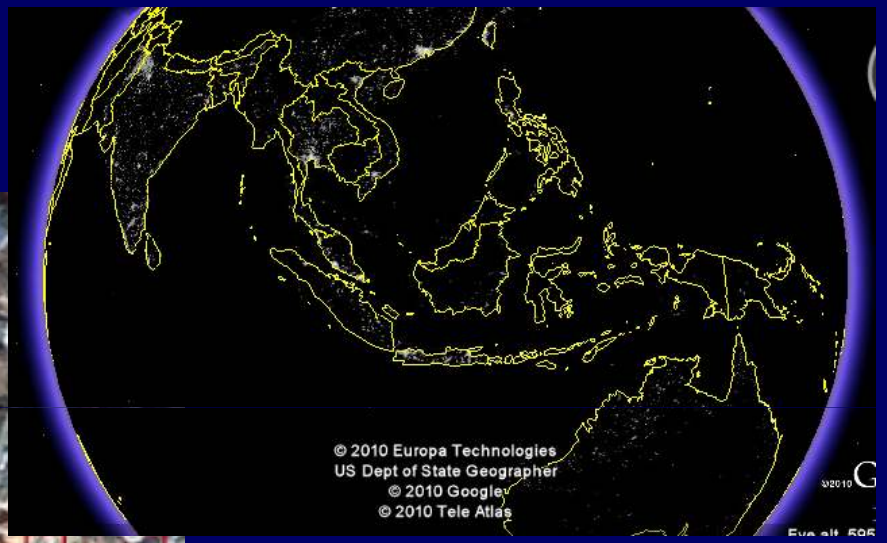
A 2010 Mapping of the Constructed Surface Area Density for S.E. Asia – Preliminary Results



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Outline

- **Motivation for Mapping Constructed Impervious Surfaces**
- **Methods: Data Acquisition**
  - **http://www.ngdc.noaa.gov/dmsp/imaps/isamapper/**
- **Methods: Regression Analysis**
  - **%ISA = B1*Nighttime Lights + B2* Population Density**
- **Results: Data Product - ISA of Southeast Asia at ~ 1km^2**
- **Discussion and Future Research**

Why Map Impervious Surface Area?

- **Constructed Areas (aka ISA) have significant environmental impacts**
  - **ISA alters sensible and latent heat fluxes – causing urban heat islands**
  - **In naturally vegetated areas anthropogenic ISA reduces carbon sequestration**
  - **ISA alters the character of watersheds by increasing frequency and magnitude of surface runoff pulses**
  - **ISA can alter the shape of stream channels, raising water temperatures, and sweeping urban pollutants into aquatic environments**
  - **ISA causes reduced surface water quality, increased flooding, and reductions in rates of groundwater recharge**
- **Anthropogenic Impervious Surface can be mapped globally at moderate spatial resolutions using satellite imagery**
  - **Anthropogenic ISA is typically associated with developed areas.**
  - **The relationship between human settlement density and ISA fraction is regionally variable**
- **Anthropogenic Impervious Surface is a significant and universal proxy measure of human impact on the environment**

Sutton, Paul C.; Anderson, Sharolyn, J.; Elvidge, Christopher D.; Tuttle, Benjamin, T.; Ghosh, Tilottama (2009)
Paving the Planet: *Impervious Surface as a Proxy Measure of the Human Ecological Footprint* Progress in Physical Geography 33(4) pp. 1-18

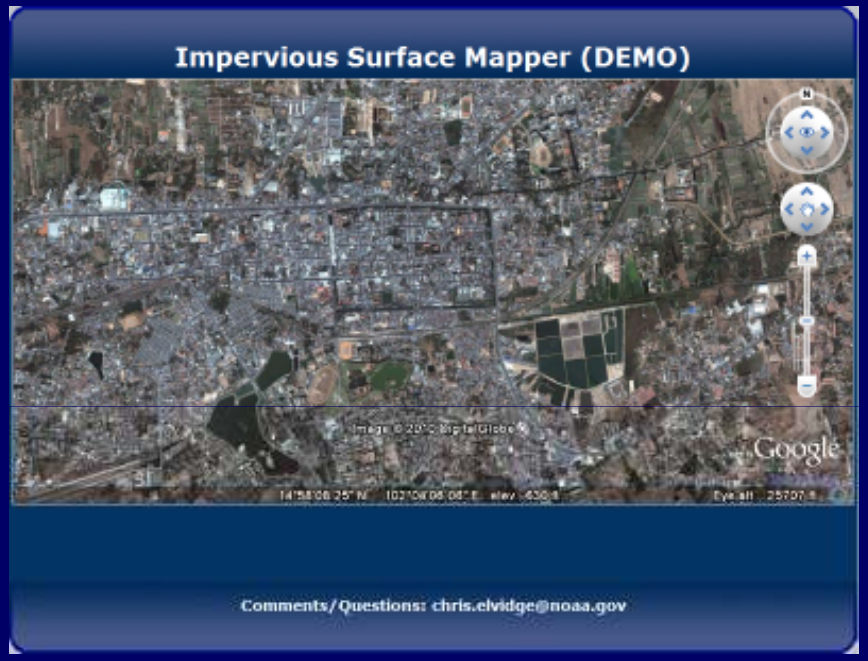
Christopher Elvidge; Benjamin Tuttle; Paul C. Sutton; Kimberly E. Baugh; Ara T. Howard; Christina Milesi; Budhendra Bhuduri, Ramakrishna Nemani (2007)
Global Distribution and density of Constructed Impervious Surfaces Sensors 2007, 7, pp 1962-1979

Methods: Data Acquisition

We affectionately refer to this
Web application as "The ISA Picker"
We have spent many hours using it.
It uses a Google Earth Plug in with
A web browser and enables a user
To log in, zoom to any area of the
Earth, and choose a DMSP 'pixel' to
Classify according to the following
Classification Scheme:

http://www.ngdc.noaa.gov/dmsp/imaps/isamapper/

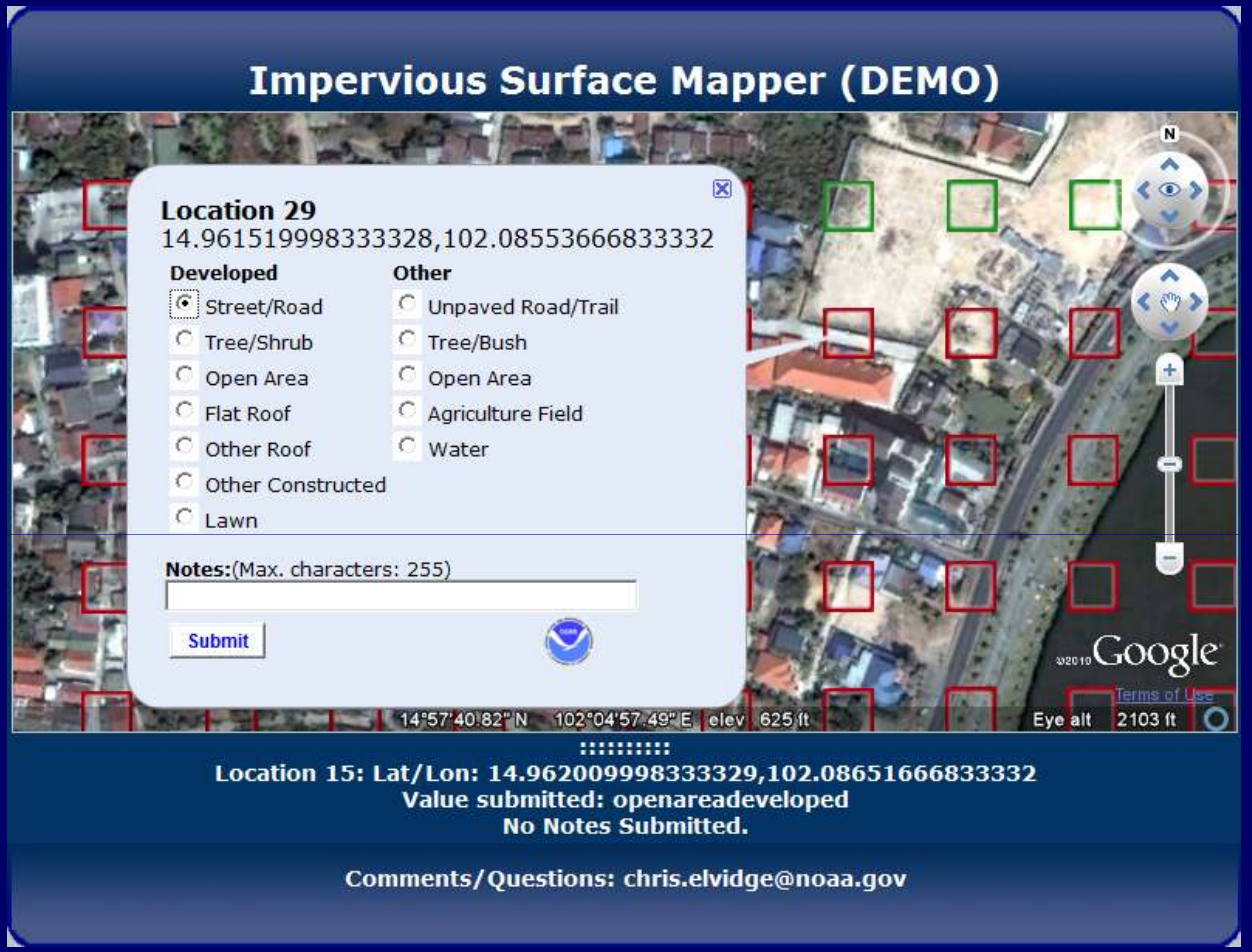
The Town of Nakhon Ratchasima, Thailand
Population ~150,000



High Resolution Satellite Imagery from Google Earth is used to classify A sample of pixels from SE asia.

DMSP OLS imagery overlaid as A KML file via the Google Earth Plug-in

Image Classification with the Light Picker



In this preliminary study we have done this about 10,000 times to produce about 35 data points to build a regression model

Once a point sample has been classified it turns green

One pixel is a bit of work…

Our dependent variable:
"% Constructed Area" is
Determined by the fraction
Of the 256 (16 x 16 red square point samples in each DMSP Pixel)
That are classified as one of the following 'Developed' categories:
'Street/Road', 'Flat Roof', 'Other Roof' or 'Other Constructed'

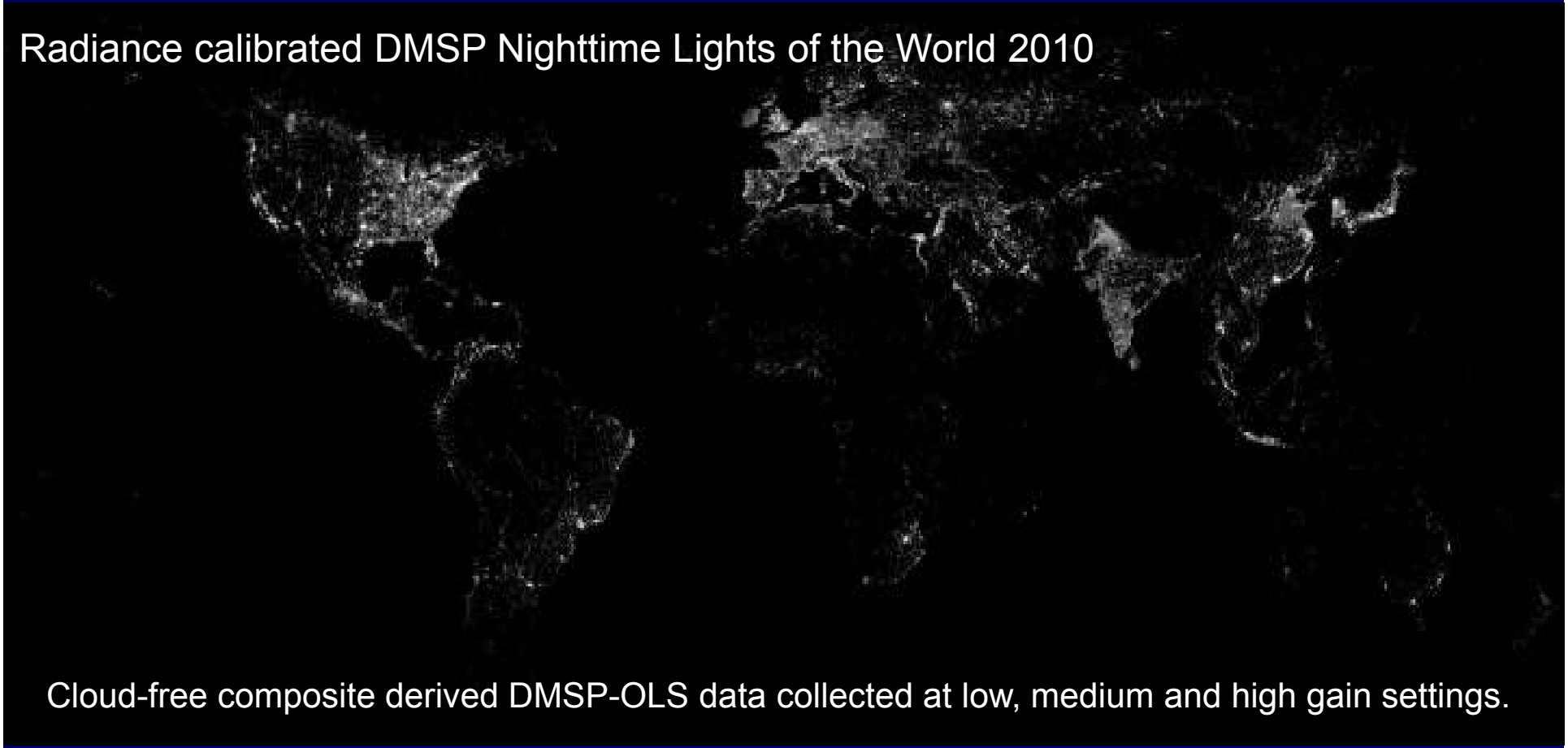
Regression Model Development

- **We use a DMSP OLS nighttime lights dataset and the Landscan Population dataset to predict % Constructed Area as follows:**

- **% Cons. Area = $\beta 1 * \text{DMSP DN}_{\text{value}} + \beta 2 * \text{Landscan}$**

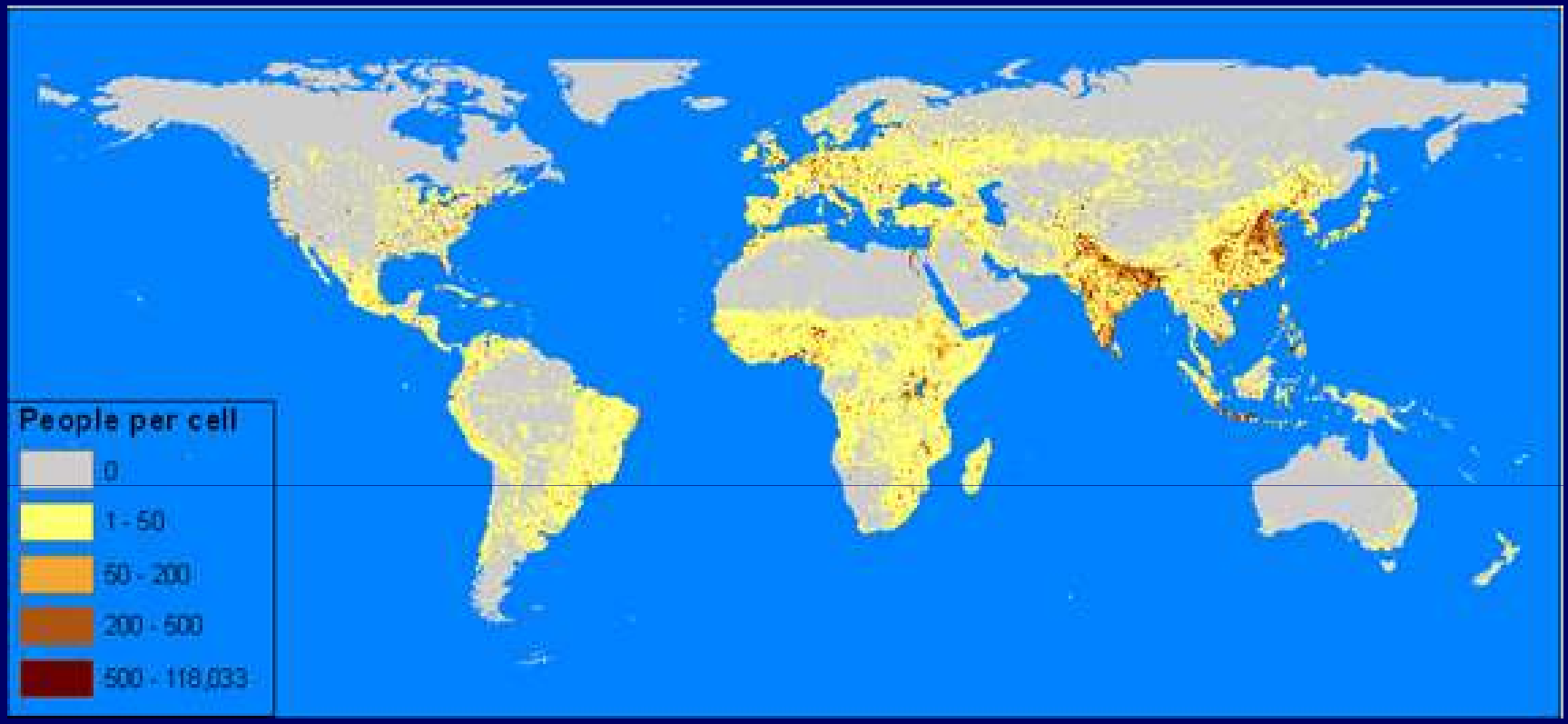
- **This model will produce non-zero Constructed Area percentages in areas with no light and in areas with no population.**

Radiance Calibrated image of 2010 (F16)



30 arc-second grid or approximately 1 km^2 at the equator

2008 LandScan population grid



- US Laboratory Department of Energy, Oak Ridge National Laboratory
- Representing ambient population count per cell
- 30 arc-second grid or approximately 1 km^2 at the equator

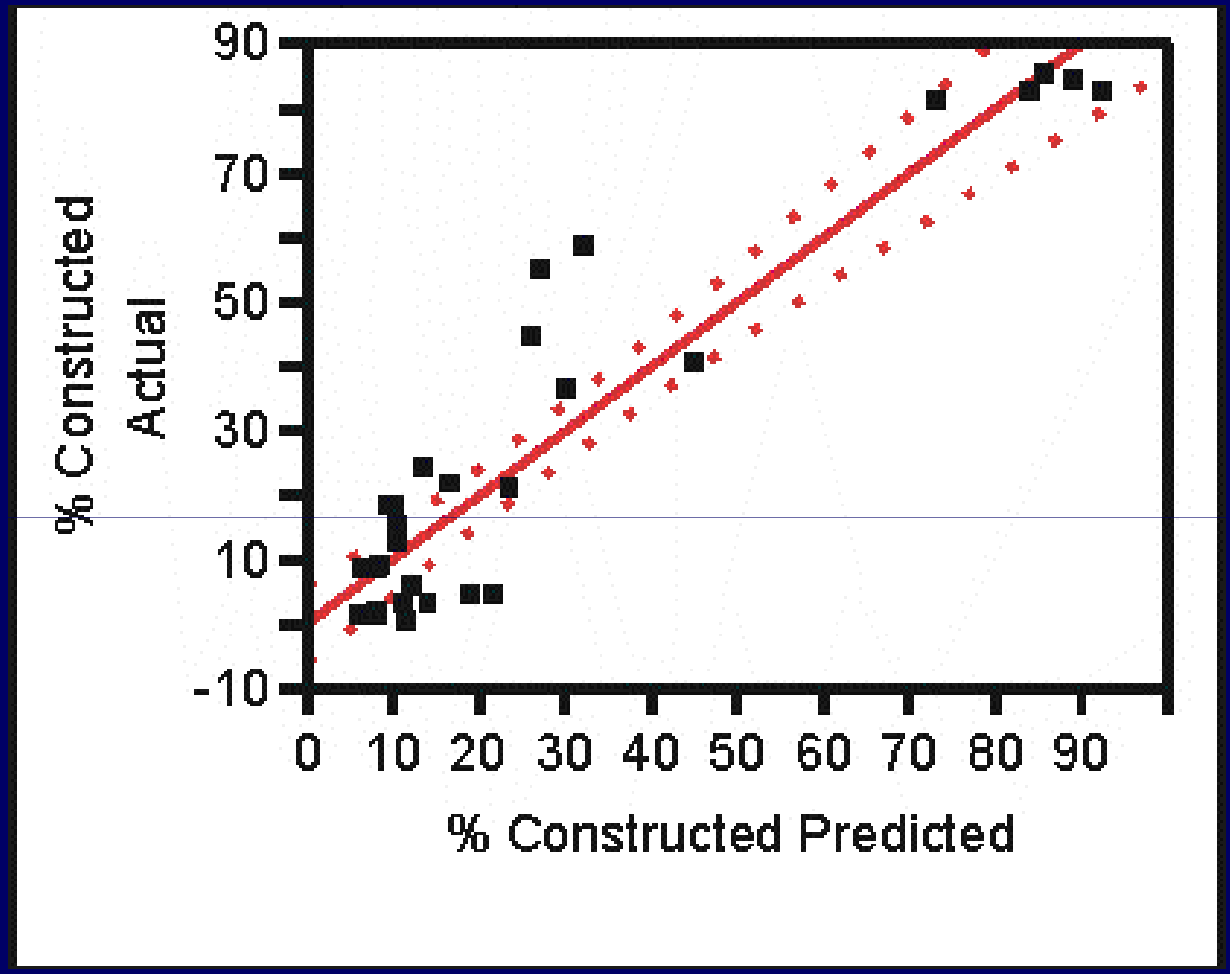
Parameter Estimation

$R^2 = 0.87$

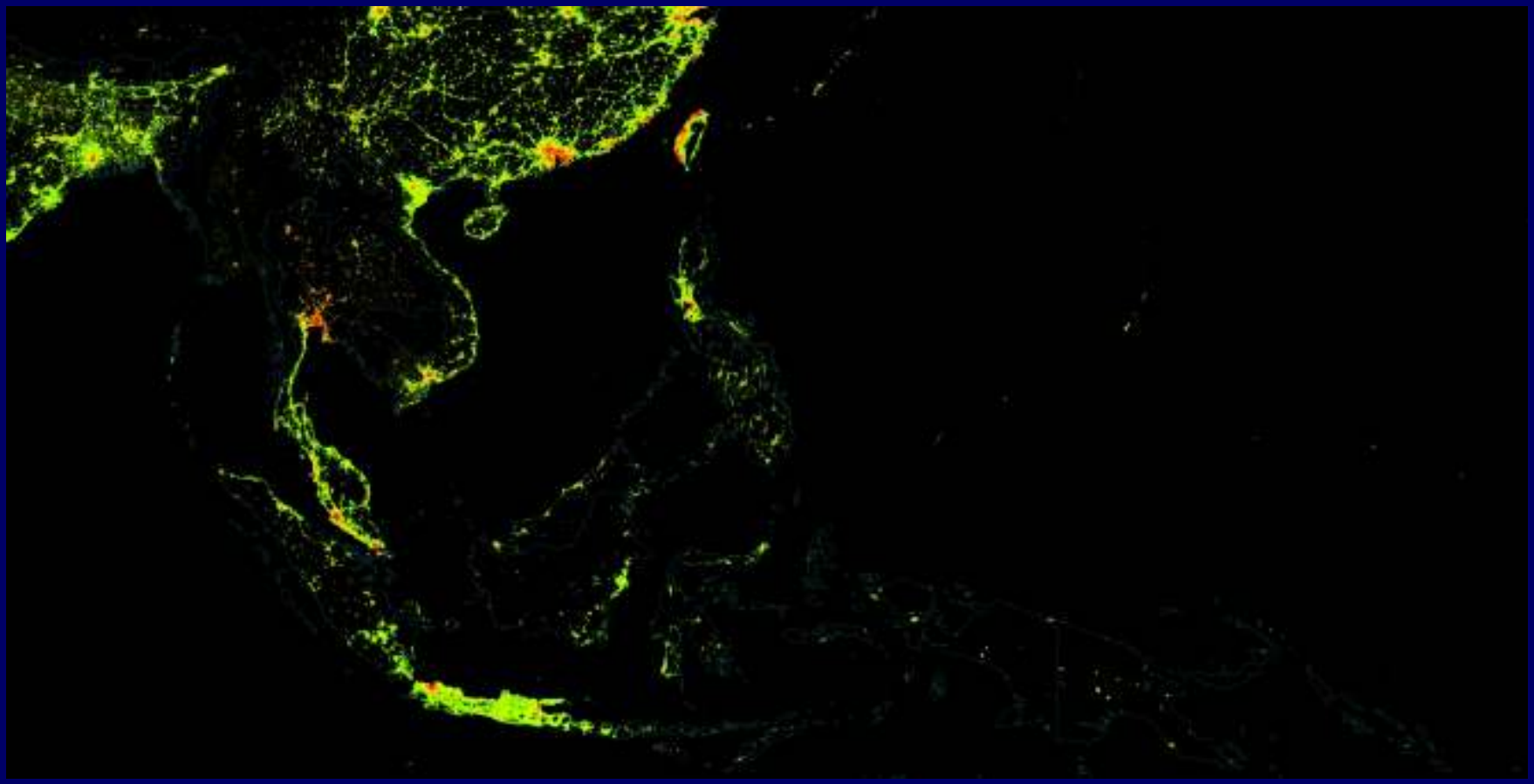
$\alpha = 0.0$ (forced)

$\beta 1 = .182$

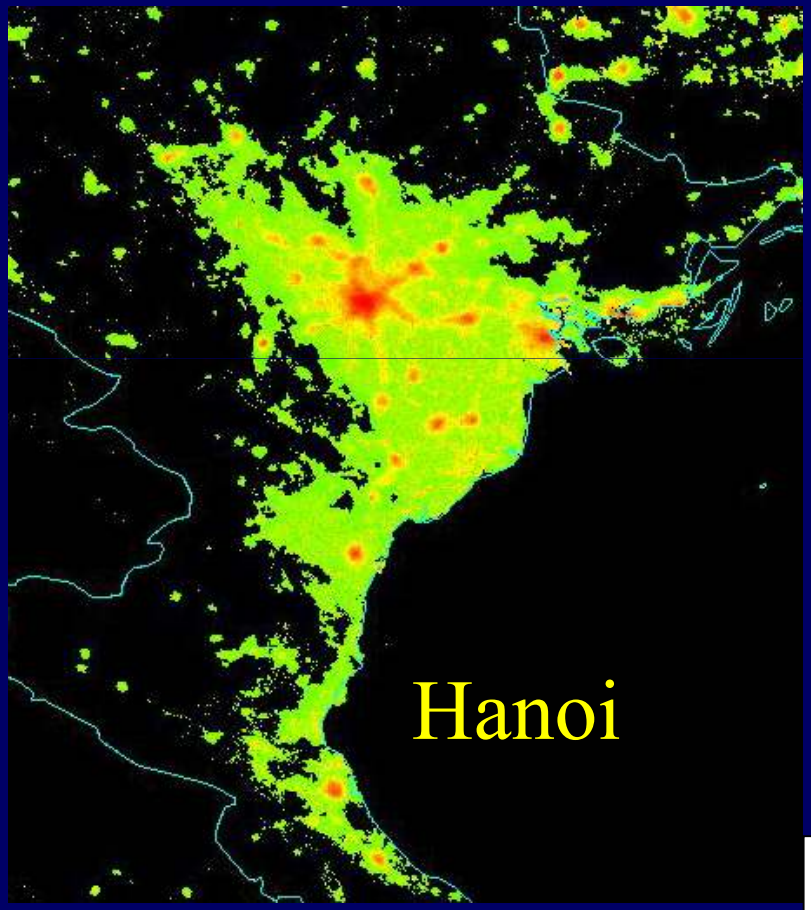
$\beta 2 = .00063$

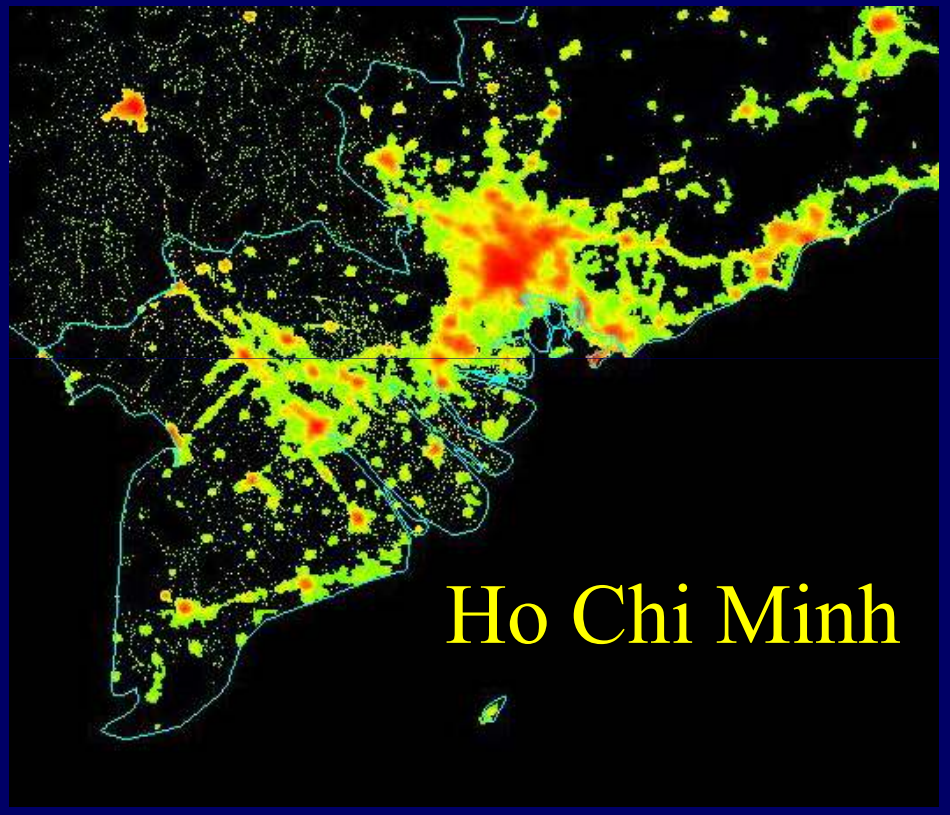


Constructed Area of South East Asia



Estimated Constructed Area of Hanoi and HCMC





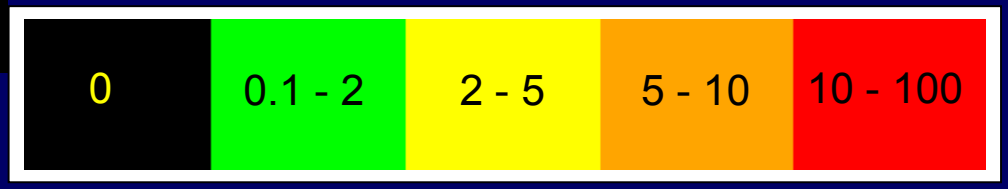


Table of Results

Countries	Population	Total Area (km^2)	Total ISA (km^2)	%ISA	GDP 2008 - (millions) US$	ISA (m^2)/person	GDP (millions)/ISA (km^2)
Brunei	318,930	5,804	114	1.97	19,559	359	171
Cambodia	14,282,900	182,857	117	0.06	28,408	8	242
East Timor	1,024,330	15,154	13	0.09	880	13	67
Indonesia	229,554,000	1,896,490	5,516	0.29	907,955	24	165
Laos	6,696,710	230,940	99	0.04	13,181	15	133
Malaysia	24,087,200	330,669	2,797	0.85	384,002	116	137
Myanmar (Burma)	46,965,100	670,705	392	0.06	?	8	?
Papua New Guinea	5,424,430	466,753	98	0.02	14,337	18	146
Philippines	90,491,600	296,755	1,452	0.49	317,352	16	219
Singapore	4,314,760	552	314	56.89	238,685	73	760
Thailand	64,857,000	515,058	3,511	0.68	544,913	54	155
Vietnam	84,658,300	326,884	2,295	0.70	240,292	27	105
Source of GDP data - World Bank website							

Conclusion

Preliminary Results Only (N ~30 pixels) We'd love to have others join us in the classification tasks on the 'ISA Picker' ☺

Regionalization of Parameter Estimation improves accuracy of estimation. Relative to prior studies in the U.S. it takes more light and more people to predict the same percentage of pavement in SouthEast Asia.

Richer dataset not being exploited because of our simple classification into constructed vs. not-constructed. Future research will explore the relative frequency of various categories on a regional and/or national basis.