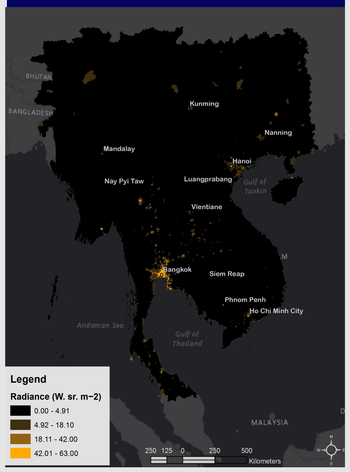
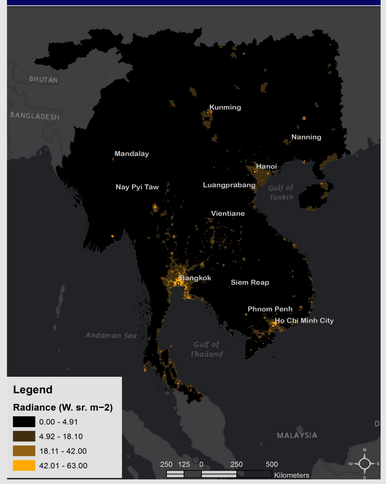
All of the Lights: Subnational Economic Development in the Greater Mekong Subregion

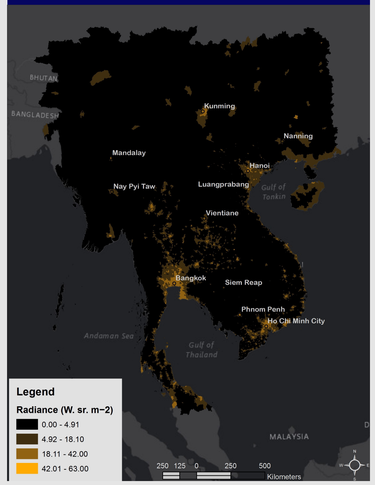
1992 Lights



2002 Lights



2012 Lights



Introduction:

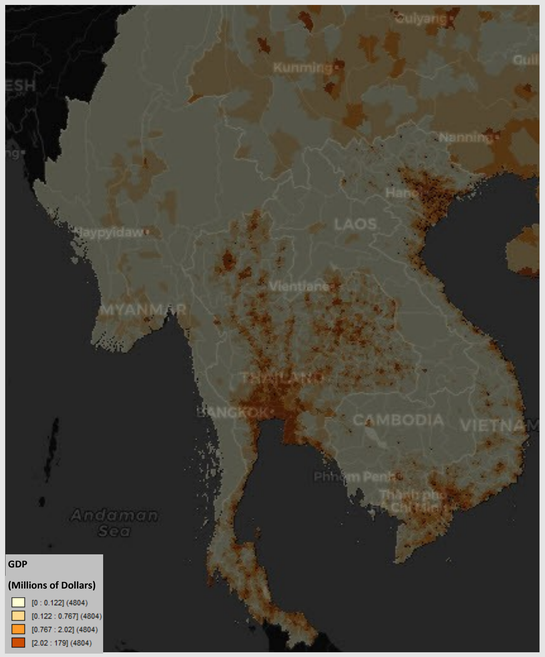
Measuring economic development at the subnational level is often complicated by limited resources that can be committed to detailed data collection efforts. Satellite imagery provides a potential opportunity for a proxy measure for economic development by capturing the radiance of nighttime lights. A well-illuminated area may be good evidence of concentrated economic development as it suggests a concentration of infrastructure that remains illuminated at night. Establishing how well of a proxy nighttime lights can be for economic activity can be done by comparing the change in nighttime lights over time to known economic growth indicators. This can allow for more rigorous economic analysis to be applied to lesser-developed economic areas that currently do not have the data collection infrastructure for subnational economic indicators. The Greater Mekong Subregion (GMS) encapsulates an area around the Mekong River that includes parts of Southern China, Cambodia, Laos, Thailand, Myanmar, and Vietnam. It was chosen as the area of interest for this project as it is a region that has experienced high rates of economic growth over the last few decades, yet does not have sufficient data collection infrastructure to capture these developments over time at the subnational level.

Image retrieved from: http://greatermekong.panda.org/discovering_the_greater_mekong/countries/ on May 7, 2018.

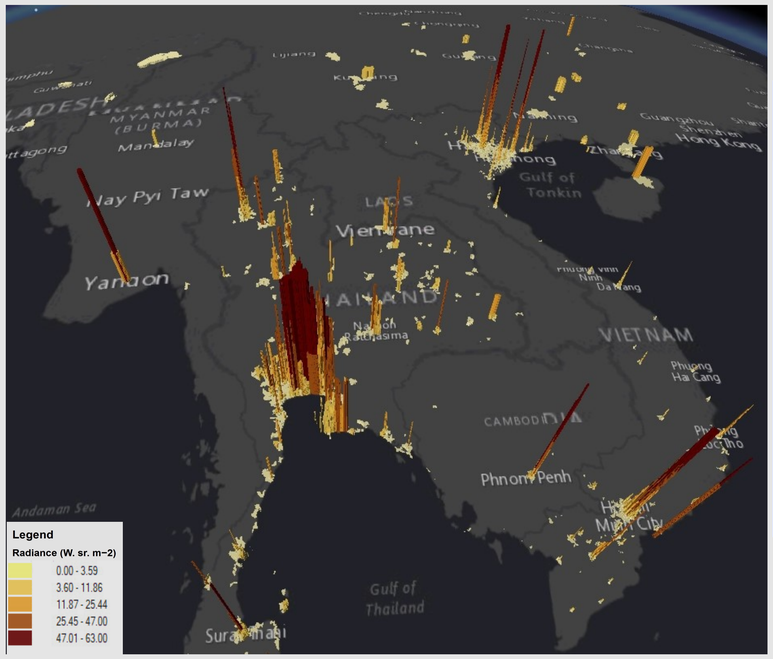
Methodology:

After retrieving the DMSP-OLS Nighttime Lights Time Series dataset compiled by the National Oceanic and Atmospheric Administration for just the GMS region from AidData's platform, a visualization of mean radiance of nighttime lights over time was created for the years 1992, 2002, 2012. The same natural breaks distribution levels of radiance from 1992 was used throughout all three maps to show the degree and spread of nighttime light levels over time. A 3-D visualization of 1992 mean radiance levels of nighttime lights was created with the extrusion feature in ArcGlobe. For visualization purposes, the data was exponentially fit and then linearly scaled by a factor of 100. This image can then be compared to the mean subnational Gross Domestic Product (GDP, measured in millions of dollars in terms of Purchasing Power Parity) estimations by AidData on the left. This image visualizes an estimate of the mean gross GDP levels in subnational districts in 2009. Using GeoDa, the hypothesis that nighttime lights can be a proxy of economic development is tested by bivariate Local Moran's I cluster analysis. 1992 nighttime lights and 2009 mean GDP estimates test whether lighting levels in 1992 are a good indicator of GDP levels. 1992 nighttime lights and 2012 nighttime lights test whether the former measure corresponds to similar levels of lighting 20 years later. The 2012 nighttime lights and GDP relationship provides a more recent test of whether nighttime lights still correspond to GDP levels. 2012 nighttime lights and distance to a city tests the relationship between proximity to a city (in km) with a population of at least 50,000 people and its lighting levels. Distance to a city with at least 50,000 people and mean gross GDP levels in 2009 tests how proximity to a city affects GDP levels. For all five of these relationships, scatter plots were also generated and their correlation statistics were included in the data table.

Gross Domestic Product



1992 Lights in 3D



Correlation Statistics

Variables (units)	Bivariate Local Moran's I Coefficient	R^2	Standard Error	Standard t– statistic	P-value	Observations
Mean 1992 DMSP-OLS Lights (W. sr. m−2) and 2009 Mean GDP (millions of dollars– Purchasing Power Parity)	0.56896	0.715	0.045	33.710	0.000	19,216
Mean 1992 DMSP-OLS Lights (W. sr. m−2) and Mean 2012 DMSP-OLS Lights (W. sr. m−2)	0.539464	0.646	0.048	97.428	0.000	19,216
Mean 2012 DMSP-OLS Lights (W. sr. m−2) and 2009 Mean GDP (millions of dollars– Purchasing Power Parity)	0.448513	0.423	0.092	-29.964	0.000	19,216
Mean 2012 DMSP-OLS Lights (W. sr. m−2) and Mean Distance to a City with a 50,000 population (km)	-0.318055	0.219	1.243	174.668	0.000	19,216
Distance to a City with a 50,000 population (km) and 2009 Mean GDP (millions of dollars– Purchasing Power Parity)	-0.175473	0.055	0.136	51.598	0.000	19,216

Conclusion:

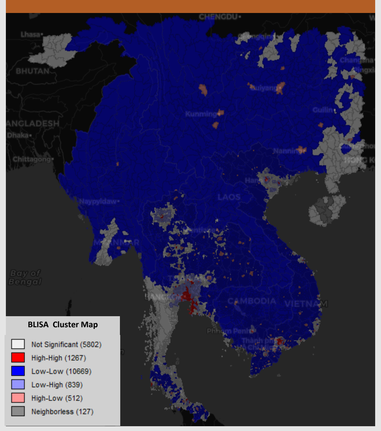
The visualizations of nighttime lights over time show a spread centered around major cities that already had high levels of radiance in 1992. This would be consistent with the "urban sprawl" phenomenon common in Southeast Asia that has created mega-cities and large urban centers like Bangkok, Ho Chi Minh City, and Jakarta. The 1992 levels of nighttime lights showed statistically significant correlations with 2009 mean gross GDP estimates and 2012 nighttime lights levels. These findings were further supported by positive bivariate local Moran's I coefficients in both relationships, suggesting positive clustering between the variables. The correlation between 2012 nighttime lights data and 2009 mean gross GDP estimates was not as strong, perhaps highlighting how nighttime lights after a certain point of saturation in economic development may lose its accuracy in approximating GDP levels. Both distance to city relationships that were tested produced intuitive conclusions that the farther away from a city, the less lighting and GDP levels.

Based on the decrease in linear fit between 1992 and 2012 nighttime lights data with estimated GDP levels, a follow up study could delve deeper into examining what type of relationship best estimates GDP from nighttime light levels. Perhaps a logarithmic trend that reflects a trend of diminishing marginal increases of GDP at higher levels of radiance may be a more accurate approximation method. Another level of detail that could be added is to classify areas by whether they are urban, rural, or mixed. This granularity may allow for more accurate predictions of economic activity rather than the approach this project used of generalizing across these very different types of economic environments.

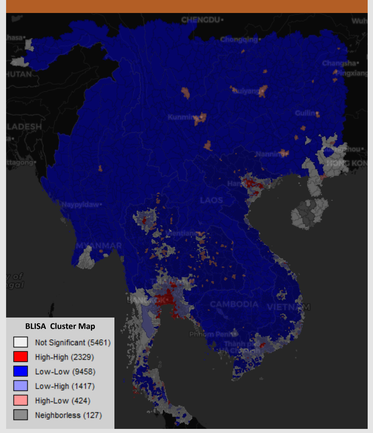
Data Sources and References:

Nighttime Lights, GDP estimations, Distance to Cities references extracted from:
Goodman, S., BenYishay, A., Runfola, D., 2016. Overview of the geo Framework. AidData. Available online at geo.aiddata.org. DOI: 10.13140/RG.2.2.28363.59686 , last accessed April 10, 2018
Spatial References for the Greater Mekong Subregion were based on shapefiles available on the Greater Mekong Subregion Information Portal:
http://portal.gms-eoc.org/maps?cmbIndicatorMapType=data , *last accessed May 5, 2018*
Administrative Boundary Shapefiles were extracted from:
https://gadm.org/download_country_v3.html, *last accessed April 27, 2018*

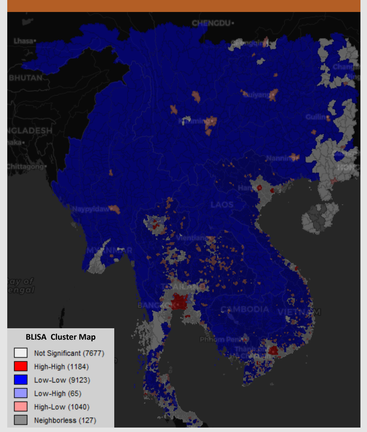
1992 Lights and GDP



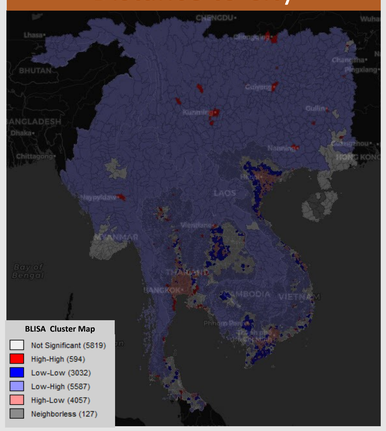
1992 and 2012 Lights



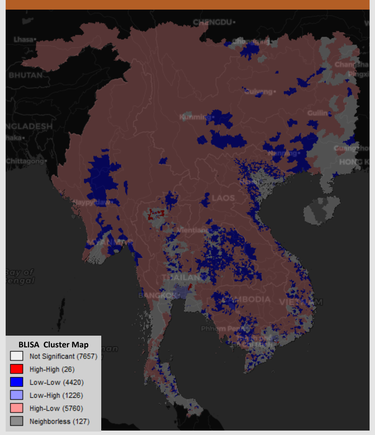
2012 Lights and GDP



2012 Lights and Distance to City



Distance to City and GDP



Coordinate System: WGS 1984 UTM Zone 47 N
Projection: Transverse Mercator
Datum: WGS 1984
Cartographer: Mathew Lee
Date: May 7, 2018
Course: GIS-102 Advanced Geographic Information Systems

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