

Relationships between Nighttime Imagery and Population Density for Hong Kong



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Outline

- **Introduction**
- **Data**
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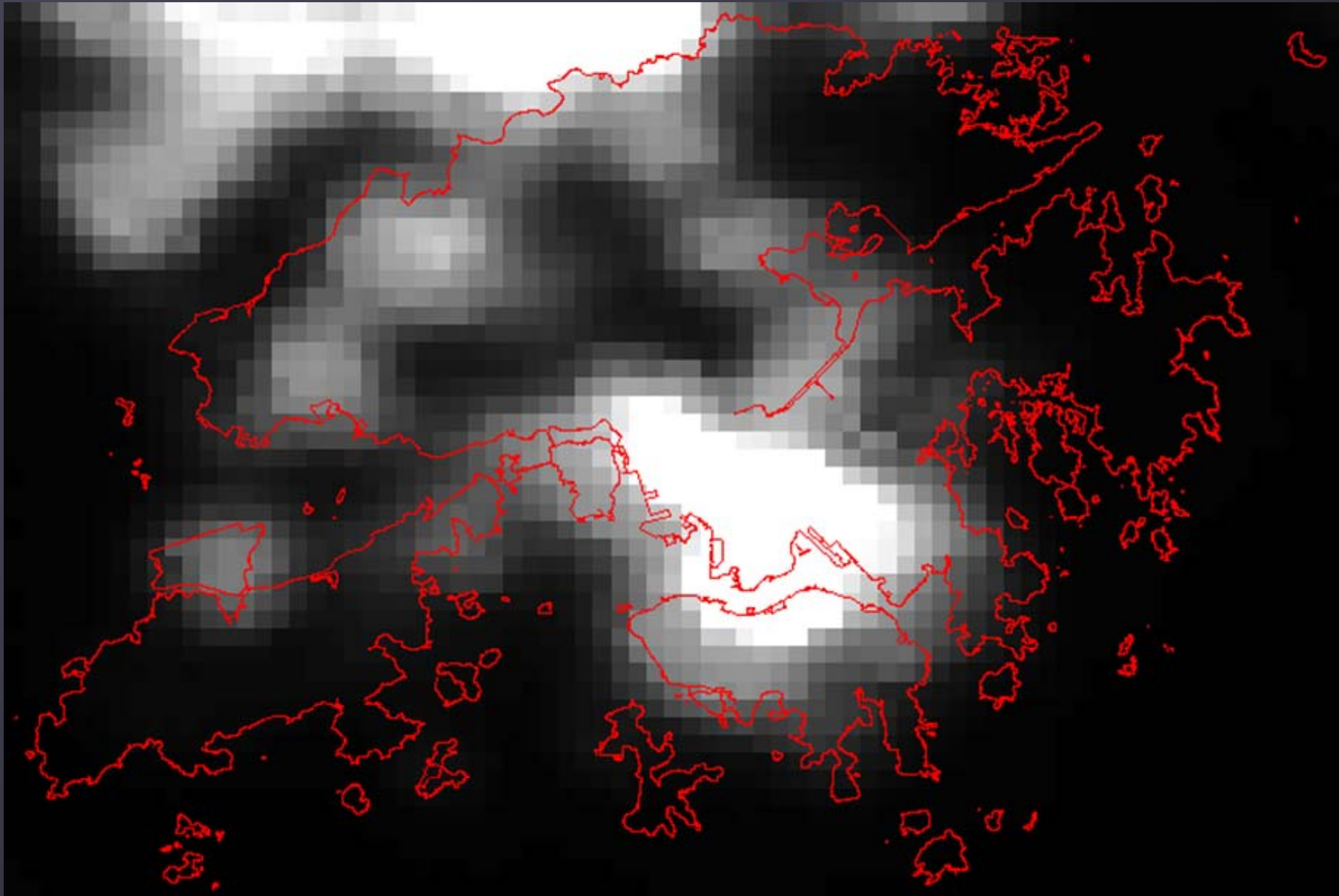
Introduction

- Previous analyses have revealed a striking correlation between city-lights and human population density
- Some researches suggested correlation between measures of population or population density and nighttime imagery is low and not statistically significant.
- DMSP-OLS imagery saturated in most of the areas of high population density.
- ISS photograph provide more information of nighttime lights with finer spatial resolution.
- Will ISS photograph produce better model to estimate population for areas with high population density than DMSP-OLS imagery?

Data

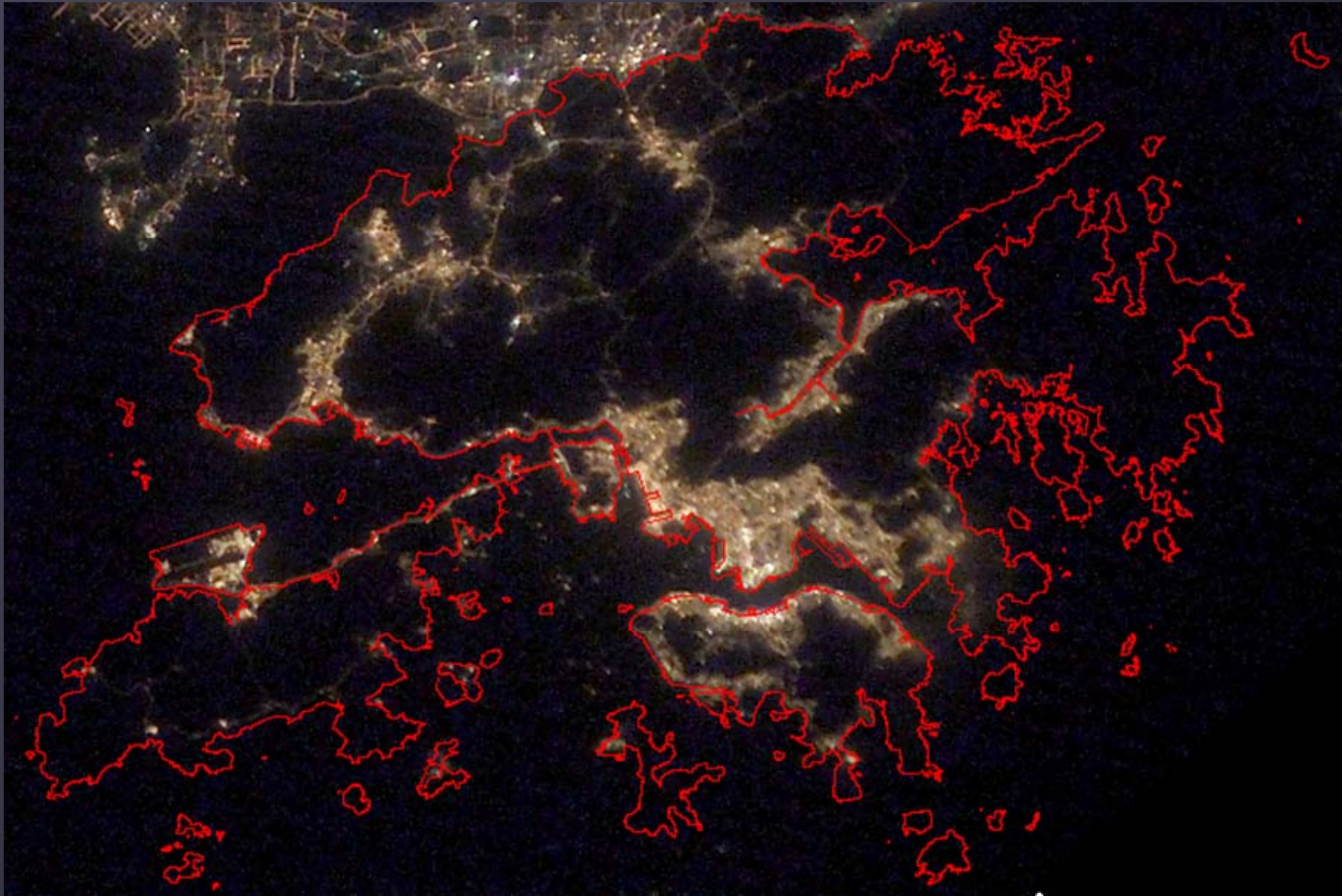
- Nighttime Imagery
 - Radiance calibrated DMSP Nighttime Lights 2006
 - Hong Kong at Night - Astronaut Photography from ISS 2003
- Population Representations
 - 2008 LandScan population grid
 - 2006 Hong Kong population by administrative district

Radiance calibrated DMSP Nighttime Lights of Hong Kong 2006 (F16)



Cloud-free composite derived DMSP-OLS data collected at low, medium and high gain settings.
30 arc-second grid or approximately 1 km² at the equator

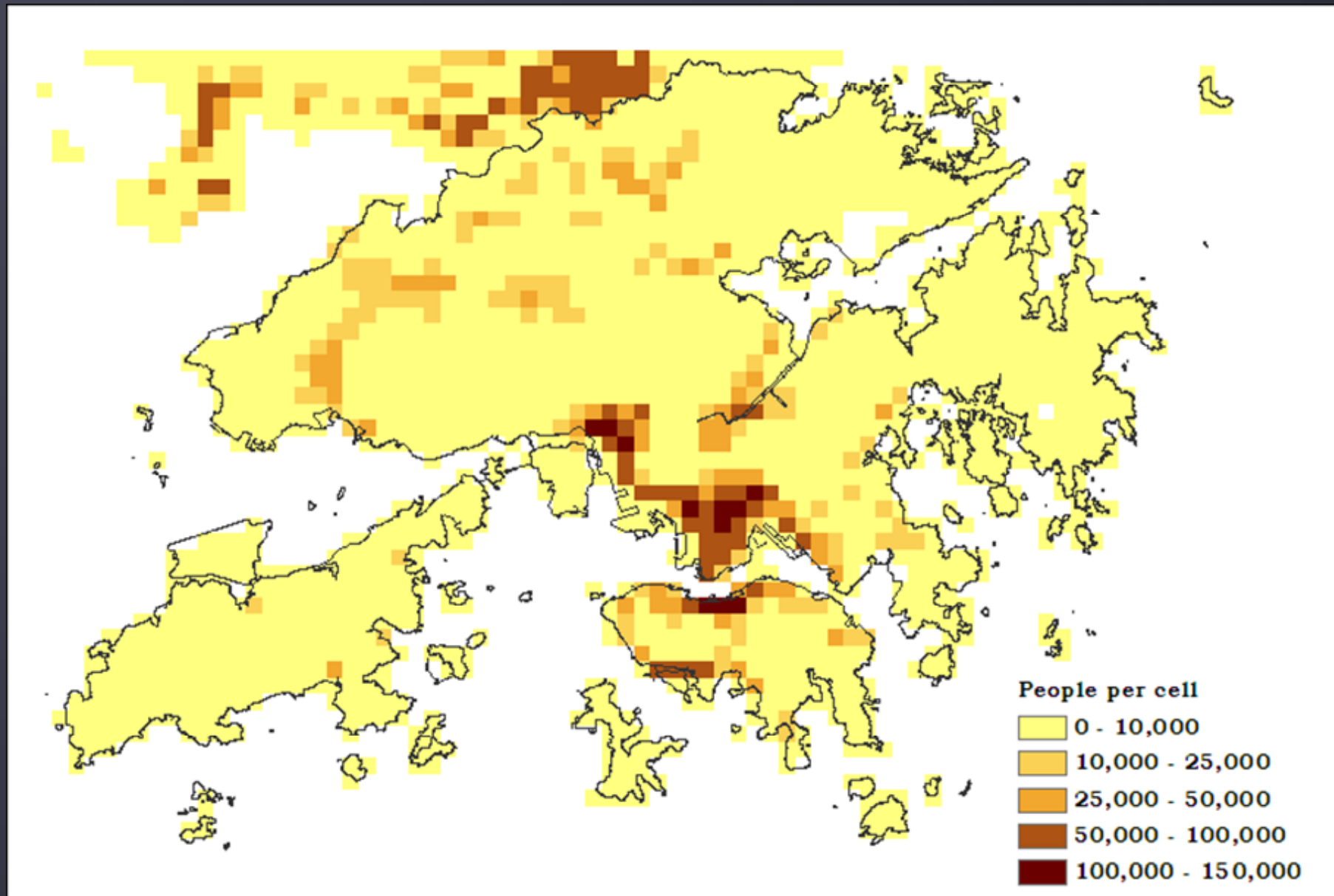
Hong Kong at Night - Astronaut Photography from ISS 2003.03.10



Spatial Resolution: approximately 90m, estimated to be 6m per pixel

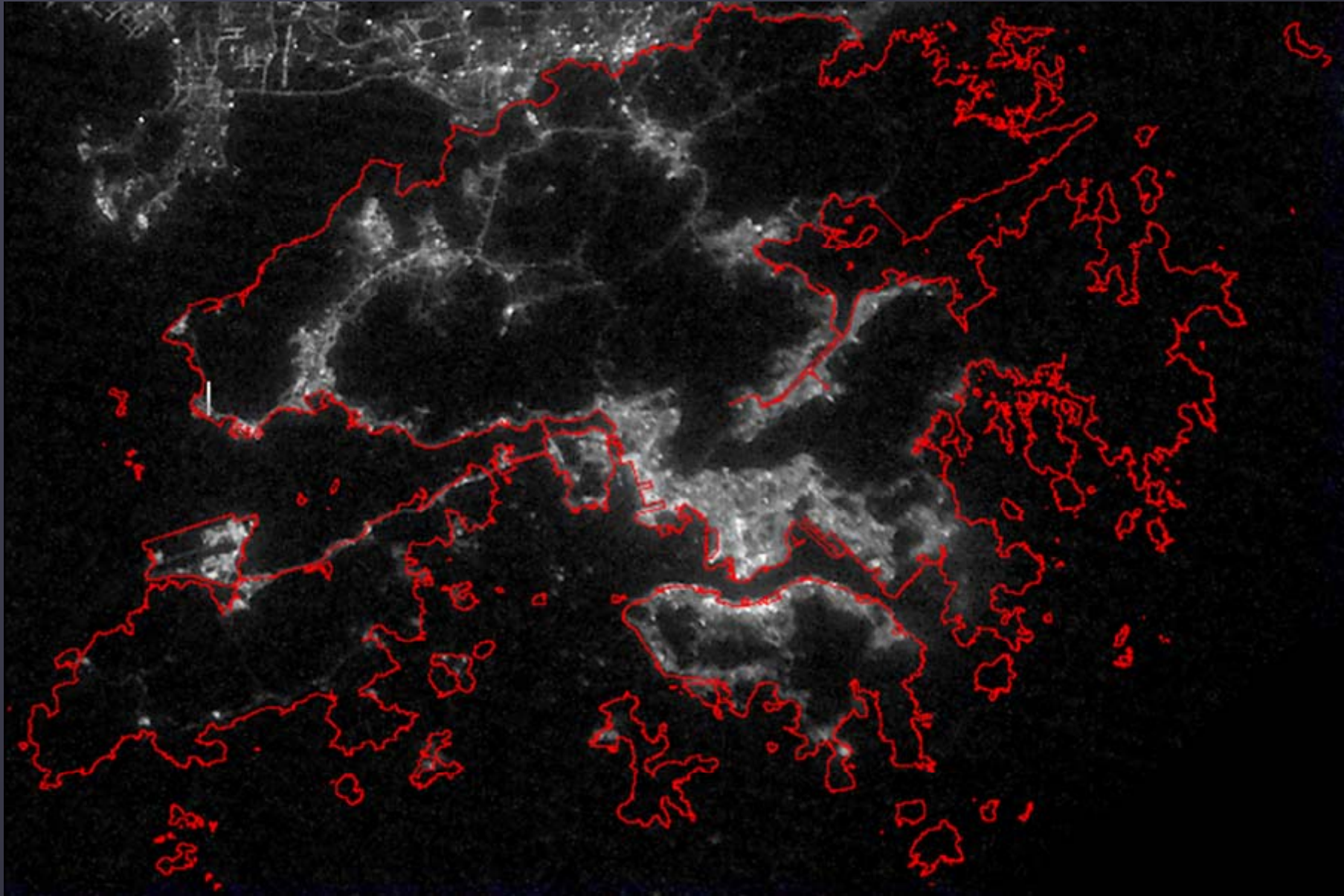
LandScan Population Density of Hong Kong 2008

US Laboratory Department of Energy, Oak Ridge National Laboratory



Representing ambient population count per cell
30 arc-second grid or approximately 1 km² at the equator

First-Principal Component of ISS photograph



Hypothesis

- Nighttime light intensity will positively correlate with the population density
- Integration of nighttime lights within district polygons will positively correlate with the total population of those polygons
- ISS imagery will produce better model than existing models using DMSP-OLS imagery for estimation of population or population density in high population density area

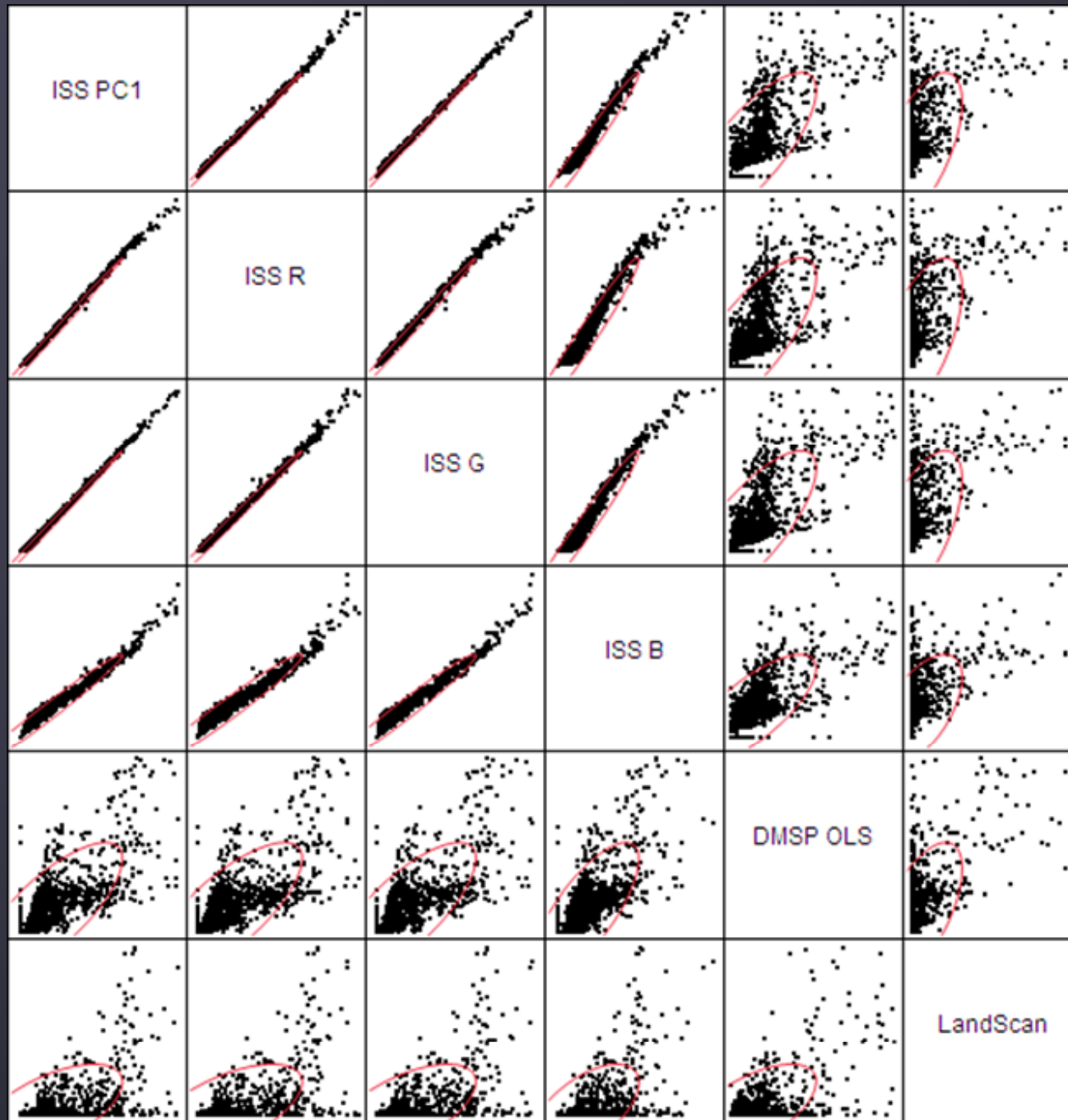
Methods

- Pixel-based
 - Multi-variate Analysis
 - LandScan, DMSP-OLS, ISS red, ISS green, ISS blue, ISS PC1
 - Correlation and scatterplot matrix
- Polygon-based
 - Mean aggregation of ISS PC1 to 1km² grid
 - Zonal statistics: sum of light in each district polygon
 - Ordinary least squares regression
 - Independent variable: sum of ISS lights within district polygon
 - Dependent variable: total population for each district

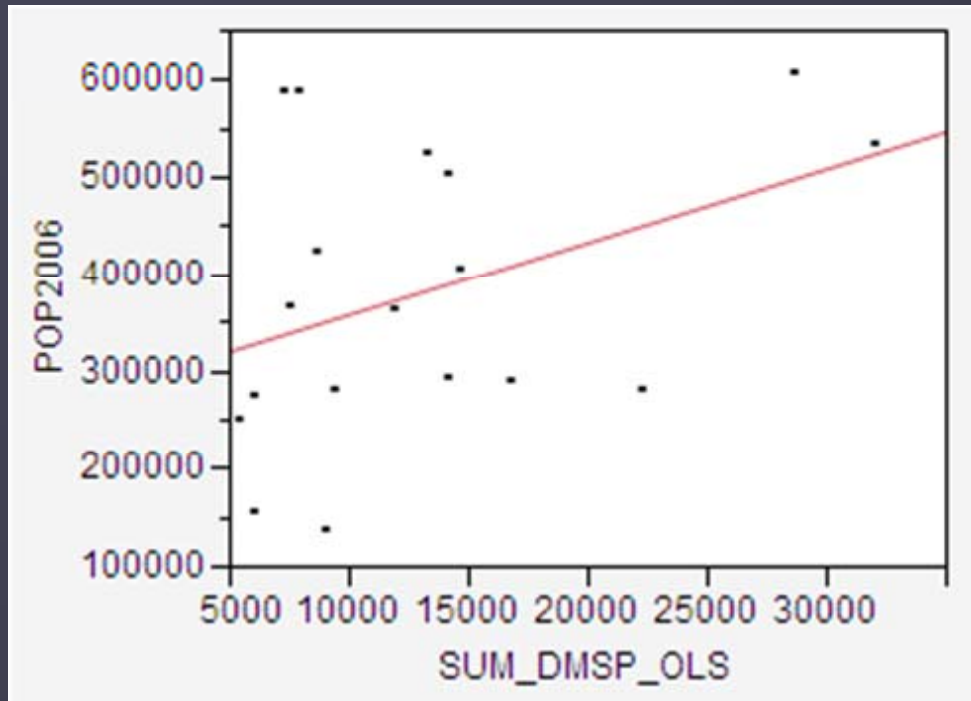
Correlations

	ISS PC1	ISS R	ISS G	ISS B	DMSP- OLS	LandScan
ISS PC1	1.0000	0.9988	0.9989	0.9851	0.7706	0.6118
ISS R	0.9988	1.0000	0.9976	0.9768	0.7677	0.6116
ISS G	0.9989	0.9976	1.0000	0.9796	0.7709	0.6127
ISS B	0.9851	0.9768	0.9796	1.0000	0.7618	0.5976
DMSP-OLS	0.7706	0.7677	0.7709	0.7618	1.0000	0.6239
LandScan	0.6118	0.6116	0.6127	0.5976	0.6239	1.0000

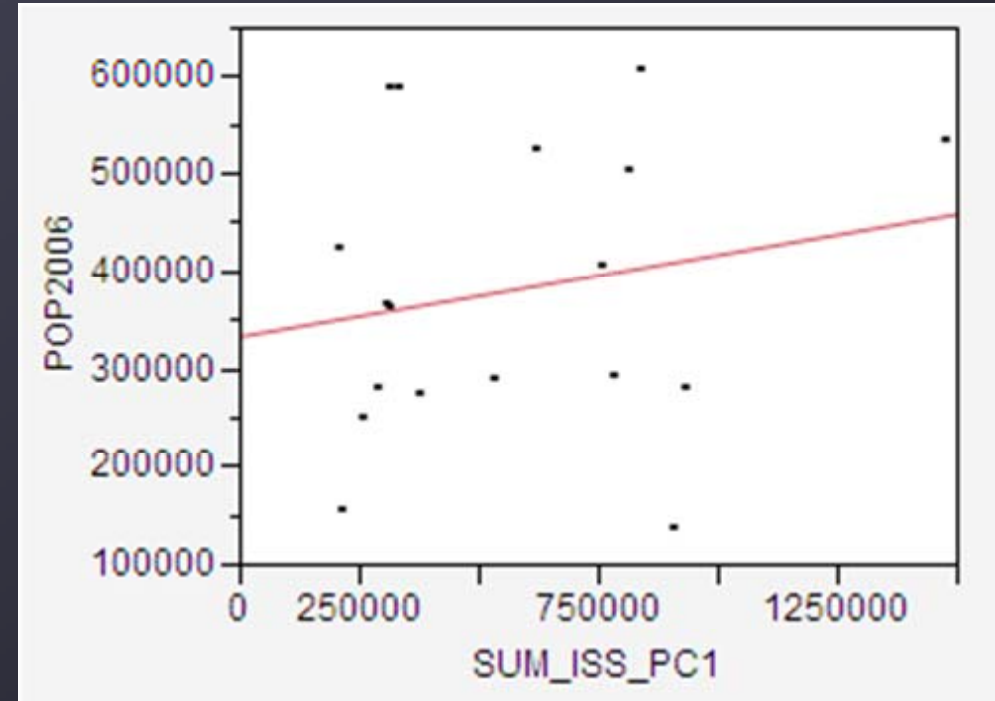
Scatterplot Matrix



Parameter Estimation

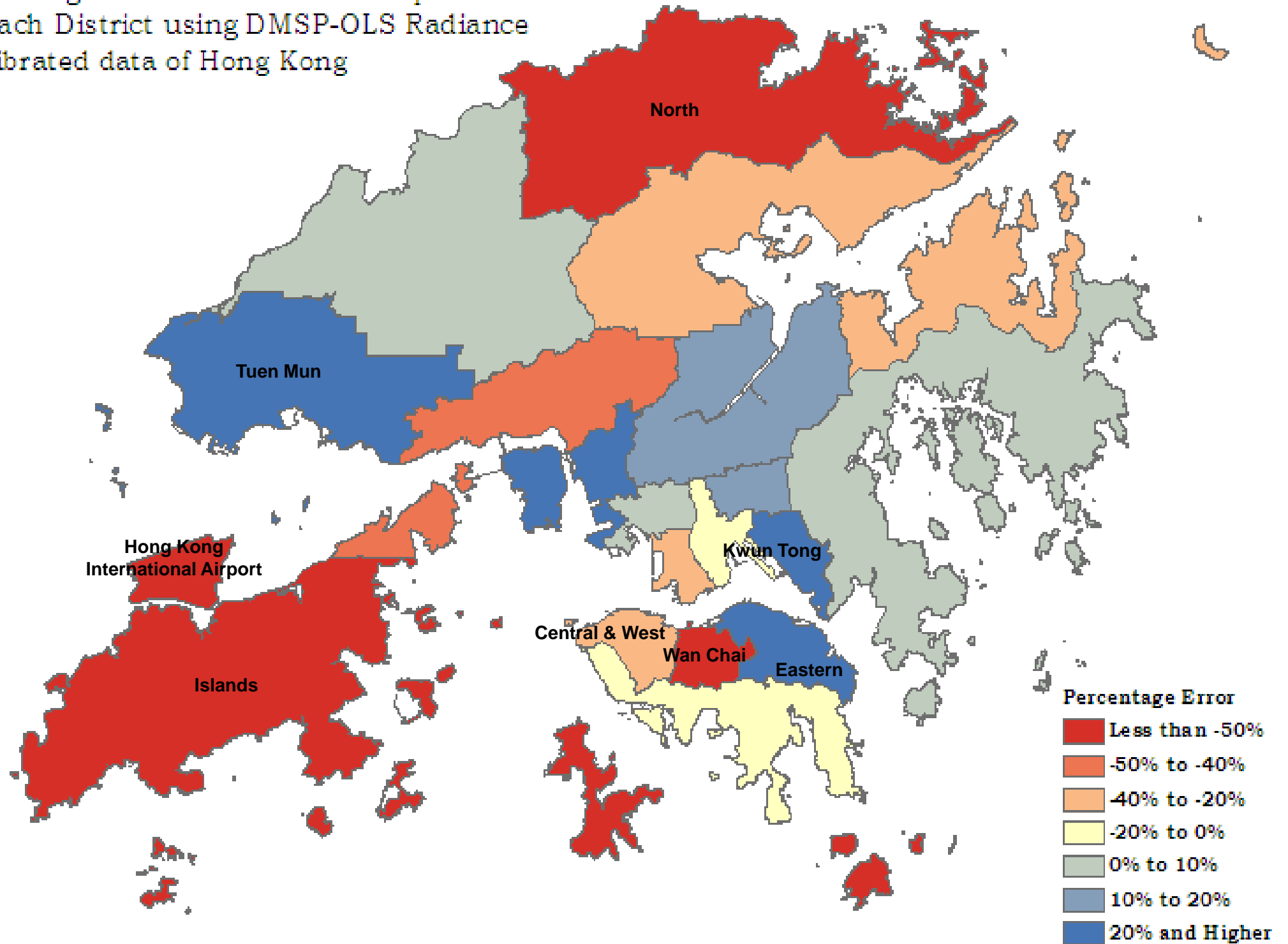


- $R^2 = 0.15$
- p-value = 0.1072
- Weak linear relationship between sum of lights from DMSP-OLS imagery and total district population

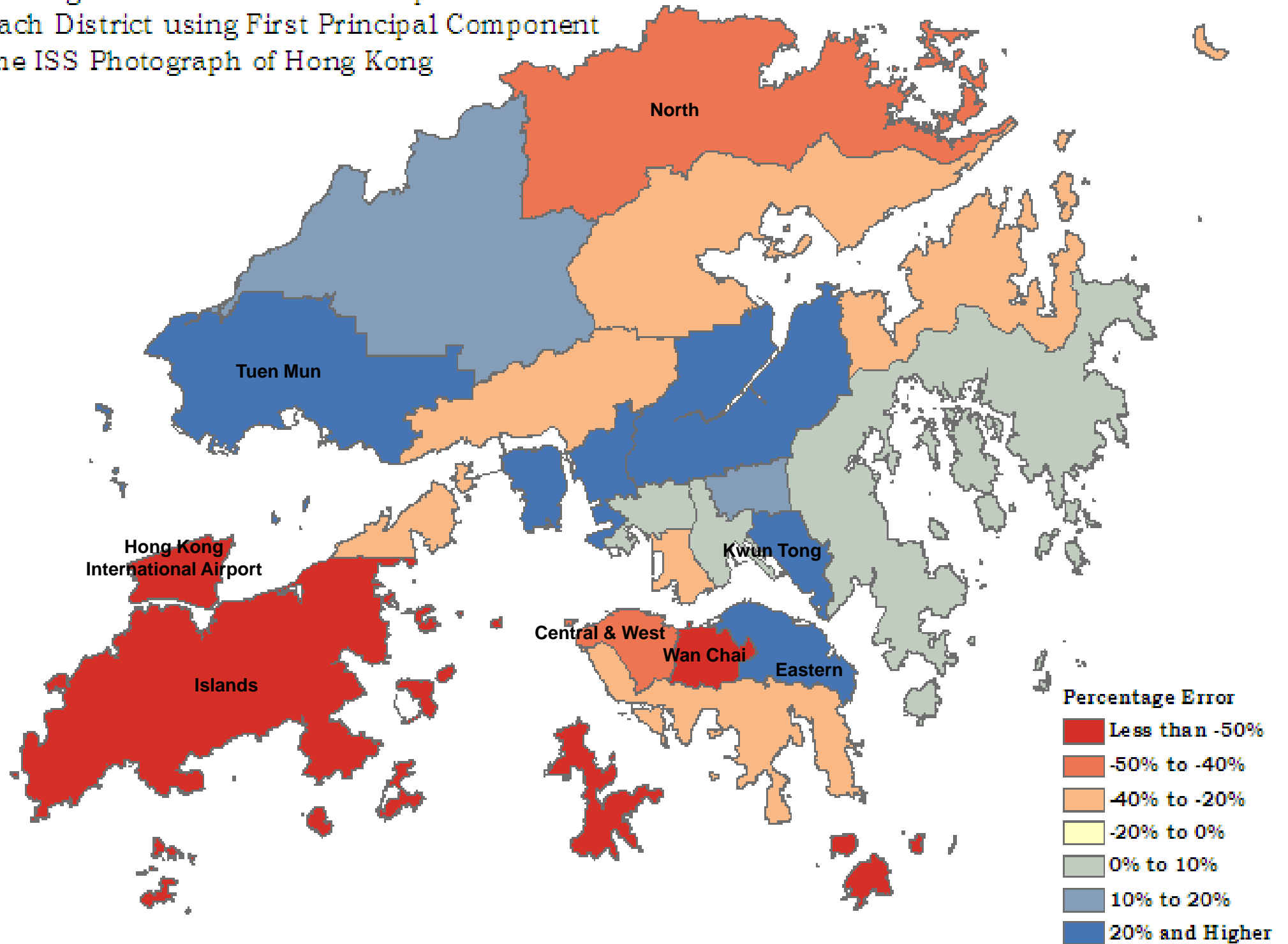


- $R^2 = 0.03$
- p-value = 0.4381
- No linear relationship between sum of lights from ISS PC1 imagery and total district population

Percentage Error in Estimate of Population
of each District using DMSP-OLS Radiance
Calibrated data of Hong Kong



Percentage Error in Estimate of Population
of each District using First Principal Component
of the ISS Photograph of Hong Kong



Discussion

- Overestimation for districts:
 - containing airport, commercial areas, residential areas in new town;
 - with residents of high income and education.
- Underestimation for districts:
 - containing large residential areas and industrial areas;
 - with residents of low income and education.

Conclusions

- ISS photograph is no better than the DMSP OLS imagery at predicting population density of Hong Kong at the spatial resolution of LandScan.

The finer spatial and spectral resolution of the ISS photographs does not increase correlation between nighttime lights and measures of population or population density.

- Residence-based population at district level of Hong Kong provided by census data are not well modeled by nighttime imagery alone.
- Areas of high ambient population density that are not residential (airports, commercial areas, etc.) tend to emit more light than residential areas.