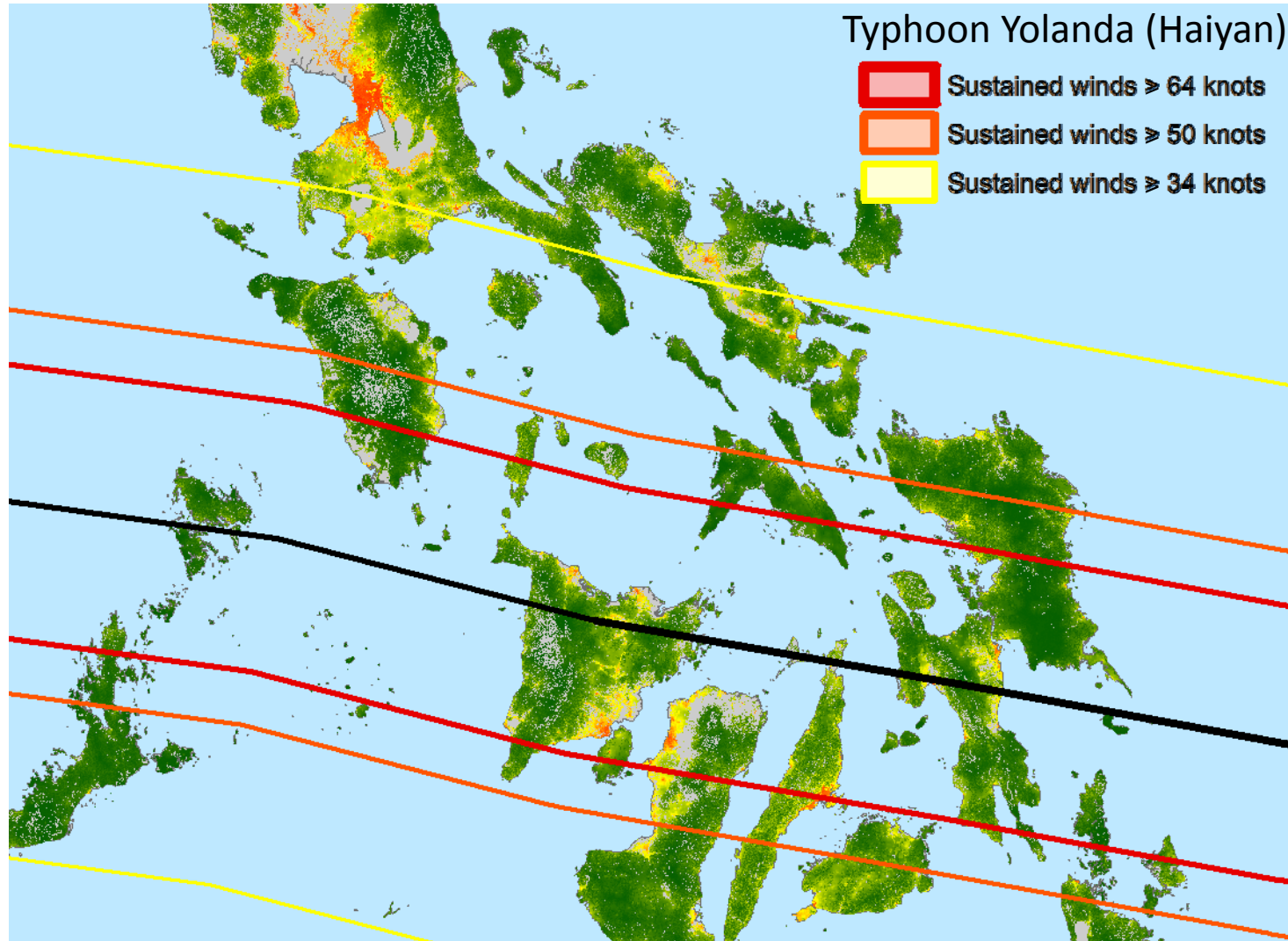


How can it be used?



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Data Sources



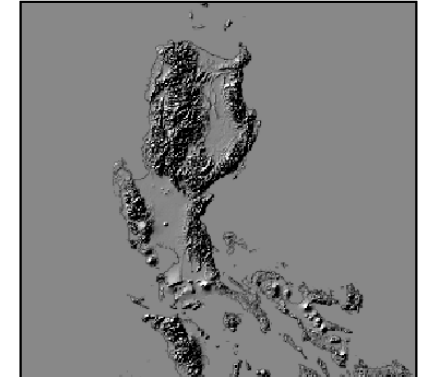
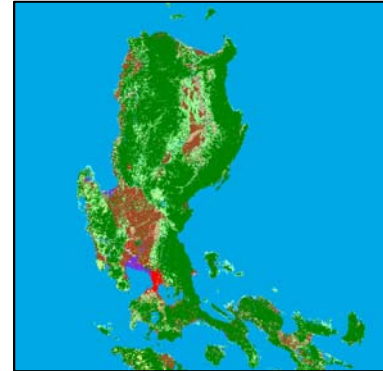
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Higher confidence

- Terrain (DEM)
- Land Cover

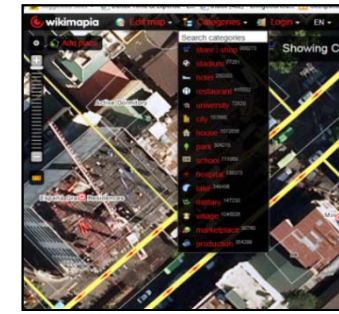
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Constraining factors



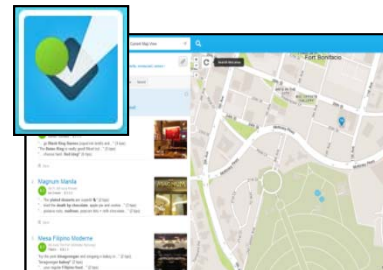
- Open Street Map
 - points of interest and roads

Gravity model



wikimapia

- Wikimapia
- 4square
- Twitter



Lower confidence

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Data Prep for Land Cover and DEM



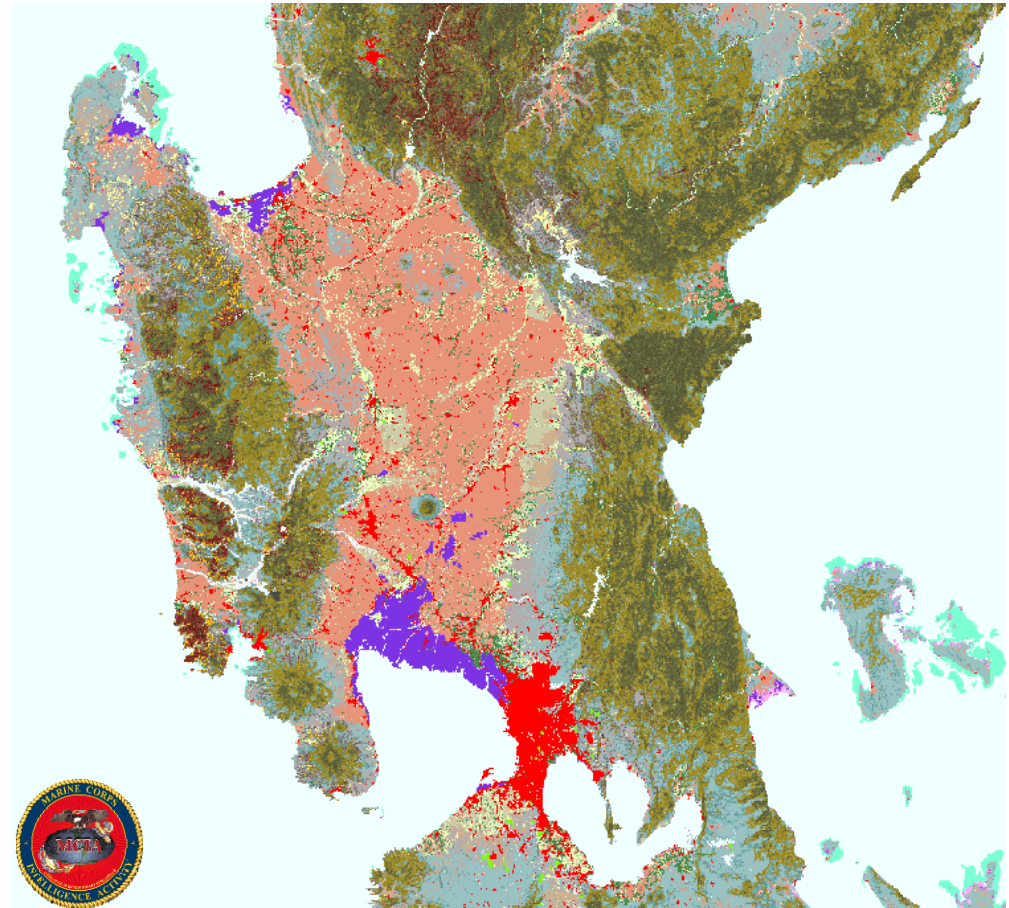
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Terrain Land Cover Base

- Uses DEM and Land Cover
- Processes over 100 calculations
- Acts as constraint on gravity model

01. Water	46. Mountains; > 50% Slope; Sparse Vegetation
02. Wetlands, Permanent	47. Mountains; 21 - 50% Slope; Sparse Vegetation
03. Mangroves	48. Mountains; 11 - 20% Slope; Sparse Vegetation
04. Agriculture, Paddy Rice	49. Mountains; <= 10% Slope; Sparse Vegetation
05. Urban/Built-Up	50. Hills; > 50% Slope; Forest
06. Reefs	51. Hills; 21 - 50% Slope; Forest
07. Fish Ponds	52. Hills; 11 - 20% Slope; Forest
08. Filtration/Aeration Beds	53. Hills; <= 10% Slope; Forest
09. Open Pits	54. Hills; > 50% Slope; Shrub/Scrub
12. Golf Courses	55. Hills; 21 - 50% Slope; Shrub/Scrub
13. Foreshore Flat	56. Hills; 11 - 20% Slope; Shrub/Scrub
14. Sand Dunes; >= 12% Slope	57. Hills; <= 10% Slope; Shrub/Scrub
15. Sand Dunes; < 12% Slope	58. Hills; > 50% Slope; Sparse Vegetation
16. Sabkha	59. Hills; 21 - 50% Slope; Sparse Vegetation
17. Floodplains; Forest; Near Streams	60. Hills; 11 - 20% Slope; Sparse Vegetation
18. Floodplains; Forest; Far from Streams	61. Hills; <= 10% Slope; Sparse Vegetation
19. Floodplains; Shrub/Scrub; Near Streams	63. Flatlands; 21 - 50% Slope; Forest
20. Floodplains; Shrub/Scrub; Far from Streams	64. Flatlands; 11 - 20% Slope; Forest
21. Floodplains; Sparse Vegetation; Near Streams	65. Flatlands; <= 10% Slope; Forest
22. Floodplains; Sparse Vegetation; Far from Streams	67. Flatlands; 21 - 50% Slope; Shrub/Scrub
38. Mountains; > 50% Slope; Forest	68. Flatlands; 11 - 20% Slope; Shrub/Scrub
39. Mountains; 21 - 50% Slope; Forest	69. Flatlands; <= 10% Slope; Shrub/Scrub
40. Mountains; 11 - 20% Slope; Forest	71. Flatlands; 21 - 50% Slope; Sparse Vegetation
41. Mountains; <= 10% Slope; Forest	72. Flatlands; 11 - 20% Slope; Sparse Vegetation
42. Mountains; > 50% Slope; Shrub/Scrub	73. Agriculture; General; <= 10% Slope
43. Mountains; 21 - 50% Slope; Shrub/Scrub	74. Grasslands; <= 10% Slope
44. Mountains; 11 - 20% Slope; Shrub/Scrub	75. Barren; <= 10% Slope
45. Mountains; <= 10% Slope; Shrub/Scrub	



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Data Prep for Social Media/Crowd Sourced Points



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	OSM	Wikimapia	4square	Twitter
Points	44,000	34,000	>500,000	>6.2 million
Tag temperament	Simple – one category per point	Complex – multiple categories per point	Simple – one category per point	None
Point temperament	One point per item	One point per list of multiple categories	Multiple points per item (smudge)	None
Tag example	Restaurant	dining and leisure, house, park, water, interesting place, nonresidential building	Restaurant	N/A

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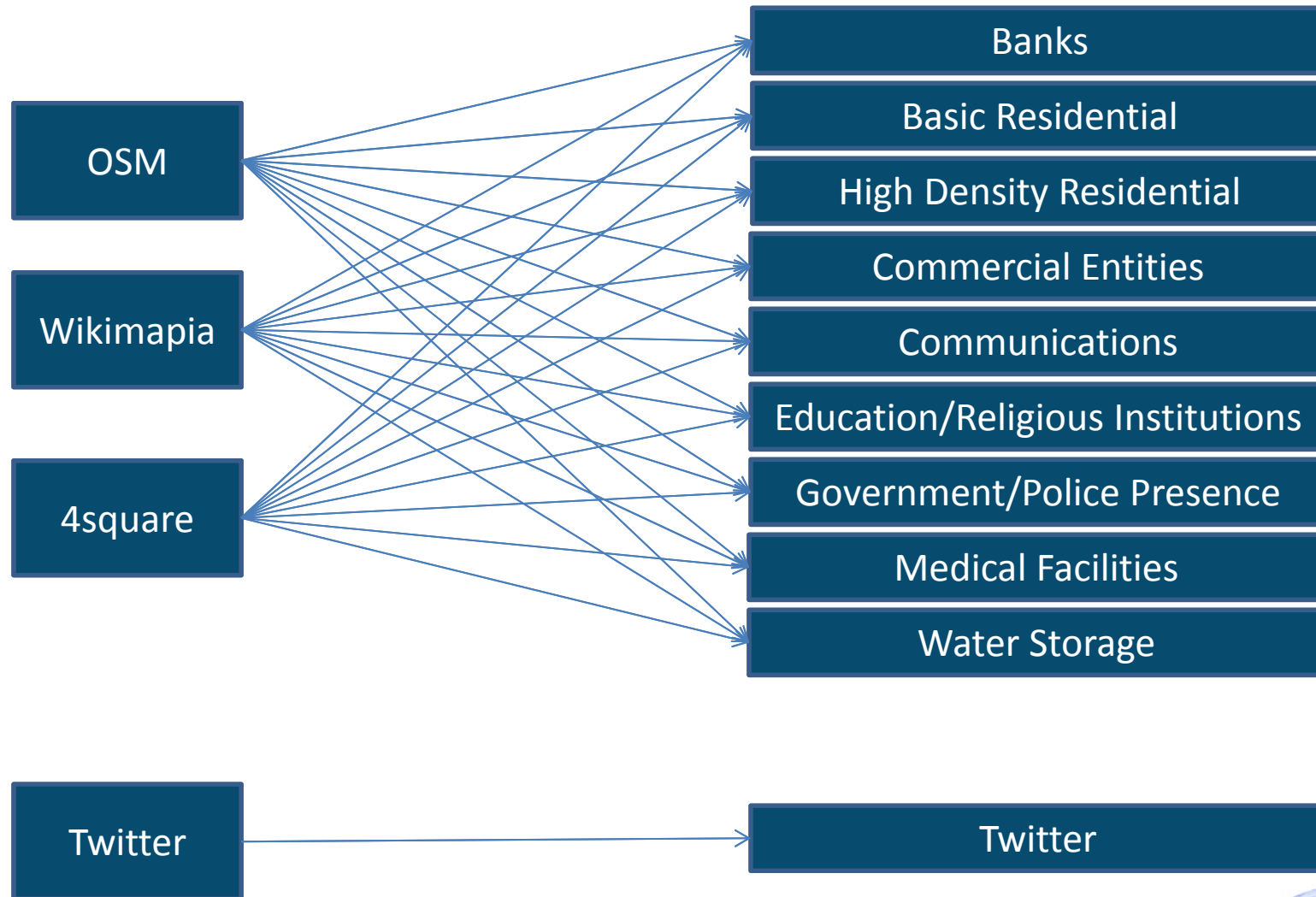


Data Prep for Social Media/Crowd Sourced Points



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Gravity Model Concepts



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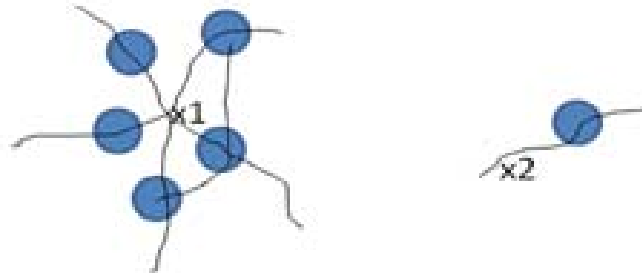
More Gravity

Less Gravity

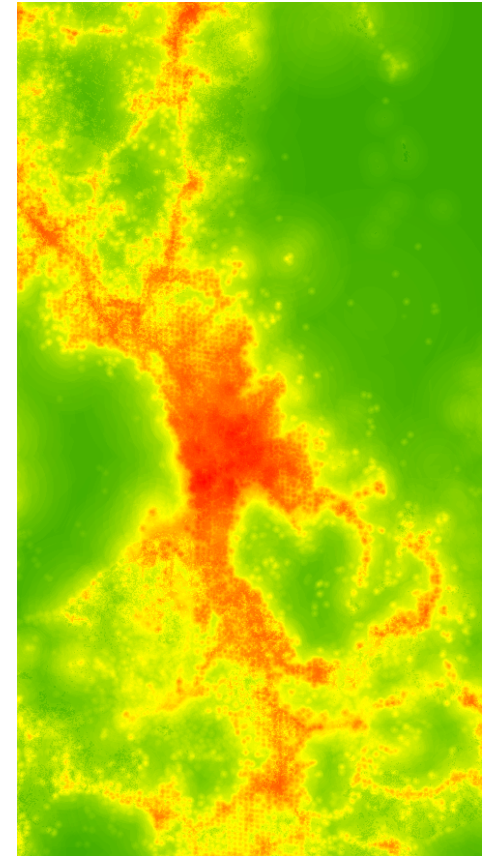
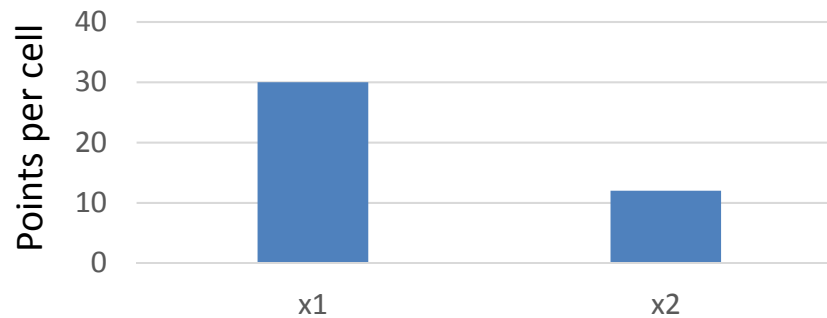
Relative Size



Regional Mass
(Neighborhood Density)



Social Media/
Crowd-Sourced Density



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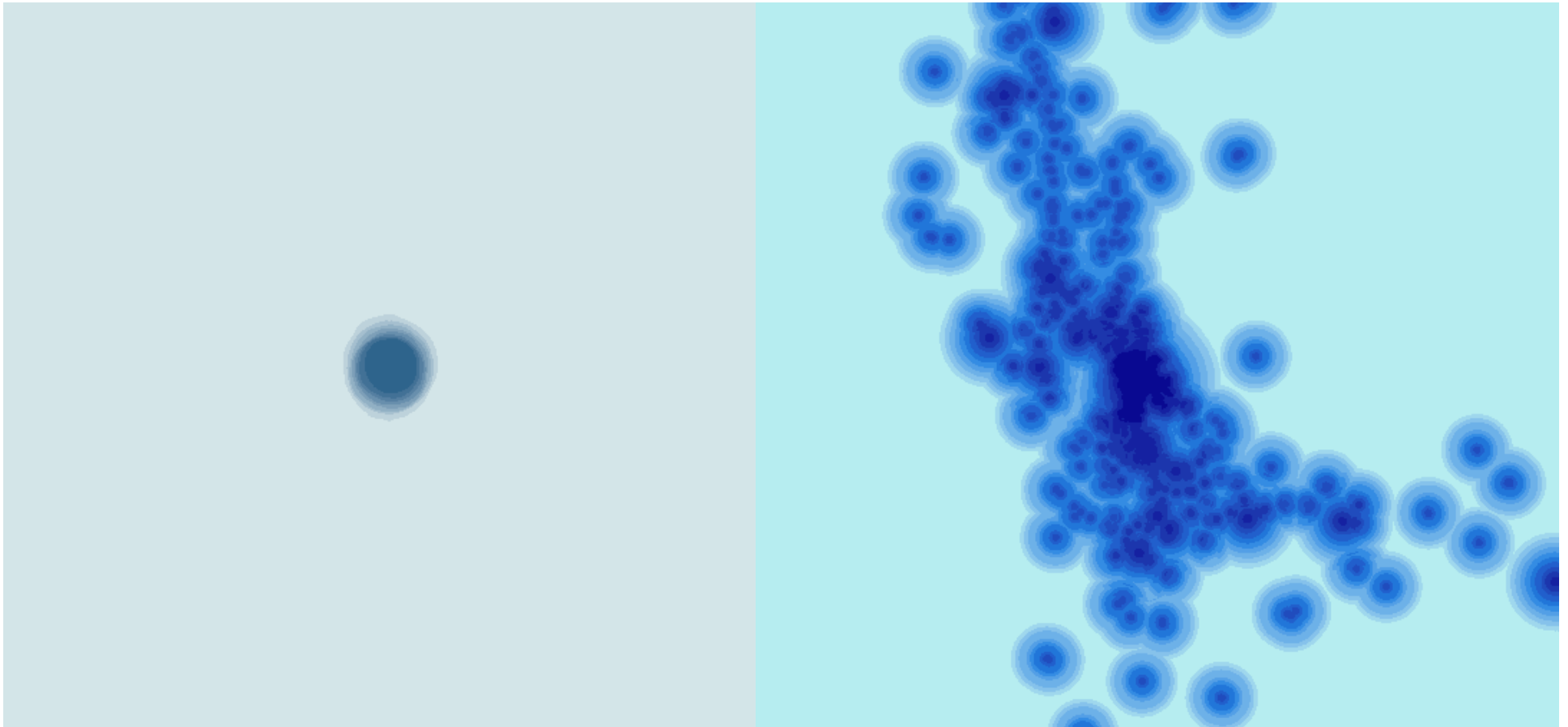


Heat Maps (Point and Kernel Density) vs Gravity Model



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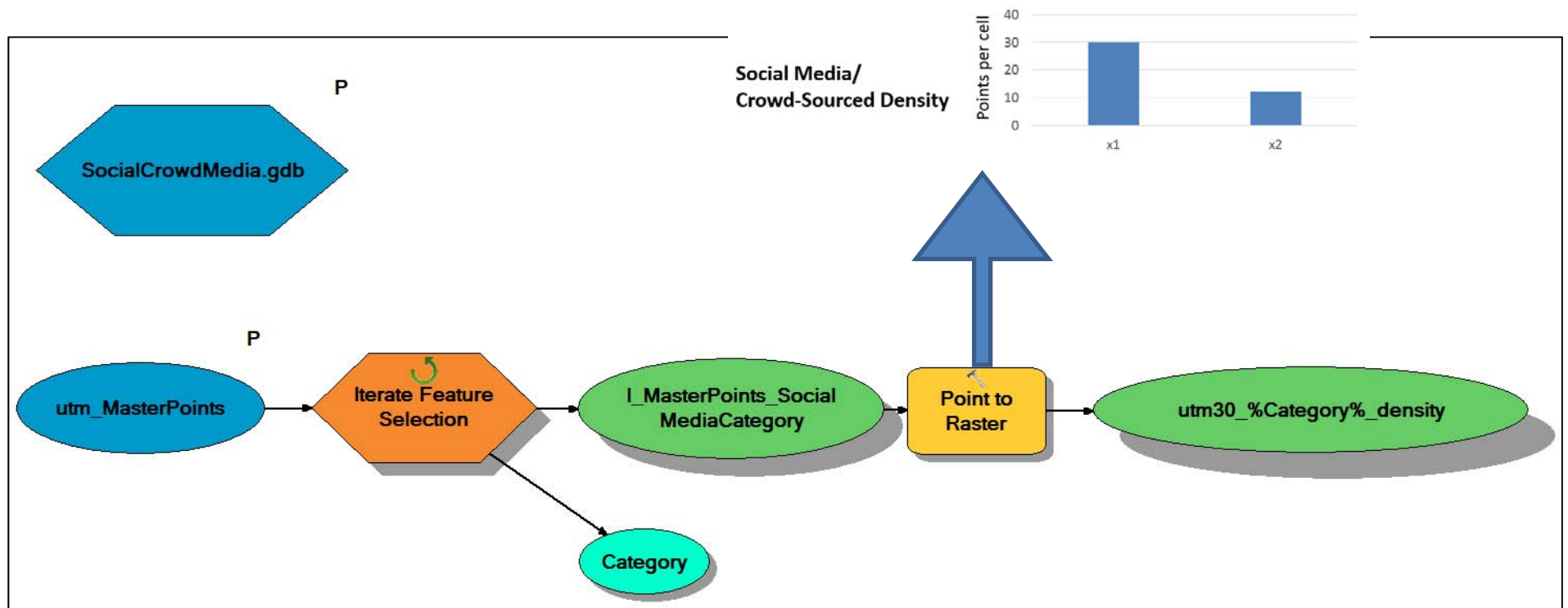


Data Prep for Social Media/Crowd Sourced Points



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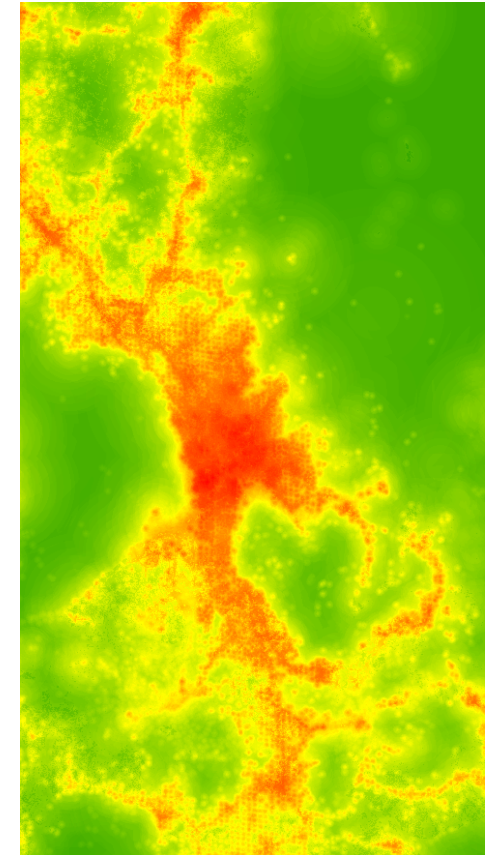
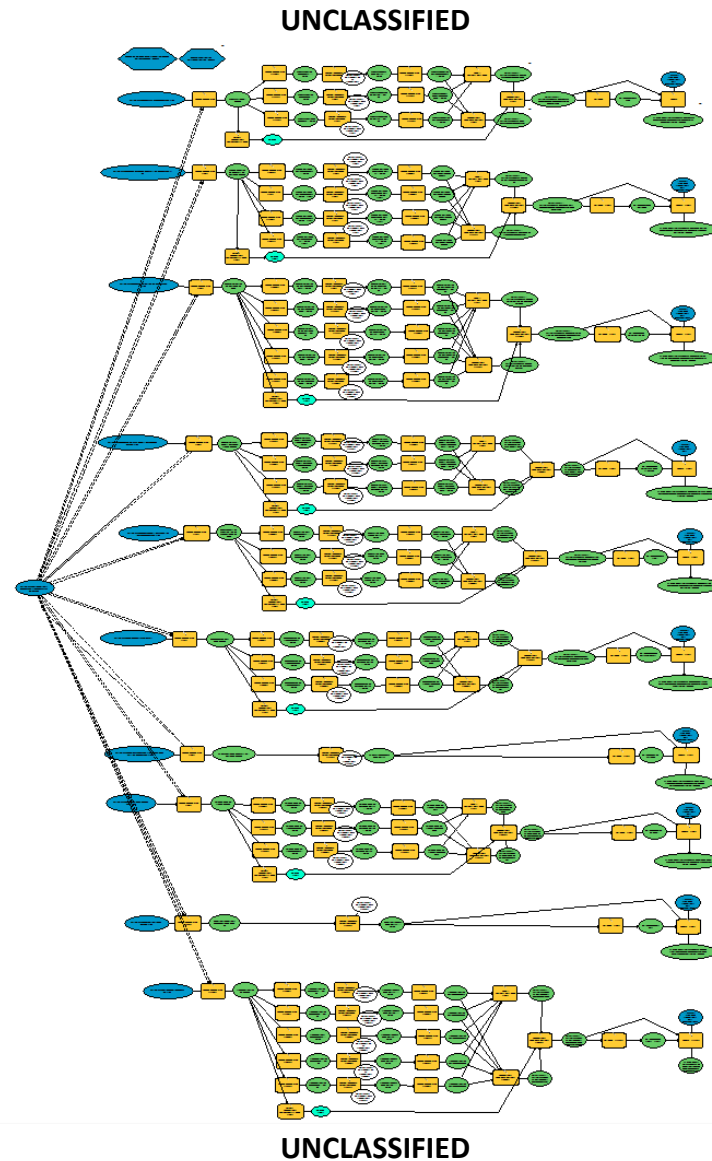
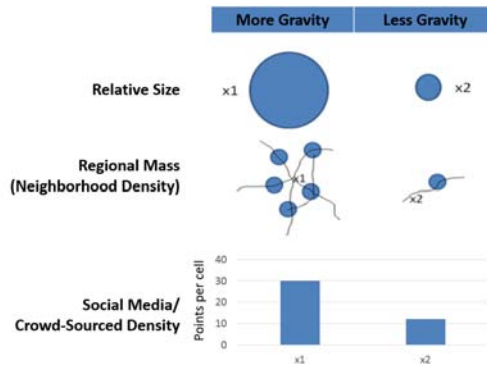
Gravity Model Practical Application



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Tools used:

- Reclassify
- Euclidean Distance
- Cell Statistics
- Raster Calculators
- Slice
- Conditional



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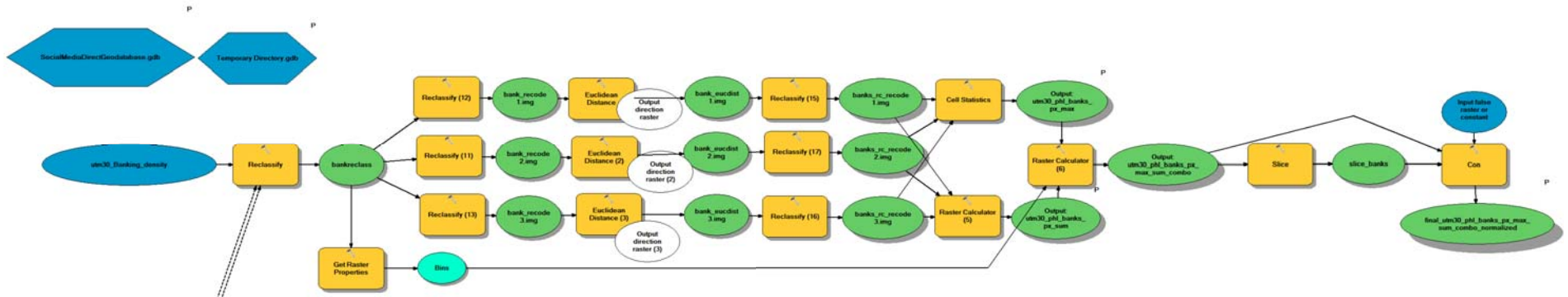


Gravity Model Practical Application



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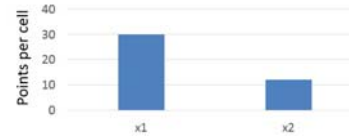
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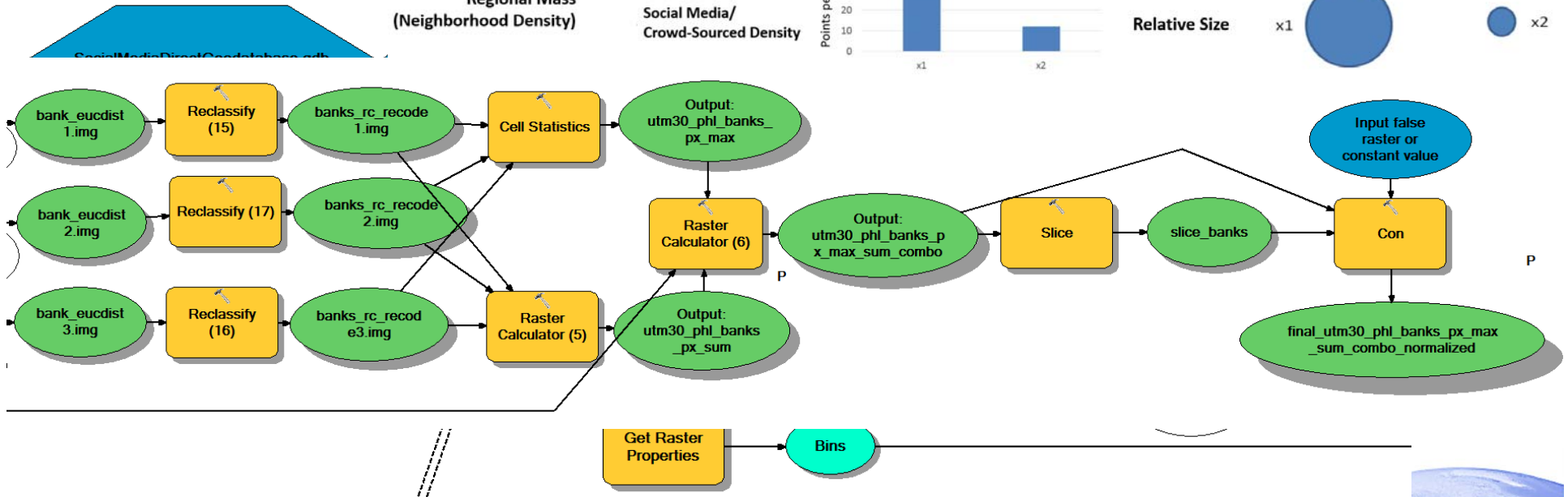
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Regional Mass
(Neighborhood Density)

Social Media/
Crowd-Sourced Density



Relative Size



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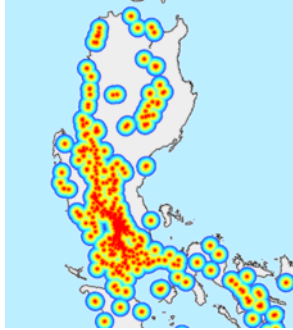
Gravity Model Practical Application



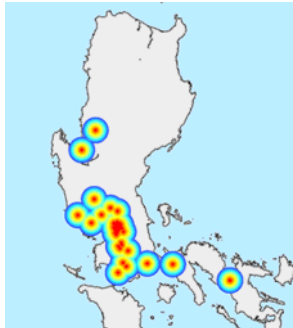
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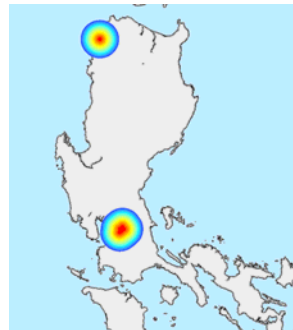
Bank
Bin 1



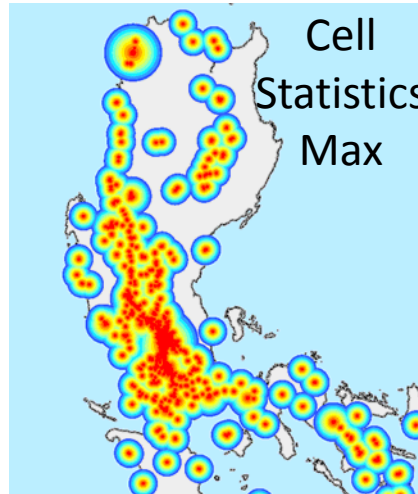
Bank
Bin 2



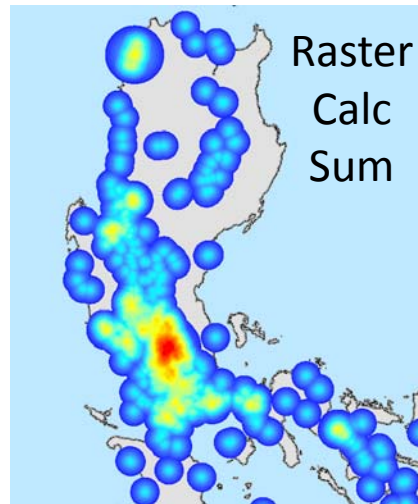
Bank
Bin 3



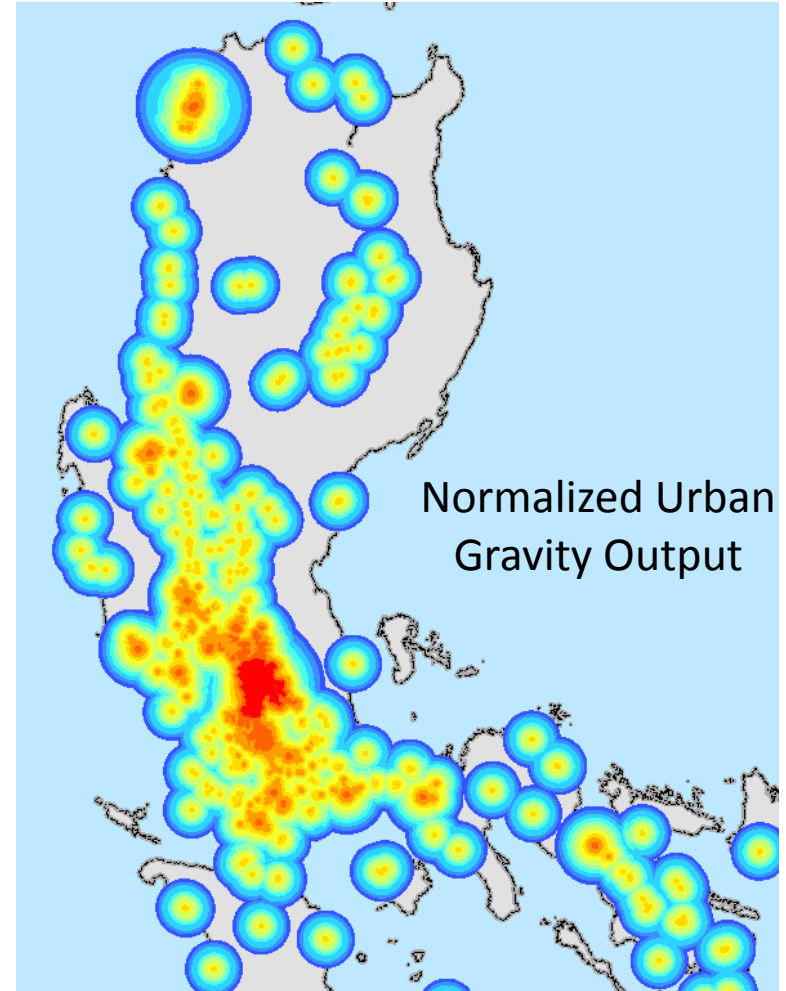
Cell
Statistics
Max



Raster
Calc
Sum



Normalized Urban
Gravity Output



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Other Inputs to Population Index



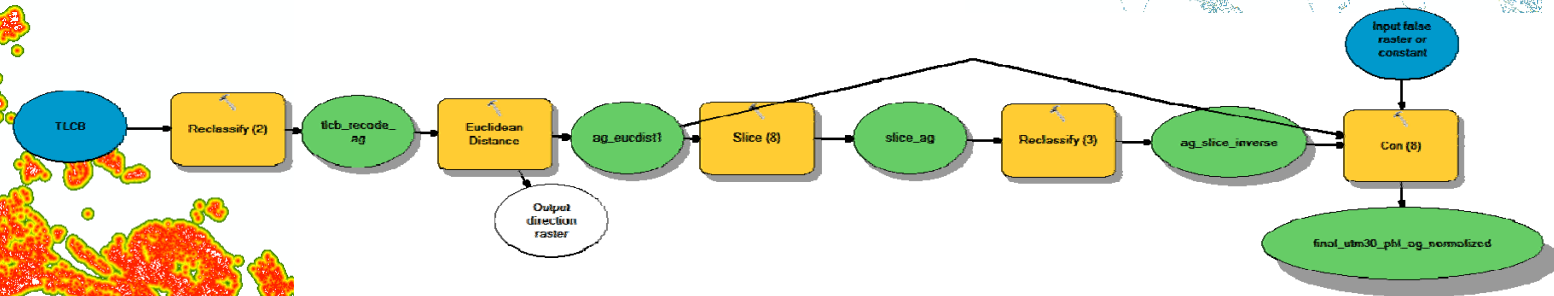
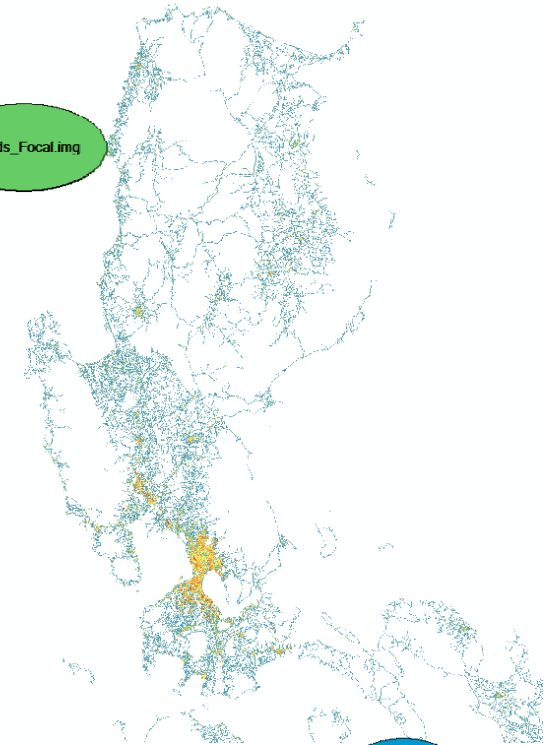
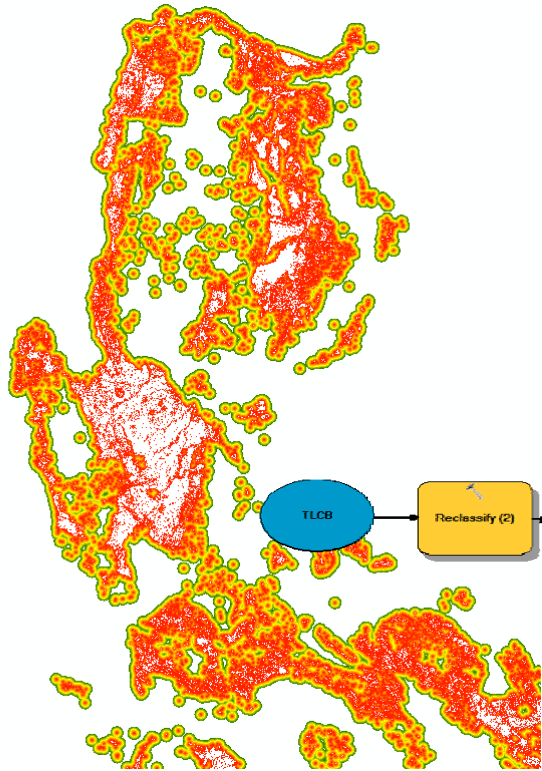
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Roads focal sum



Agriculture modified gravity model



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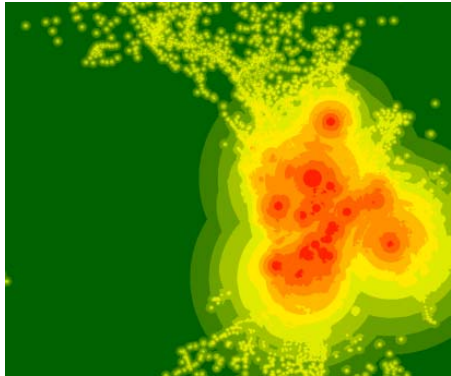


Population Index Final Calculation



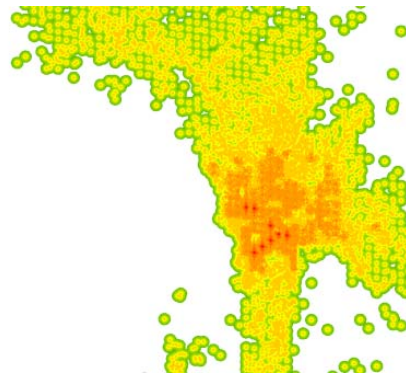
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Commercial (20 km)

+

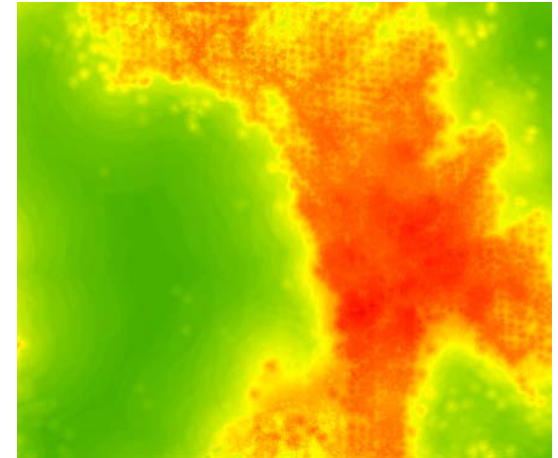


Basic residential (1km)

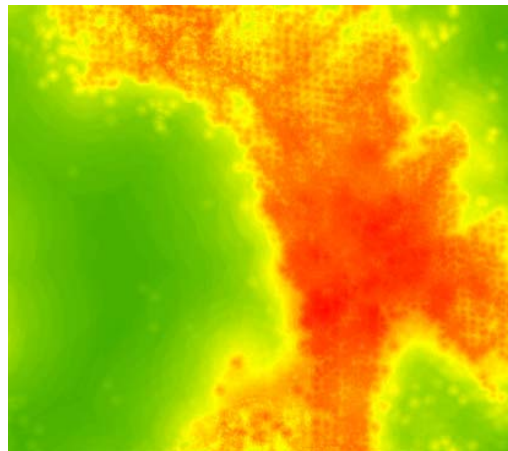
+

All other
gravity
outputs
& roads

=

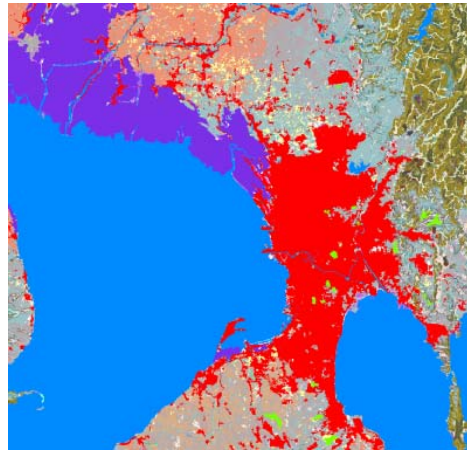


Social Media Gravity Model



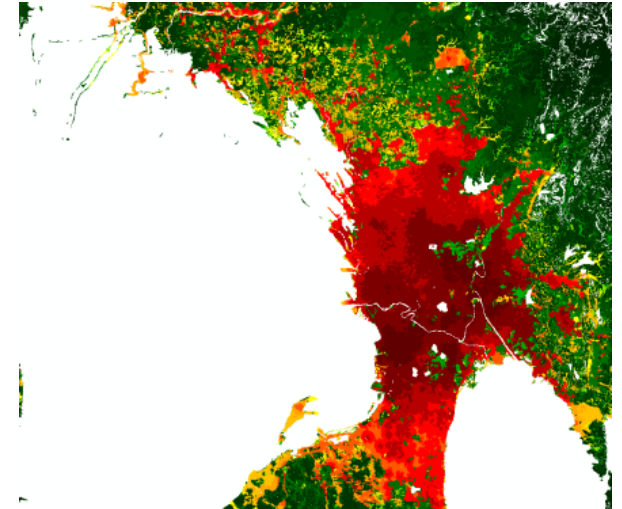
Social Media Gravity Model

x



Terrain Land Cover Base

=



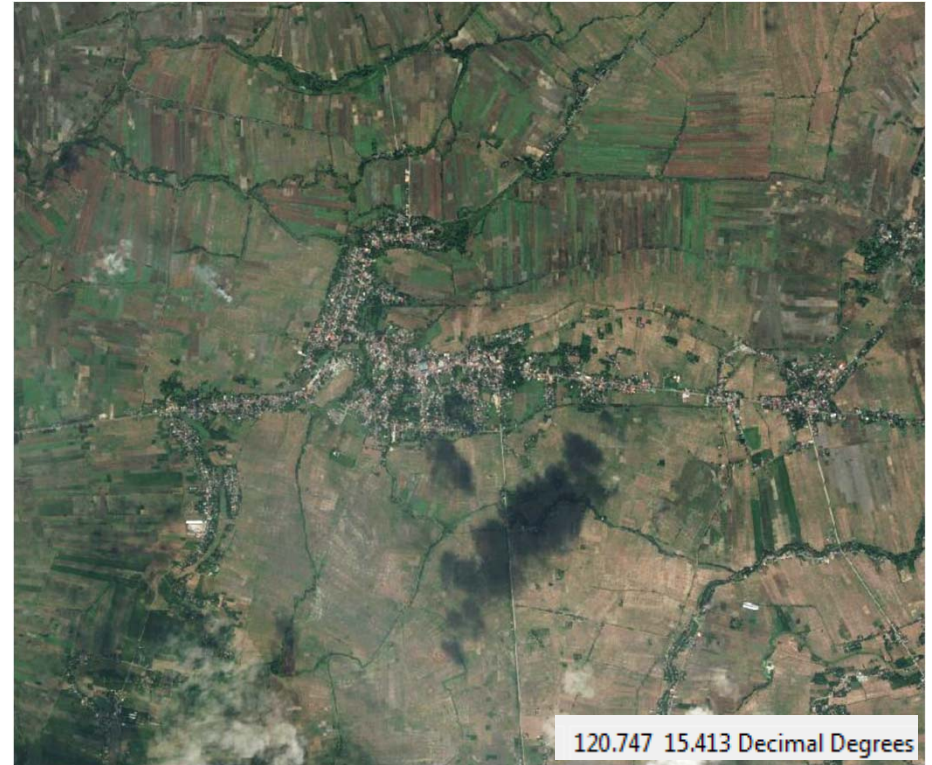
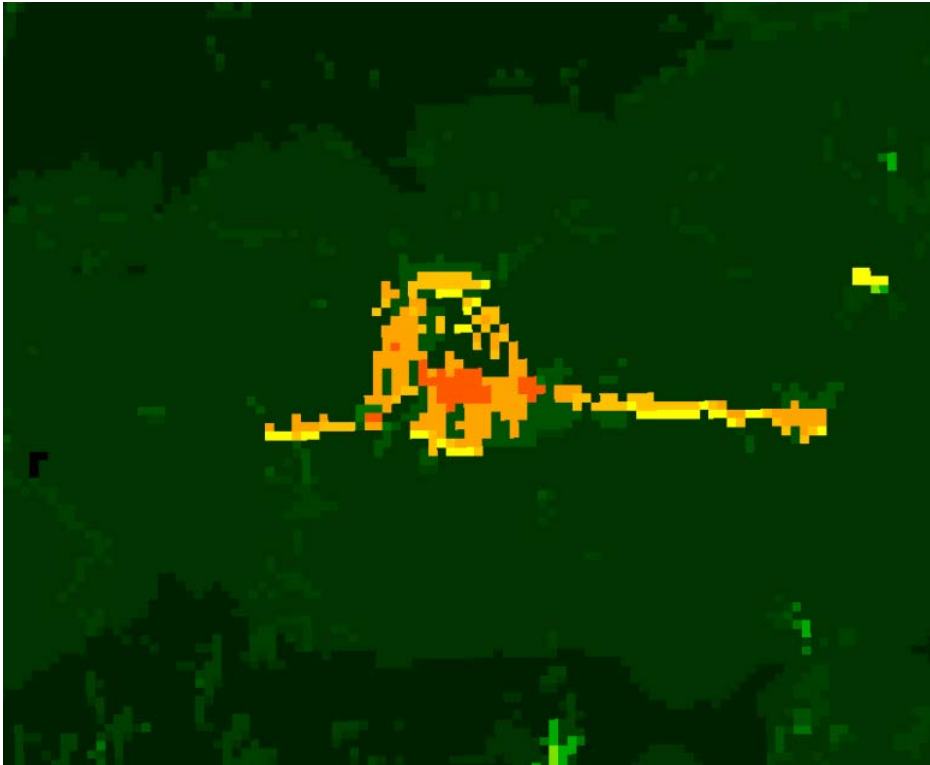
Population Index

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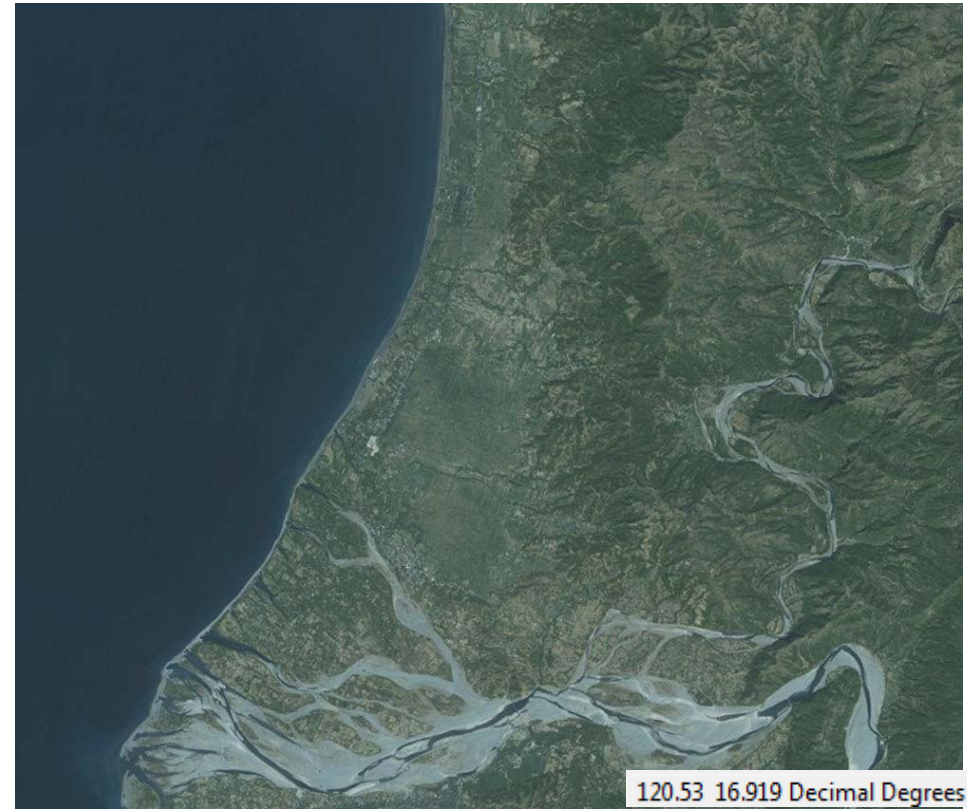
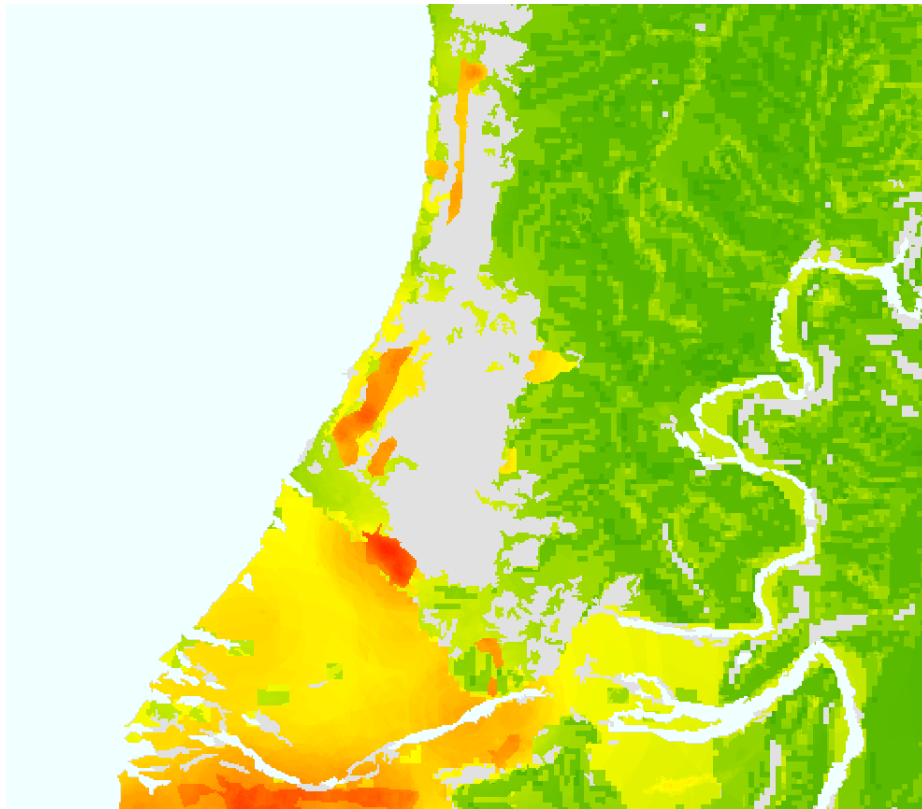


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- Imperfect. A heavy weight is placed on data gathered from members of society who have technology at their disposal.
- But better than nothing at this scale! Validation was pretty sound- satellite imagery evidence of human activity at the high range.
- Methodology must change based on data quantity, quality, and human/land interaction.
- Iterative process- relies heavily on sound analytical decision-making. No plug and play here!

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- Revise methodology to include night lights and impervious surfaces to improve results
- Develop methodology to extract pop density
 - Holloway:
 - <http://web.pdx.edu/~jduh/courses/geog492s10/lab04.htm>
 - Mennis:
 - <http://geography.wr.usgs.gov/science/dasymetric/data.htm>
 - <https://www.epa.gov/enviroatlas/dasymetric-toolbox>
 - Derive an expression that will calculate population density more directly when census data is out of date or low quality

The image shows a screenshot of a Python script named 'Dasy.py' and a corresponding geoprocessing workflow diagram. The script includes a print statement 'print "combine_sa worked"', an exception handler for errors, and code to add fields to a 'Dasy_Rast' table. The workflow diagram consists of numerous yellow and green nodes connected by lines, representing a complex sequence of geoprocessing tasks. Below the script, a console window shows a warning 'Too much output to process' followed by a list of data rows with columns 'clat_4classm' and 'popraster'.

```
print "combine_sa worked"
```

```
print "join field worked"
```

```
except:
```

```
    # If an error occurs
```

```
    gp.AddMessage(gp.GetMessages())
```

```
    # add needed fields to Dasy_Rast
```

```
    gp.toolbox = "management"
```

```
try:
```

```
    # Add fields of type LONG
```

```
    gp.addfield(Dasy_Table, "TRCTCOUNT", "long")
```

```
    gp.addfield(Dasy_Table, "INHAB", "long")
```

```
! Too much output to process
```

```
clat_4classm = 122420
```

```
popraster = 2125
```

```
clat_4classm = 122424
```

```
popraster = 2125
```

```
clat_4classm = 122425
```

```
popraster = 2125
```

```
clat_4classm = 122426
```

```
popraster = 2125
```

```
clat_4classm = 122427
```

```
popraster = 2125
```

```
clat_4classm = 122428
```

```
popraster = 2125
```

```
clat_4classm = 122429
```

```
summing the count for each population raster id
```

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Questions?



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Resources

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<http://mdaus.com/services/geospatial-modeling>
Erin.Goodnough@mdaus.com

Duh, JD. G. (n.d.) Lab 4 Dasymetric Mapping. Retrieved from Portland State University: <http://web.pdx.edu/~jduh/courses/geog492s10/lab04.htm>

Griffith, D. A. (2010, September 3). *A Generalized Huff Model*. Retrieved from Wiley Online Library: <http://onlinelibrary.wiley.com/doi/10.1111/j.1538-4632.1982.tb00062.x/pdf>

Haynes, K. and Fotheringham, A (1984). *Gravity and Spatial Interaction Models*. Retrieved from Portland State University: <http://www.web.pdx.edu/~stipakb/download/PA557/ReadingsPA557sec1-2.pdf>

Knapp, K. R. Applequist, S., et al (2010). *NCDC International Best Track Archive for Climate Stewardship (IBTrACS) Project, Version 3*. Retrieved from NOAA National Centers for Environmental Information. DOI:10.7289/V5NK3BZP on May 12, 2016: <http://gis.ncdc.noaa.gov/all-records/catalog/search/resource/details.page?id=gov.noaa.ncdc:C00834>

Sleeter, R. (2016) Dasymetric Mapping Tool. Retrieved from USGS: <http://geography.wr.usgs.gov/science/dasymetric/data.htm>

Way, D. Access to Markets Model, Marine Corps Intelligence Activity.

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