Mapping Vulnerable Populations in Rural Afghanistan

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Geography 592
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The Problem

- Available population maps of Afghanistan are aggregated at the district level
- District-level population generally not useful for identifying vulnerable populations

Research Goal

- Analyze existing data sources for clues to population distribution
- Create a dasymetric map useful for vulnerability analysis

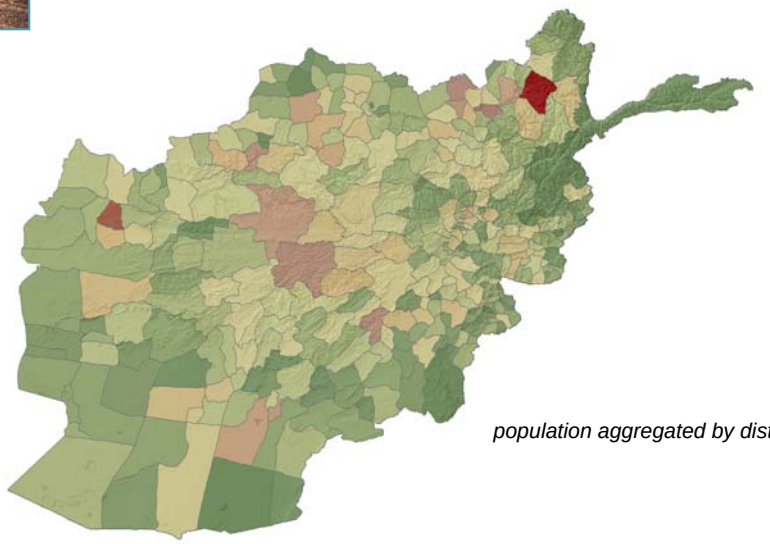
Methods

- Typical dasymetric maps use geographic attributes to create areas within which population is distributed
- Our map makes assumptions about spatial indicators based on known settlement locations, and then disaggregates district population to the settlement level
- Statistically interprets extensive data on settlement locations to calculate specific weights to model the influence of selected attributes

Possible Applications

- Locate Key Services More Effectively
- Emergency/Disaster Relief Efforts
- Food Security Analysis
- Internally Displaced Populations

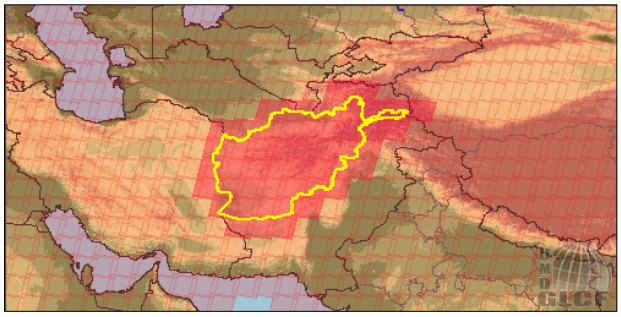
Rural Population Data



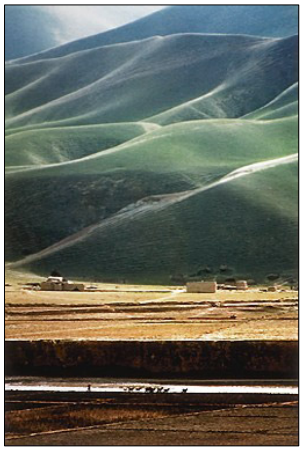
population aggregated by district

Data Layers

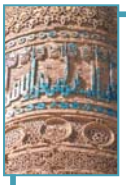
- Elevation
- Landcover
- Slope
- Settlement Locations
- District Population



Elevation

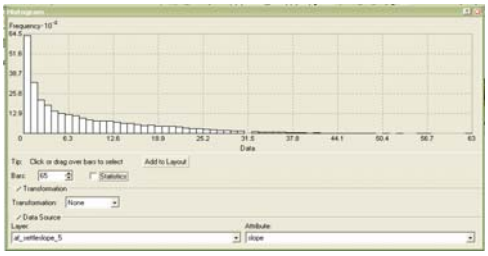


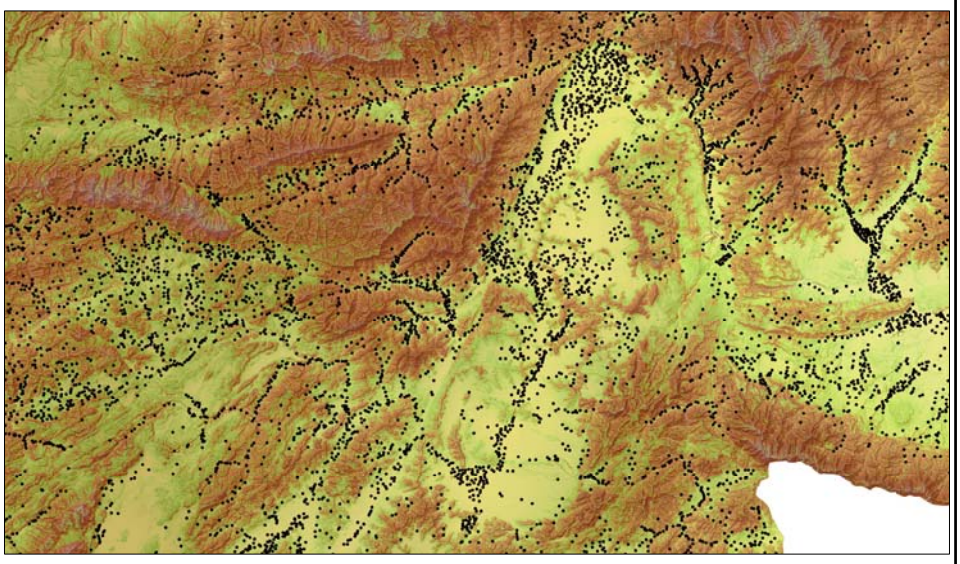
- Population density increases below an observed elevation limit
- Below this point, elevation correlates poorly with settlement locations
- Data did not reveal useable trends



Slope

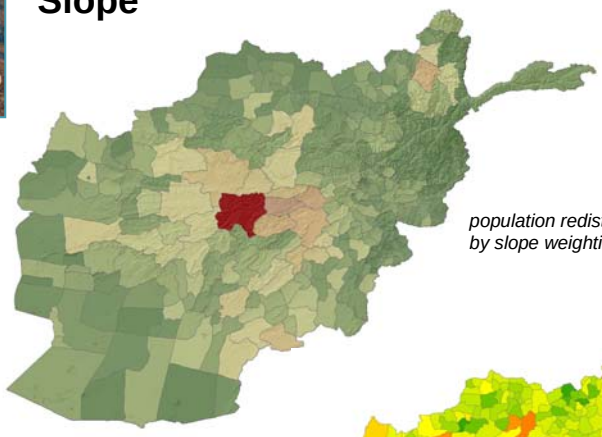
- Clear relationship observed between slope and settlement locations



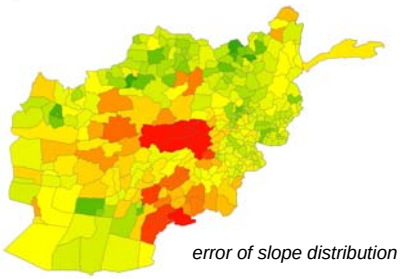


Correlation Between Slope and Settlement Locations

Slope



population redistributed by slope weighting



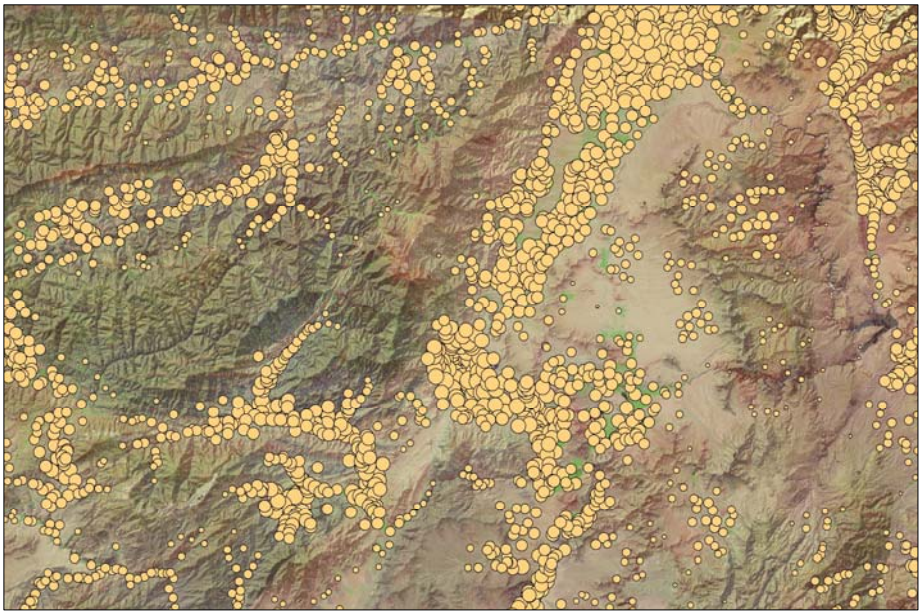
Mean error: 28,728

Unmodeled error: 29,787

error of slope distribution

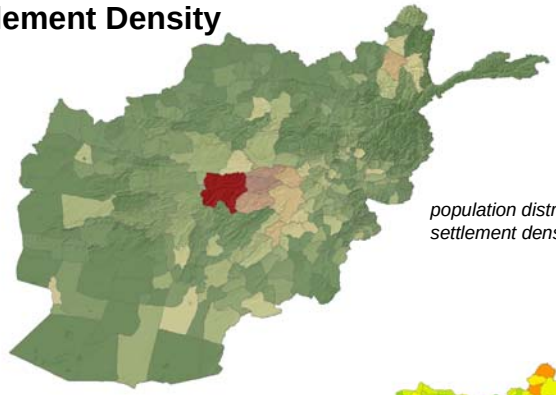
Settlement Density

- Assume that proximity to other settlements is an indicator of population density
- Weight density of settlements based on a 5km buffer

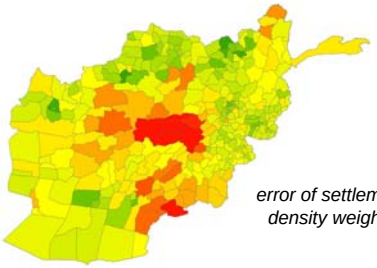


Settlements with 5km buffer

Settlement Density



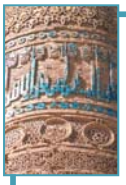
population distributed by settlement density weights



Mean error: 33,355

Unmodeled error: 29,787

error of settlement density weights

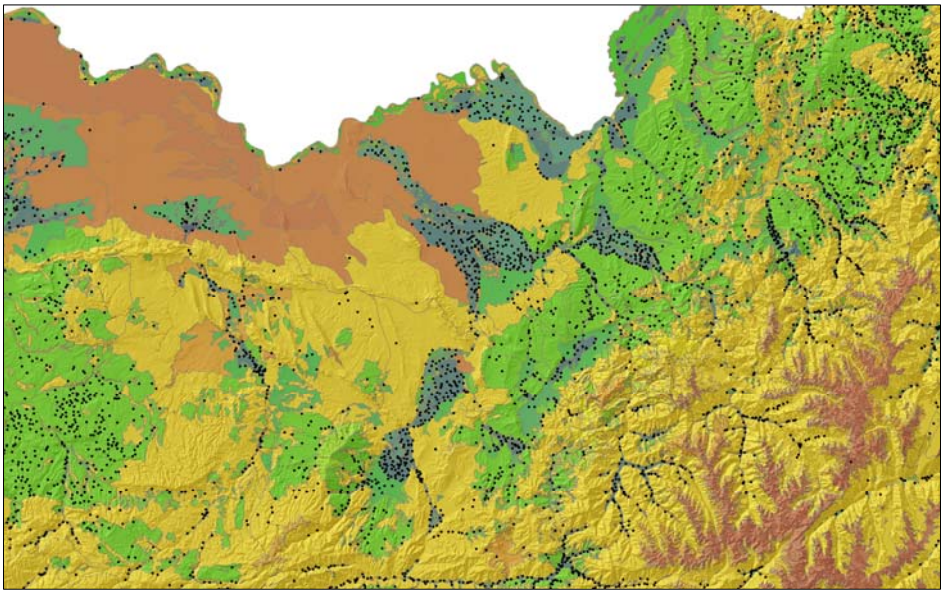


Landcover

- Manual classification of landcover types based on usefulness/economic value
- Statistically calculate settlement density for each landcover type:

$$\text{weight} = \frac{\text{settlements}}{\text{landcover class area}}$$

- Comparison of two methods showed strong correlation

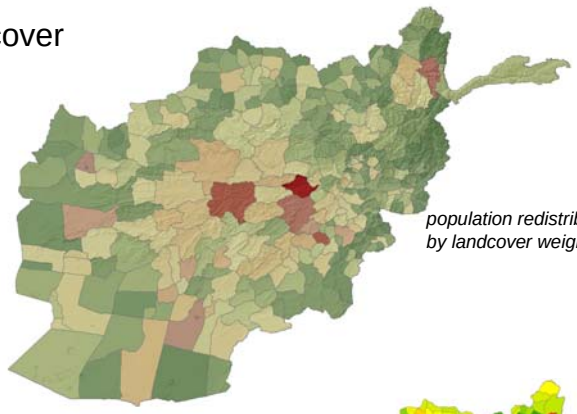


Correlation Between Landcover and Settlements

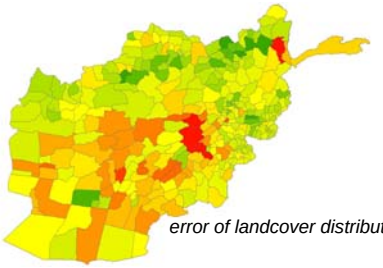
Landcover	Ours	Statistically Calculated
Permanent Snow	0	0.00
Sand Dunes	0	0.01
Sand Covered Areas	1	0.01
Pistachio Forest	1	0.04
Rock Outcrop / Bare Soil	1	0.14
Marshland Seasonal	0	0.25
Water Bodies	0	0.25
Rangeland (grassland/forbs/low shrubs)	1	0.27
Natural Forest (closed cover)	1	0.30
Natural Forest (open cover)	1	0.30
Degenerate Forest/High Shrubs	1	0.32
Rainfed Crops (sloping areas)	1	0.51
Marshland Permanently inundated	1	0.58
Rainfed Crops (flat lying areas)	2	0.64
Irrigated: Intermittently Cultivated	2	1.54
Settlements	5	2.25
Irrigated: Intensively Cultivated (2 Crops/year)	4	2.36
Gardens	3	2.60
Irrigated: Intensively Cultivated (1 Crop/Year)	5	3.26
Vineyards	4	4.80
Fruit Trees	3	5.00

How our landcover rankings compare to the statistically calculated rankings

Landcover



population redistributed by landcover weighting



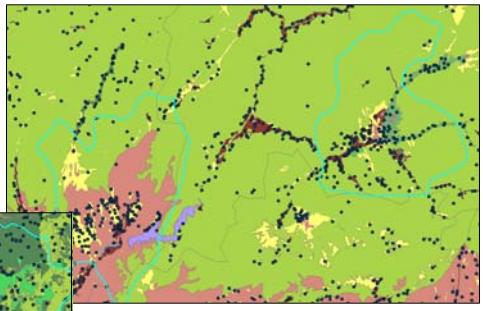
Mean error: 25,812

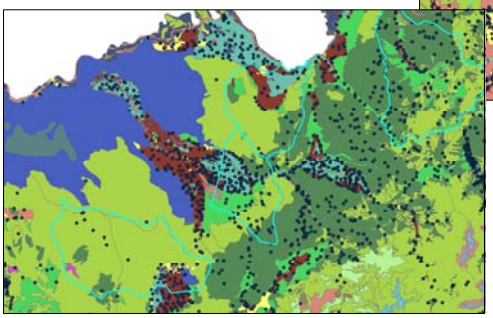
Unmodeled error: 29,787

error of landcover distribution

Finding the Perfect Map…

- Some outlying districts in landcover classification



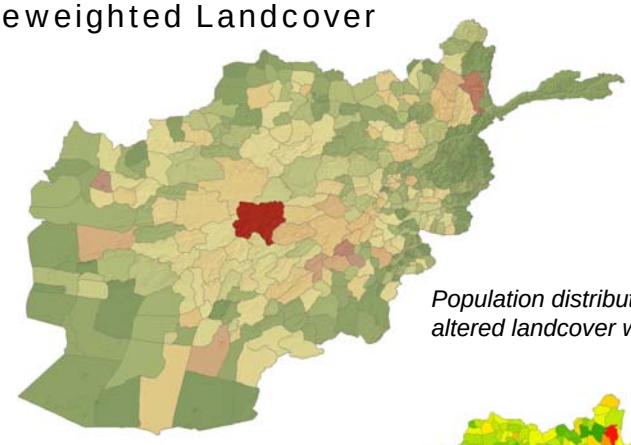


- Need to re-weight by examining landcover type in "outlier districts"

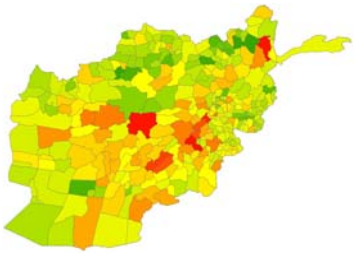
Altered Landcover Weights

Landcover	Statistically Calculated	Altered Weight
Permanent Snow	0.00	0
Sand Dunes	0.01	0
Sand Covered Areas	0.01	0.01
Pistachio Forest	0.04	0.05
Rock Outcrop / Bare Soil	0.14	0.17
Marshland Seasonal	0.25	0.31
Water Bodies	0.25	0.31
Rangeland (grassland/forbs/low shrubs)	0.27	0.33
Natural Forest (closed cover)	0.30	0.38
Natural Forest (open cover)	0.30	0.38
Degenerate Forest/High Shrubs	0.32	0.4
Rainfed Crops (sloping areas)	0.51	0.63
Marshland Permanently inundated	0.58	0.73
Rainfed Crops (flat lying areas)	0.64	2.5
Irrigated: Intermittently Cultivated	1.54	1.25
Settlements	2.25	1.25
Irrigated: Intensively Cultivated (2 Crops/year)	2.36	4.4
Gardens	2.60	3.25
Irrigated: Intensively Cultivated (1 Crop/Year)	3.26	5
Vineyards	4.80	3.75
Fruit Trees	5.00	3.75

Reweighted Landcover



Population distributed by altered landcover weights

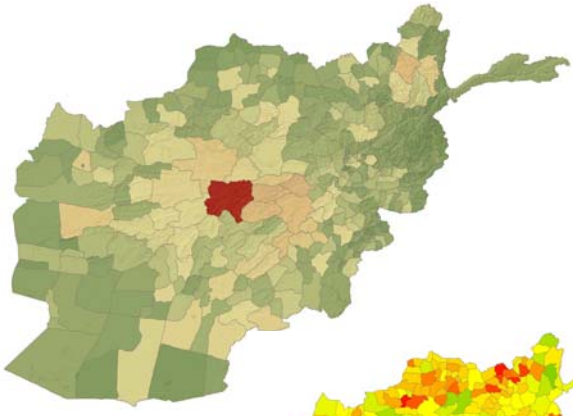


Mean error: 21,486

Original Landcover error: 25,812

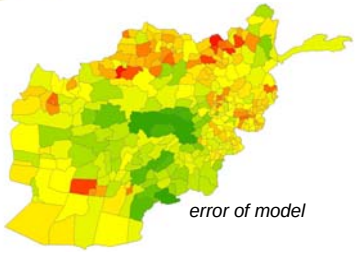
Unmodeled error: 29,787

Combined Models



Mean error: 23,658

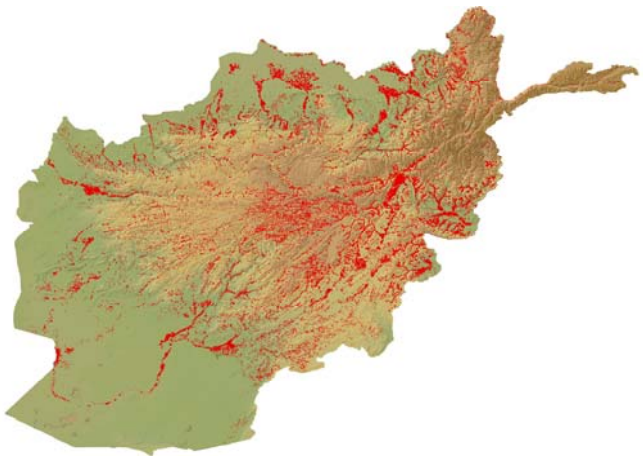
Unmodeled error: 29,787



error of model

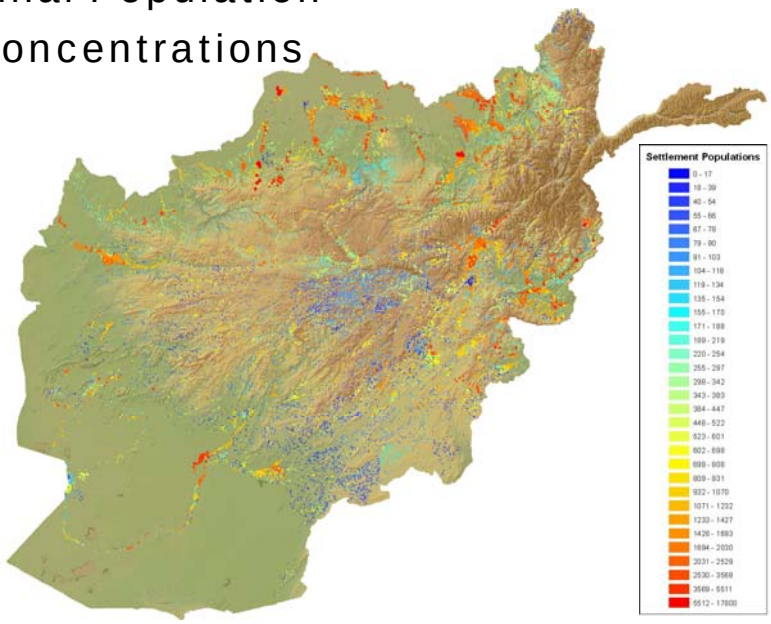
1.5 landcover + 1 slope

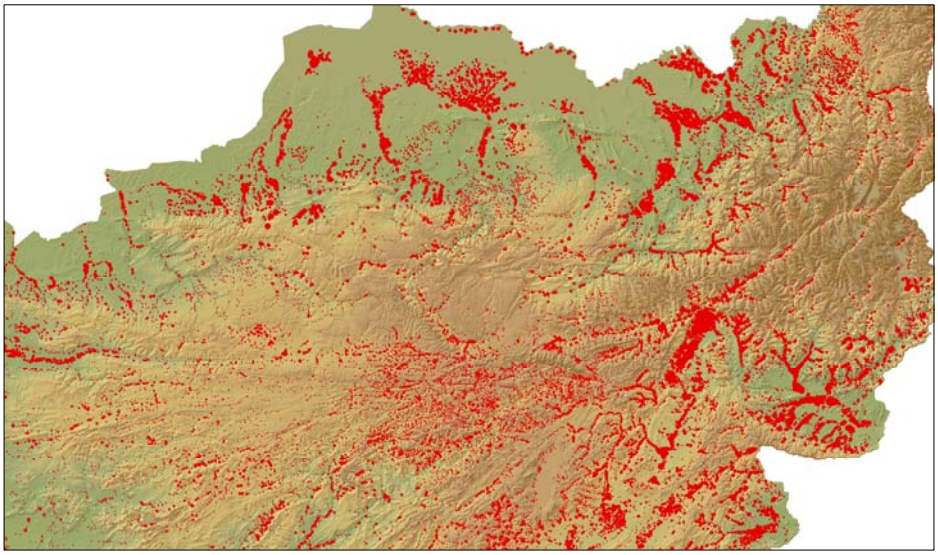
Population Locations



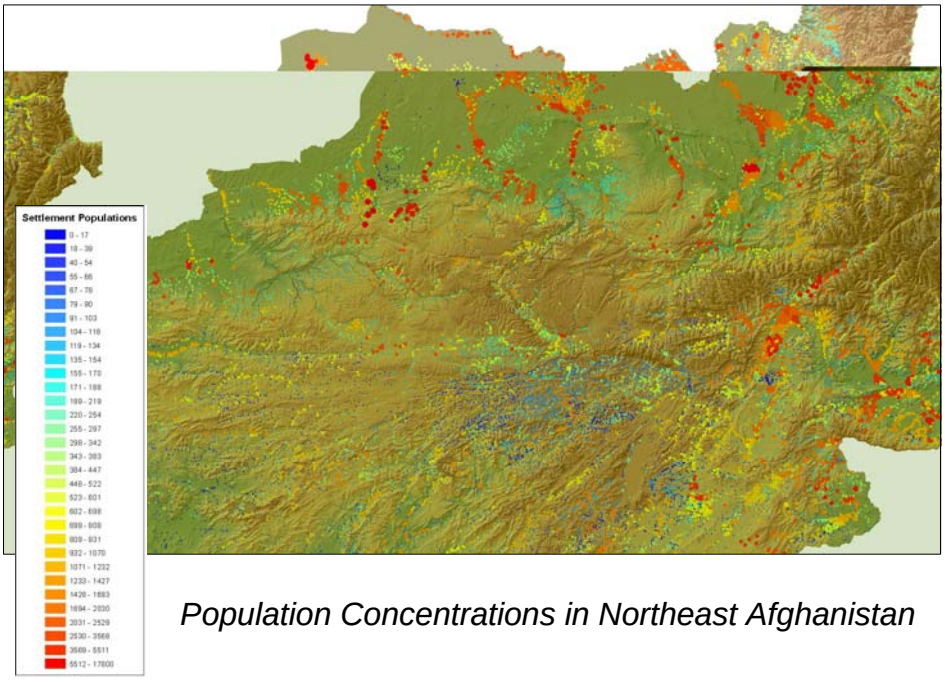
Final Population Map of Afghanistan with Our Population Distribution Model:
Based on Re-Weighted Landcover

Final Population Concentrations

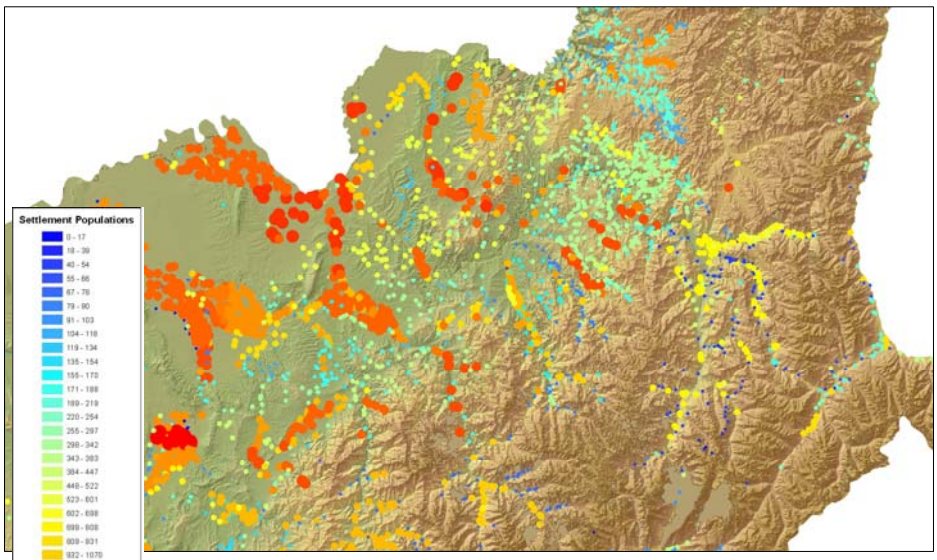




Populated Zones in Northeast Afghanistan



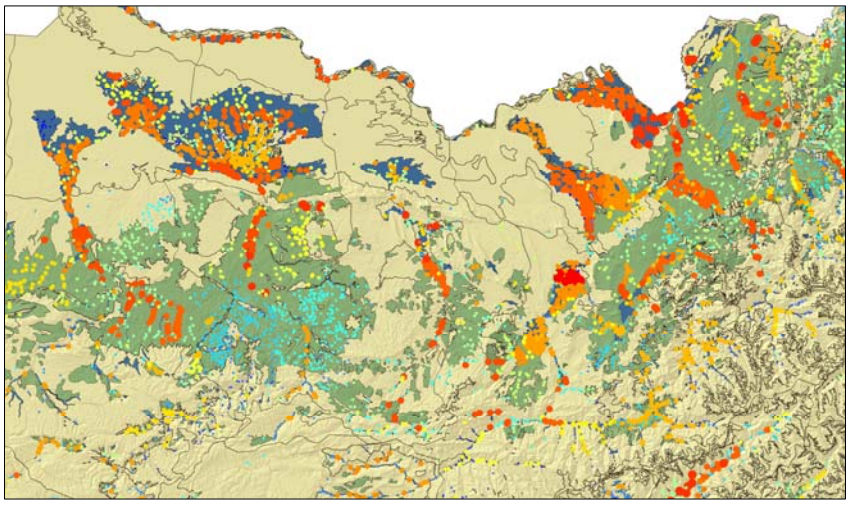
Population Concentrations in Northeast Afghanistan



Population Concentrations in North Afghanistan

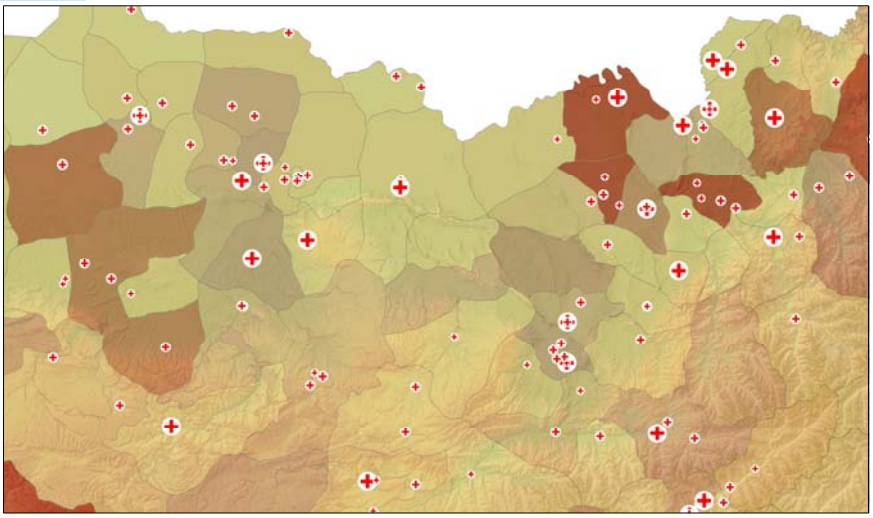
Applications:

Food Security



Applications:

Health Care



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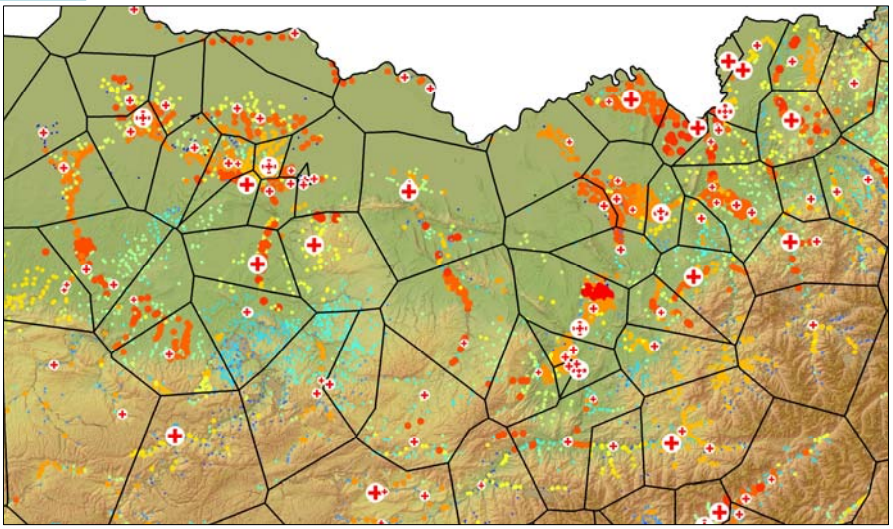
Health Care



Limitations and Pitfalls

- Results highly dependent on accuracy of original data layers
- Ecological Fallacy: Results interpret global characteristics and apply similar behavior at the local level
- Still many outliers in the mode. Further correction and adjustment needed to fit a better model

Questions?

Sources:

Afghanistan Information Management Service.
http://www.aims.org.af/

Vulnerability Analysis Unit:
Central Statistics Office - Ministry of Rural Rehabilitation and Development
http://www.mrrd.gov.af/vau/NRVA_2005.htm