Using Population Density Research to Inform a Population Distribution Model for Settlement Mapping

Geographic Information Science and Technology

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OAK RIDGE National Laboratory

Outline

- Overview of Settlement Mapping Process
- Overview of LandScan Global
- Settlement Mapping Results
- Settlement Mapping Combined with Population Distribution Model Results

Why Settlement Mapping

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- It's important to know where people live

- Distribution, location, size, and growth of settlements are important parameters

- To plan for emergencies, understand societal growth, monitor policy impacts. Mapping population has several commercial advantages too …

- Need to map settlements from high-resolution satellite imagery

Example: Housing Types & High Resolution Imagery

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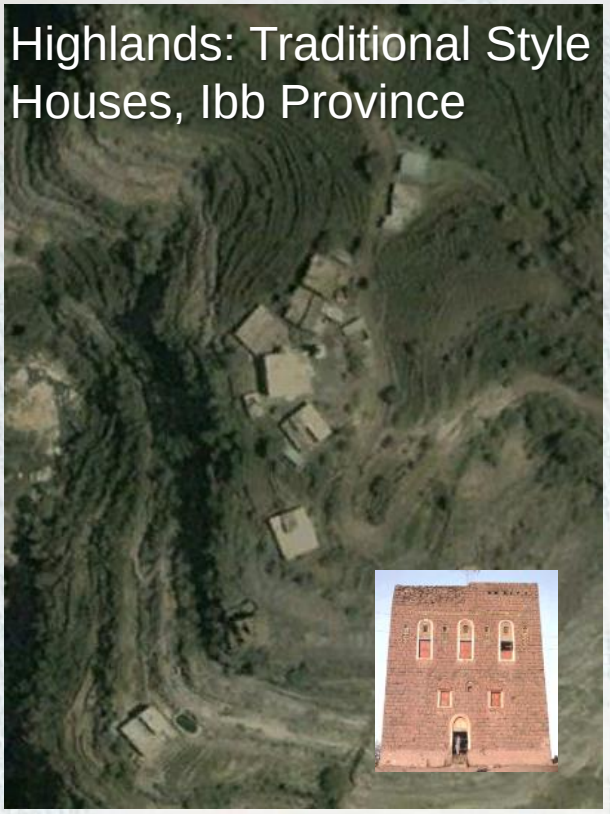

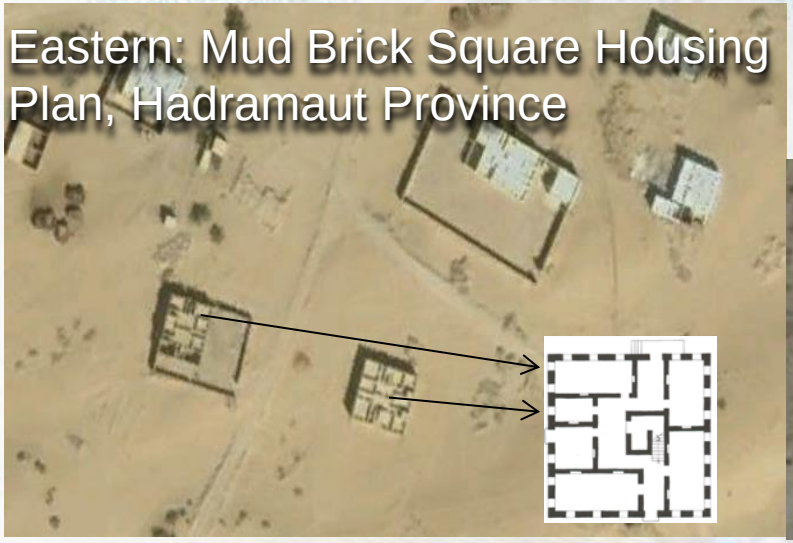

LAHORE

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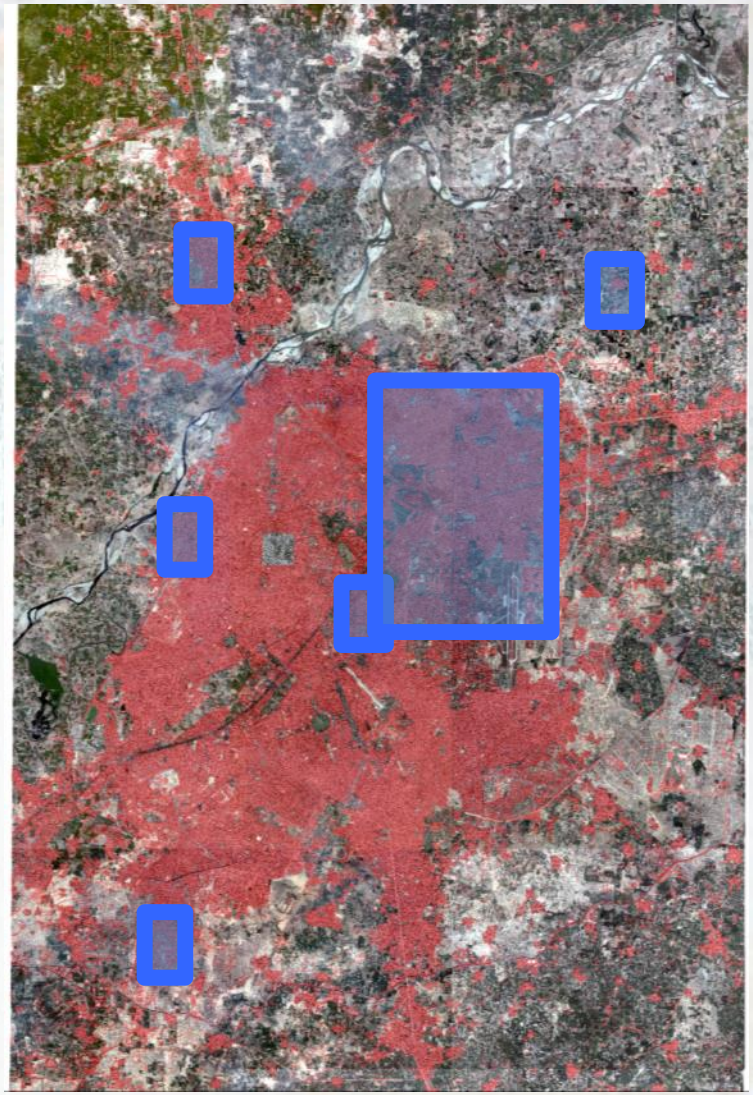

Extraction Process

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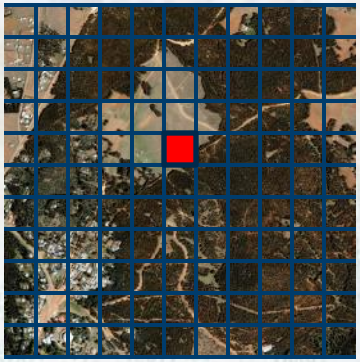
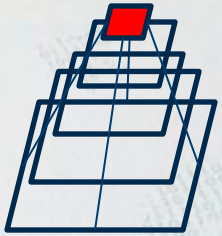


Divide image into pixel blocks



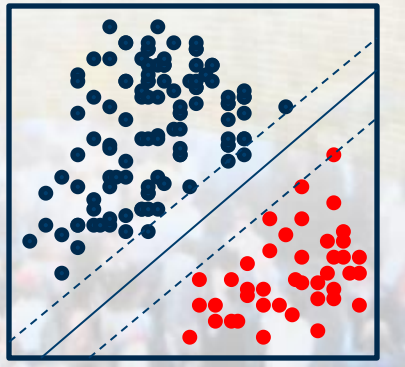
For each pixel block compute multiscale features

Histogram of Gradient Statistics (5features x 5scales)

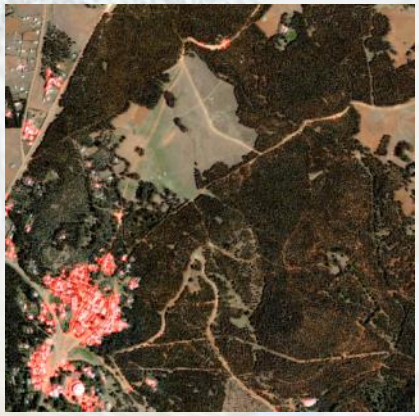
Pixel block intensity mean and variance (2features x 5 scales)

Gray-level Co-occurrence Contrast (1feature x 1 scale)

Each pixel block mapped to a 36-dimensional vector



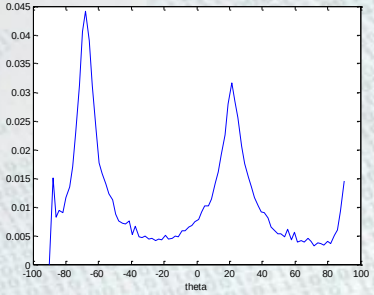
Apply learned linear SVM model



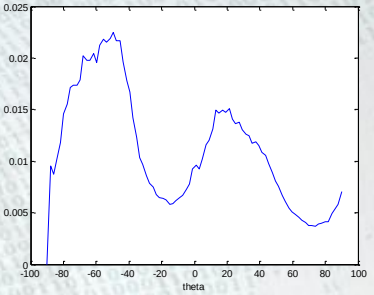
Statistical Features

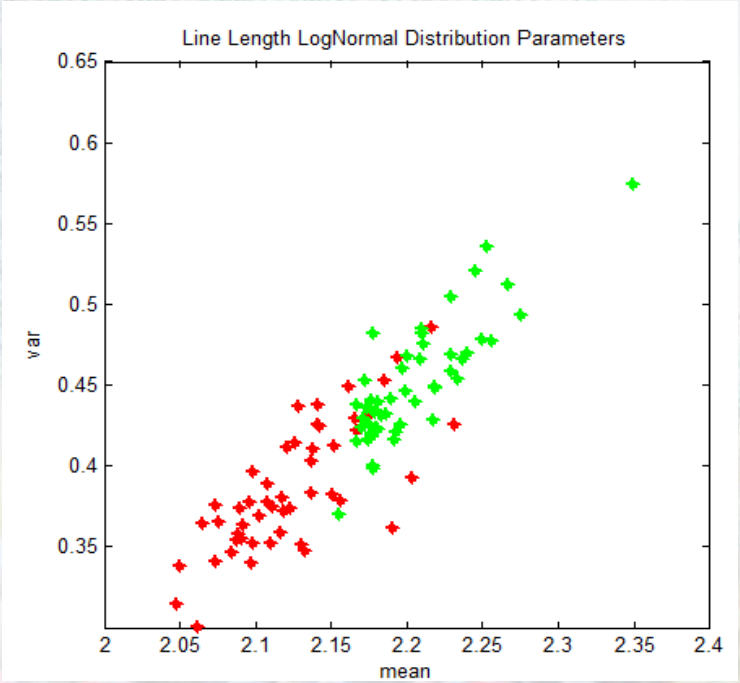
- **Features**
  - Histogram of Gradients and Orientation
    - Distribution of local intensity gradients or edge directions
    - Dividing the image window into small spatial regions (*cells*)
  - GLCM
    - Calculates how often a pixel with gray level (gray scale intensity or tone) value occurs either horizontally, vertically, or diagonally to adjacent pixels.

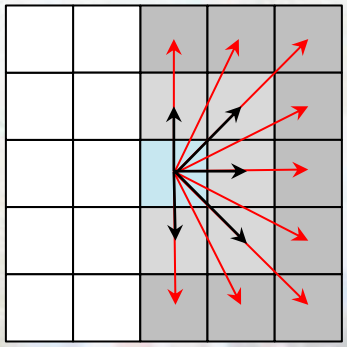
Formal

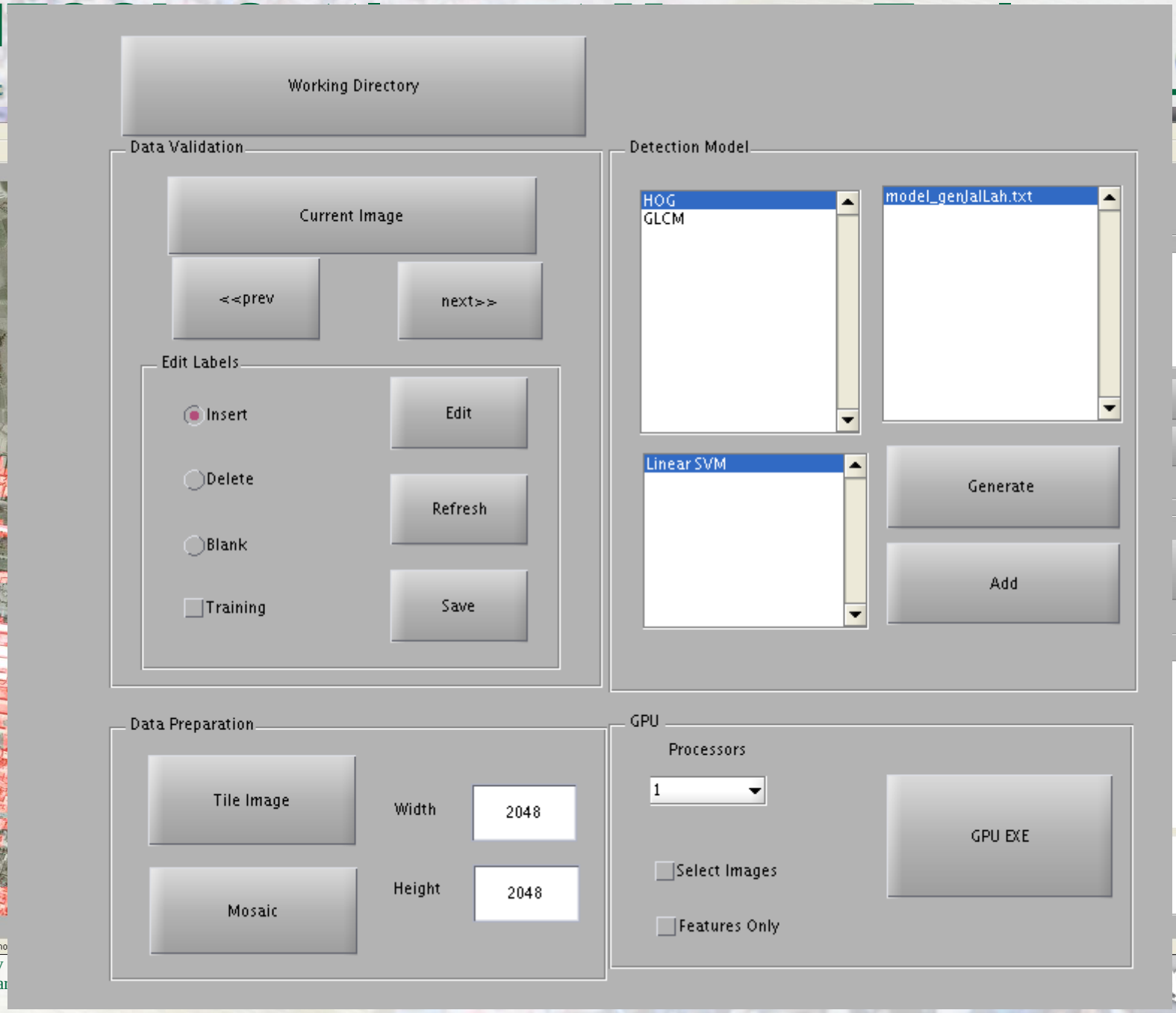


Informal





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Select Images
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Resolution Examples

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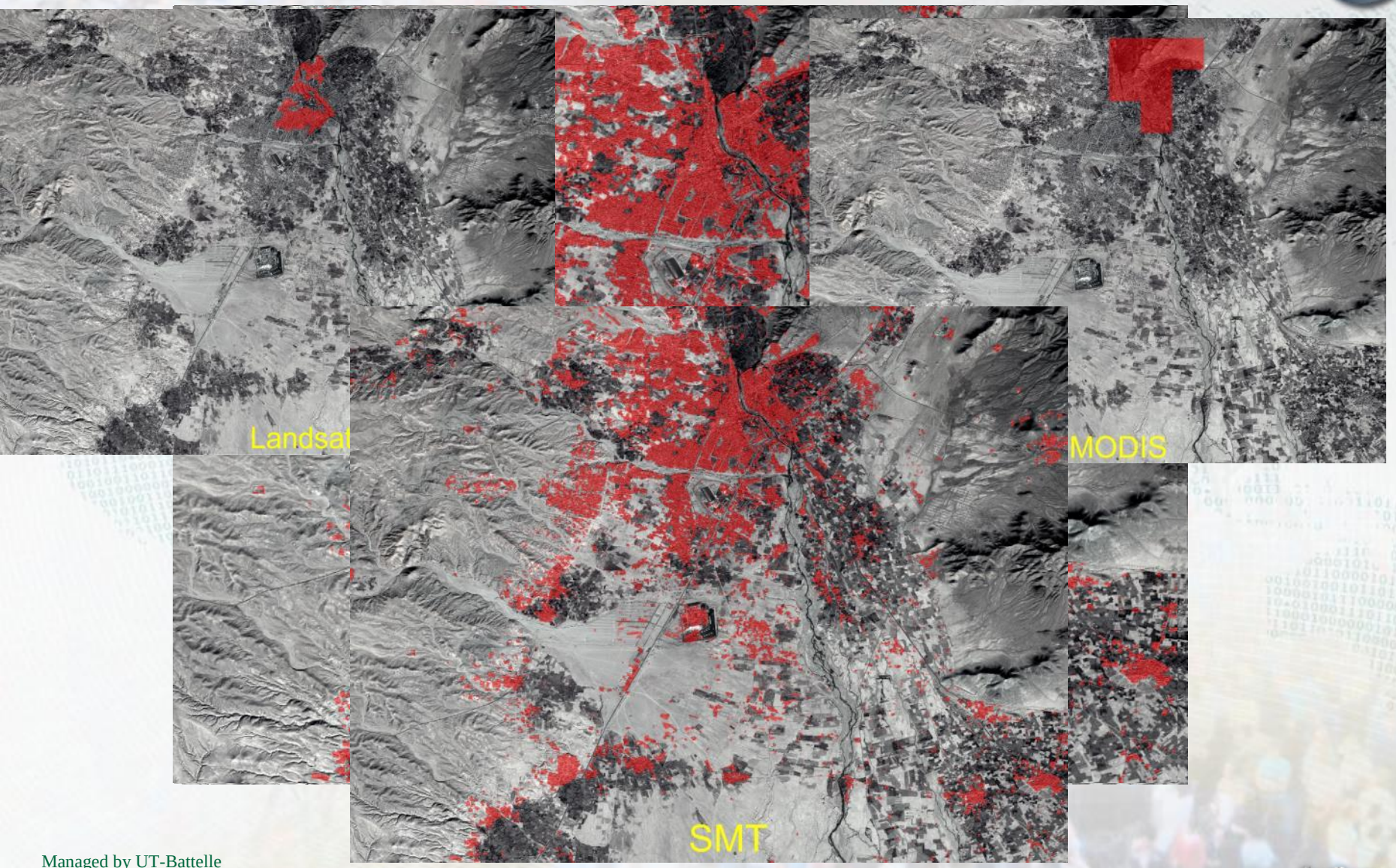

What is LandScan?

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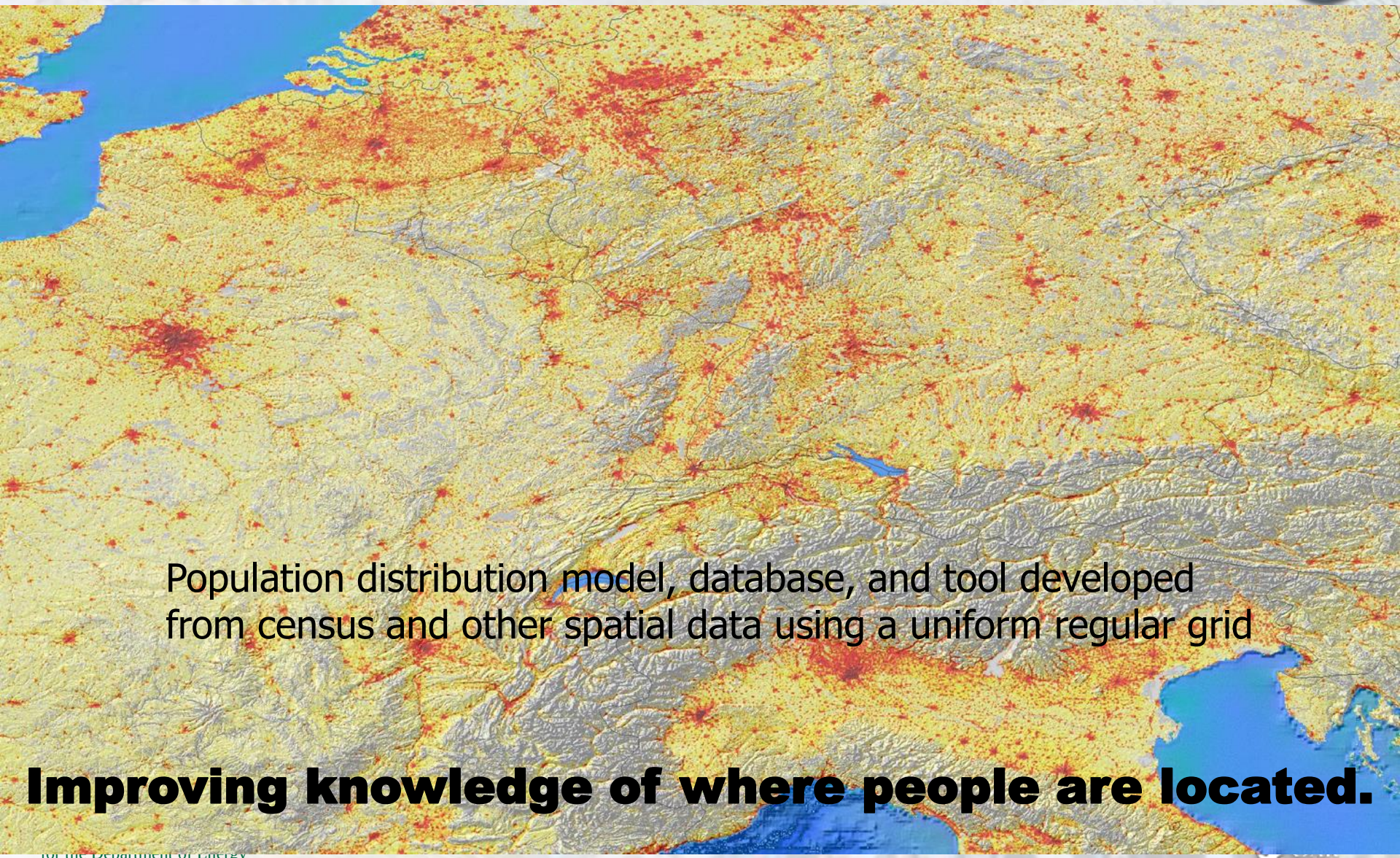

Population distribution model, database, and tool developed from census and other spatial data using a uniform regular grid

Improving knowledge of where people are located.

How Is LandScan Developed?

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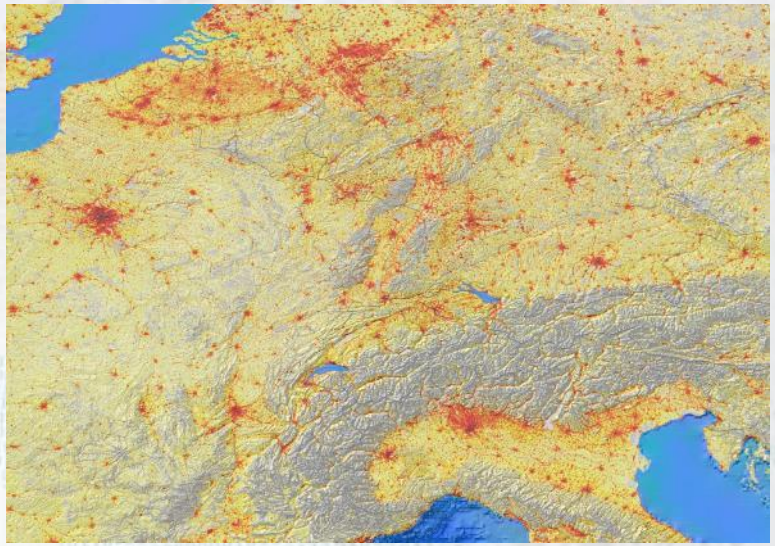

- Dasymetric Spatial Modeling
- Distribute best available census counts to LandScan cells based on a likelihood coefficient calculated by spatial models
- Model structure is the same everywhere, but weights for each variable are tailored to each country
- Similar operations performed for each data layer and outputs are mathematically combined
- Population is allocated to each cell

H	H	H	L	L	F
H	H	H	L	F	W
H	L	L	L	F	W
H	L	F	W	W	W
L	L	F	W	W	W
L	F	F	W	W	W

H: High Density Residential
L: Low Density Residential
F: Evergreen Forest
W: Water

150	150	150	90	90	4
150	150	150	90	4	0
150	90	90	90	4	0
150	90	4	0	0	0
90	90	4	0	0	0
90	4	4	0	0	0

Aggregated to Coefficient Cell Size

1230	372
526	0

3250	630
1120	0

325	63
112	0

$$Population_{Cell\,i,j} = PC_{Block} \times W_{Cell\,i,j}$$

$$PC_{Block} = \frac{Total\ Population_{Block}}{\sum_{1}^{n} W_{Cell\,i,j}}$$

Product of additional data types
(e.g. distance from roads, slope, etc.)

$$W_{Cell\,i,j} = LC_{i,j} \times PR_{i,j} \times S_{i,j} \times LM_{i,j}$$

Test Area- Ghazni Province Afghanistan

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Ghazni Province Settlement Results

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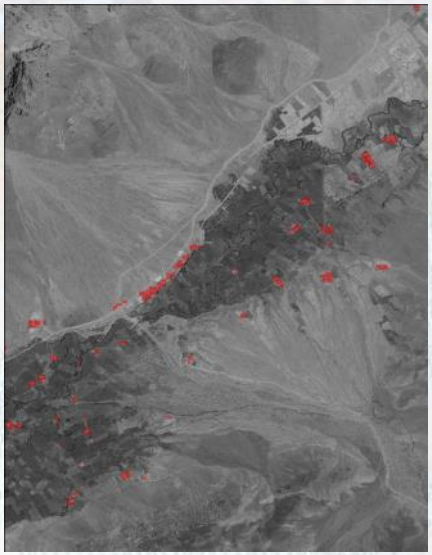

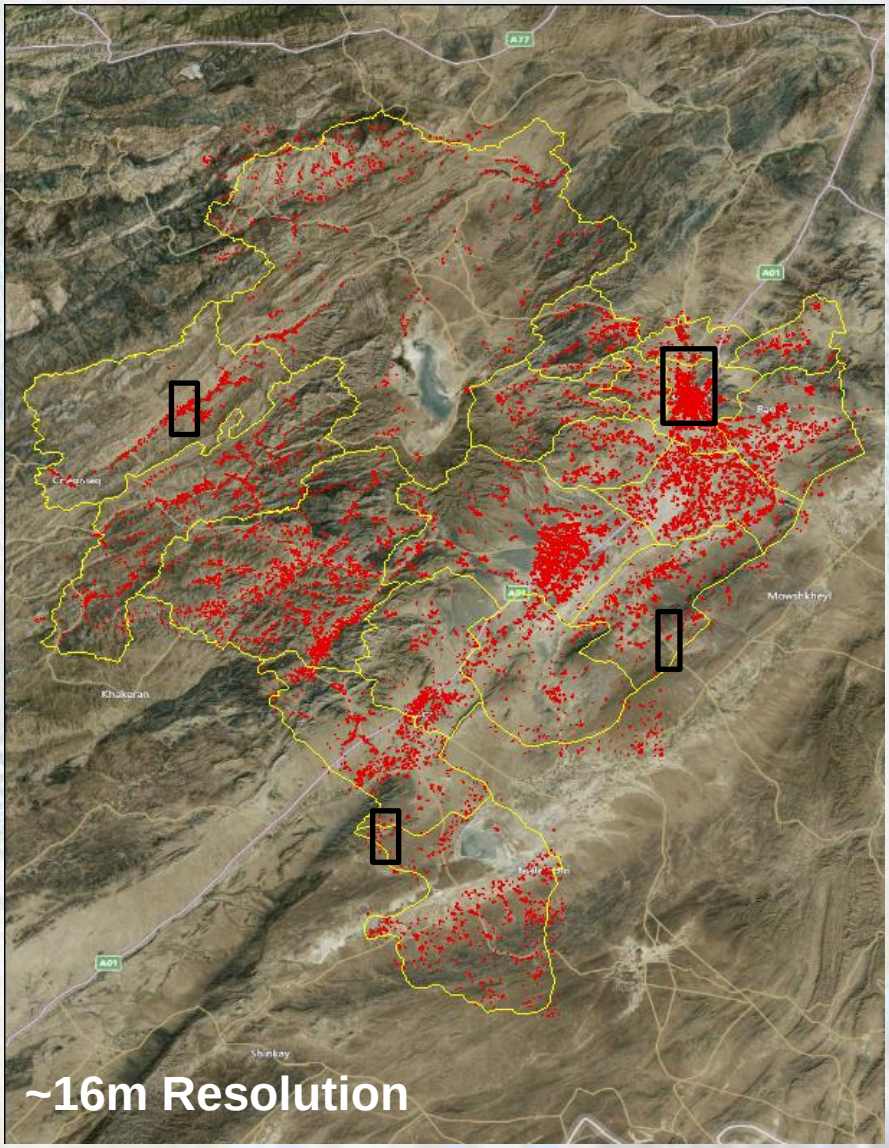

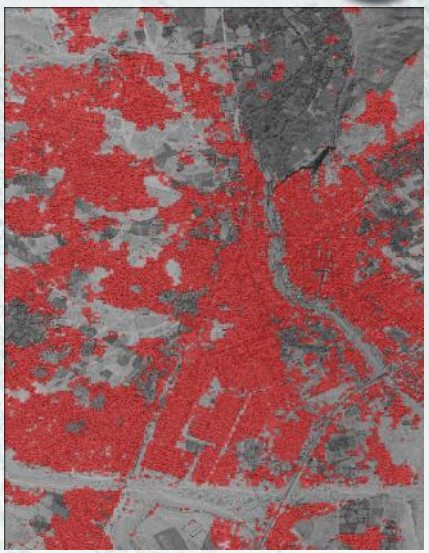

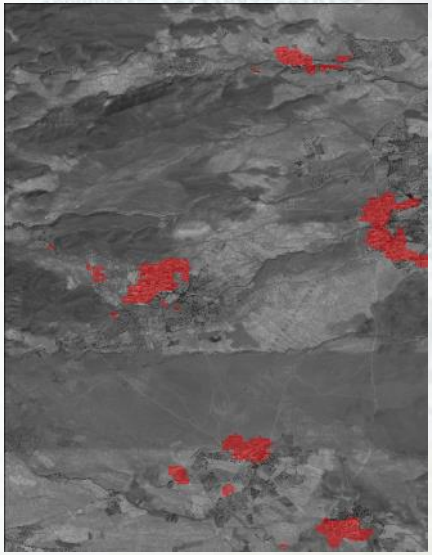

Settleme

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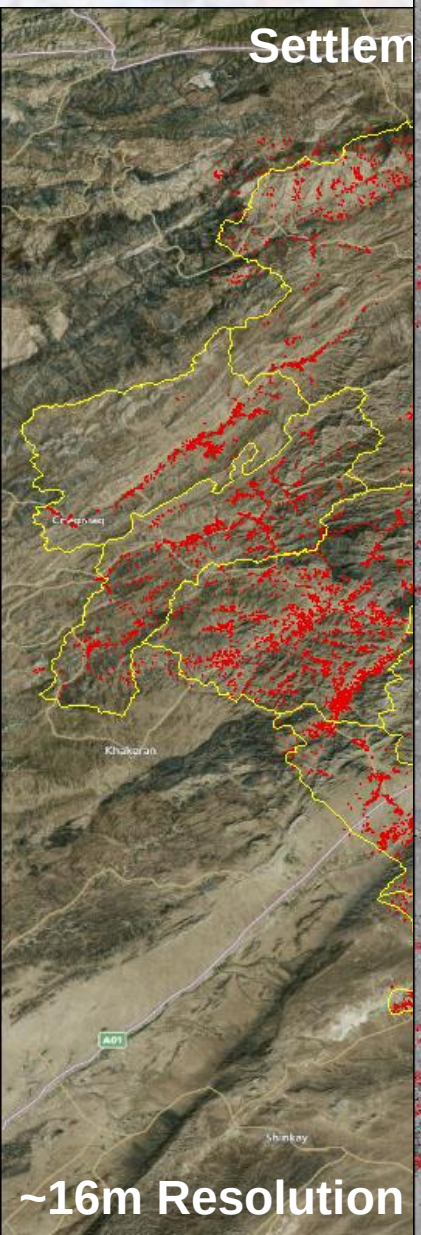
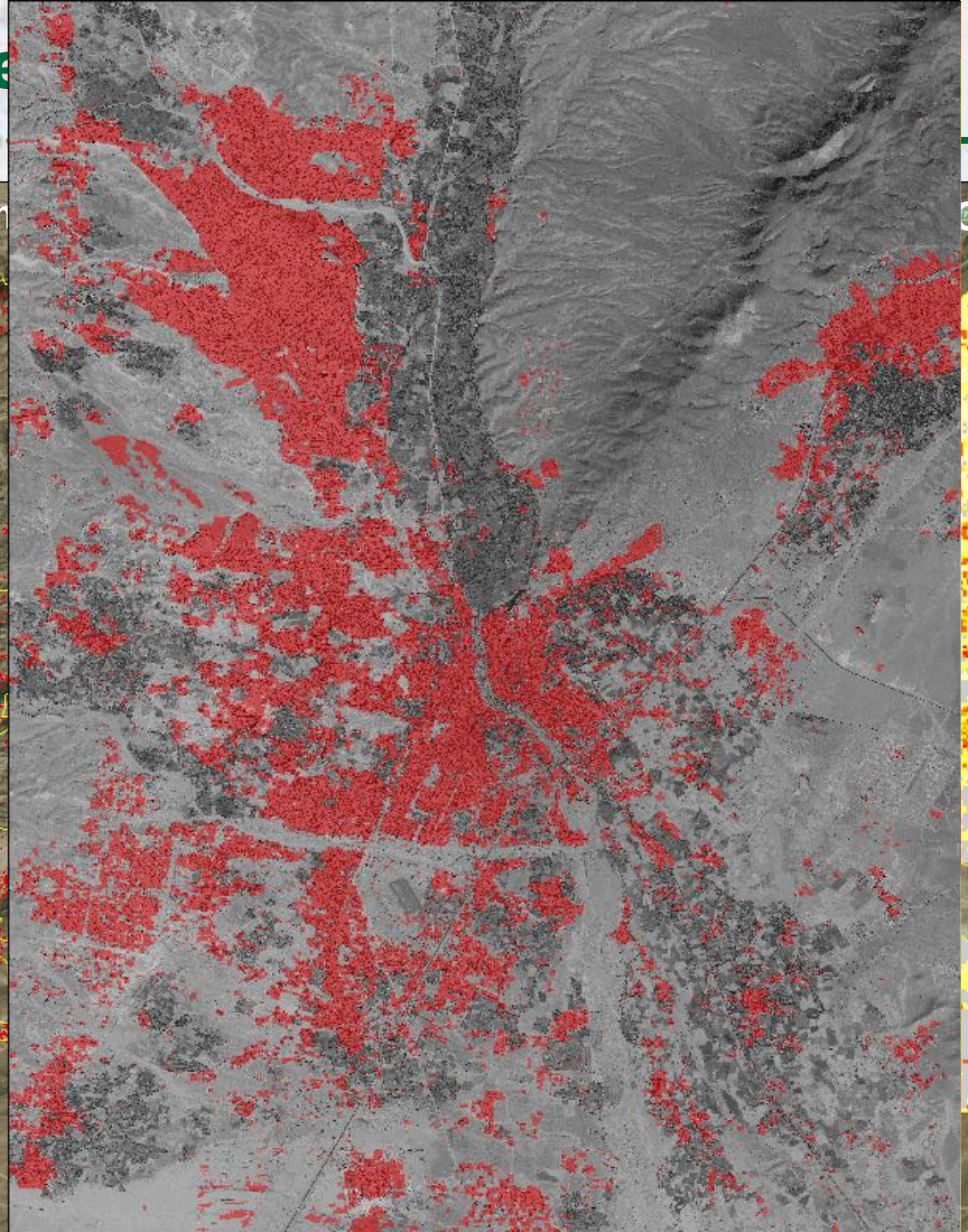
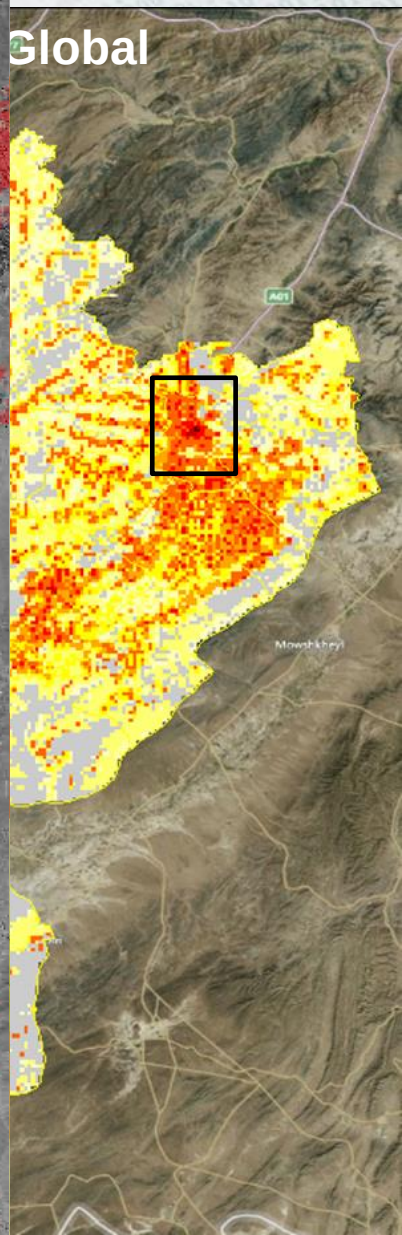






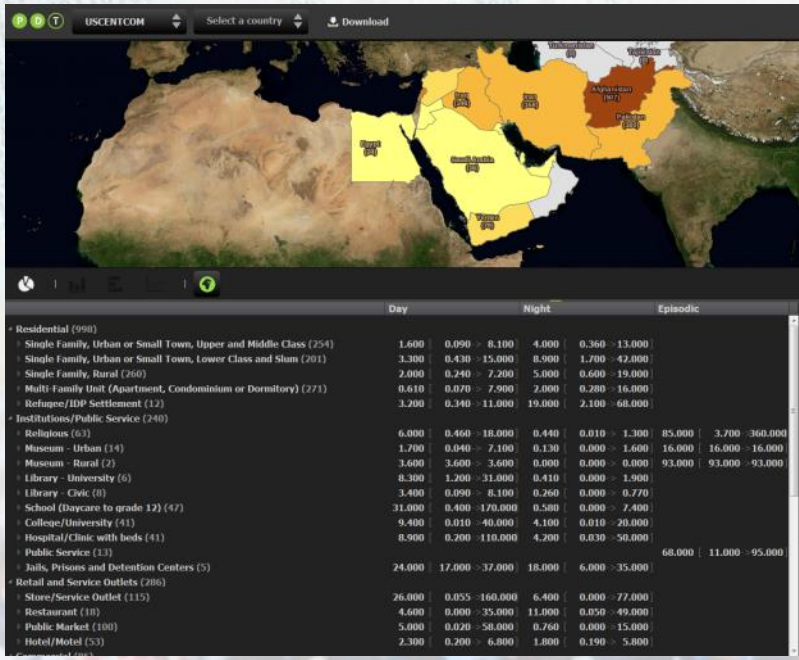
Using Settlements in Population Model

- **Weighted Settlement Results by size and building distribution**

H	H	H	L	L	L
H	H	H	L	L	L
H	L	L	L	L	RS
H	L	L	RD	RS	RD
L	L	L	RD	RD	RD
L	F	L	RD	RS	RS

H: High Density Residential
L: Low Density Residential
RD: Rural Dense
RS: Rural Sparse

- **Used Population Density Tables to help with building distribution**
- **Tested at the Settlement output at 16m pixel size**
- **Currently testing aggregating up pixel sizes to test outputs**



Population Results- 16 Meters

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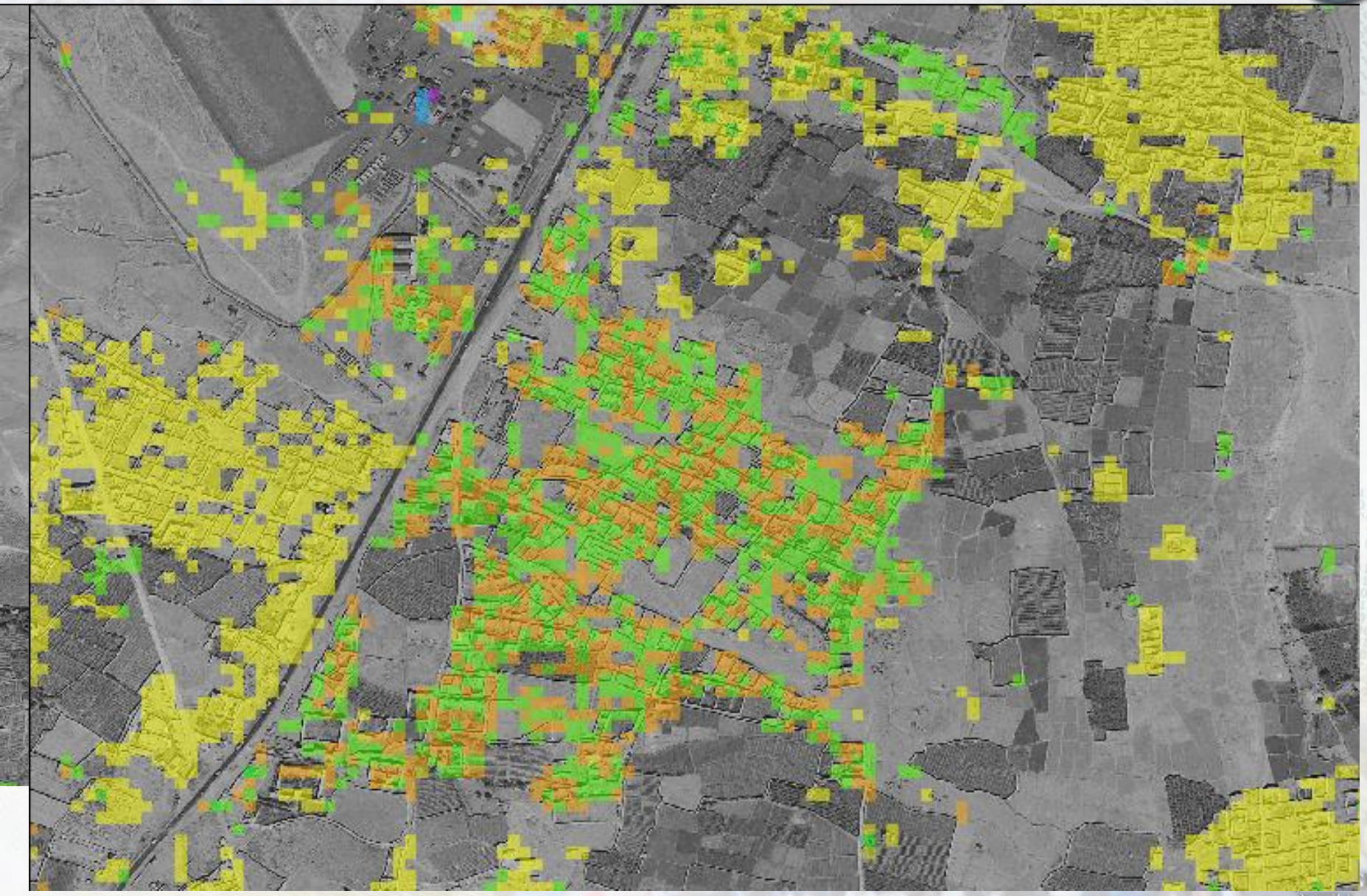

Future Work

- **Next Steps……**
- **Define different weighting systems and test**
  - Depending on Location and Building Types Associated
  - Low, Medium, High Distribution Numbers
- **Test on more than one province**
- **Accuracy Assessments**

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