Let the Sun Shine In: Optimal Sites for Solar Farms in Indonesia

Indonesia is home to the world's third largest democracy and largest archipelagic state. Its population is growing at an annual rate of .95% on 253 million, and economic growth at 5.2% in 2014. With a majority of the population (42.3%) between the ages of 25 and 54 years old, Indonesia is ripe for economic growth opportunities which create jobs, and increase environmental sustainability. Indonesia is currently characterized as a "resource state," with large reserves of oil, gas and coal. Unfortunately, Indonesia's oil reserves are waning -- the US Energy Information Agency notes that "A strong economy, population growth, and state subsidies for fuels have worked together to push domestic oil demand beyond supply. Fuel subsidies have cost the government at least 7% of its annual budget since 2005, pressuring the government to reduce fuel subsidy spending. Indonesia's rising domestic demand and waning oil production in the past few years have led to increased import levels of both crude oil and petroleum based products." Indonesia does have large coal reserves, most of which it exports. Finally, with regard to electricity production, Indonesia's "generation capacity growth [...] has been lower than growth in electricity demand, leading to power shortages and a low electrification ratio." As Indonesia looks towards the future, it should be asking whether it can support solar PV farms as an alternative, which is clean, more cost effective, and a source of economic development.

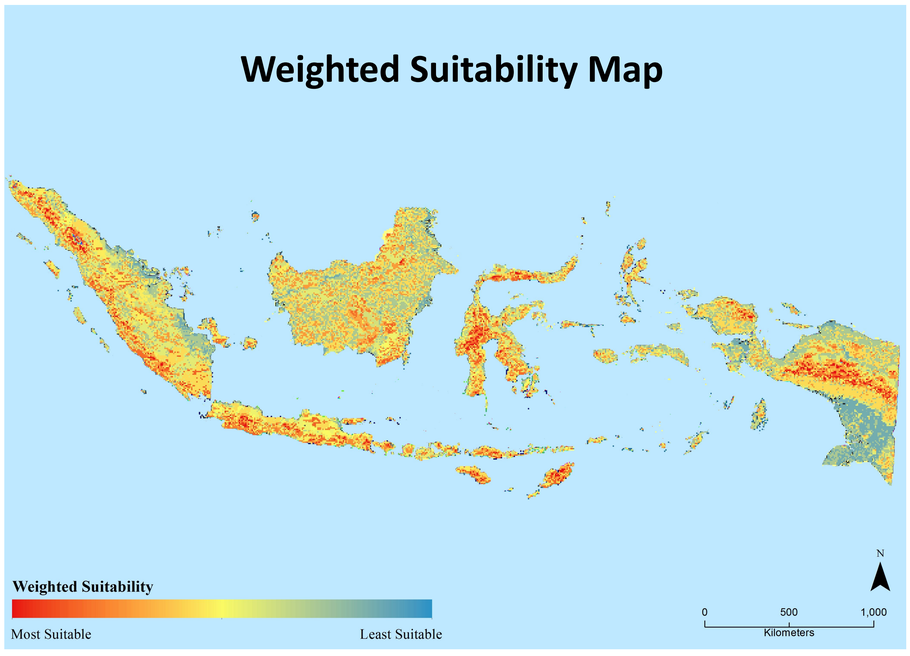
Methodology In order to see the places where utility-scale solar energy may be the most appropriate, I conducted a suitability analysis on the most important factors for maximizing energy production through solar, as well as population and land cover data. To the right is a table showing the criteria I used to assess suitability.

These criteria included slope, aspect, population, land cover and solar radiation. Three of these five criteria were derived from a basic Digital Elevation Map (DEM). The purpose of the suitability analysis, completed using the ArcMap Raster Calculator function, was to identify areas with moderately dense population, suitable slopes and aspects and, most importantly, the highest possible levels of annual solar radiation that could support solar PV farms on land areas that do not have to be cleared.

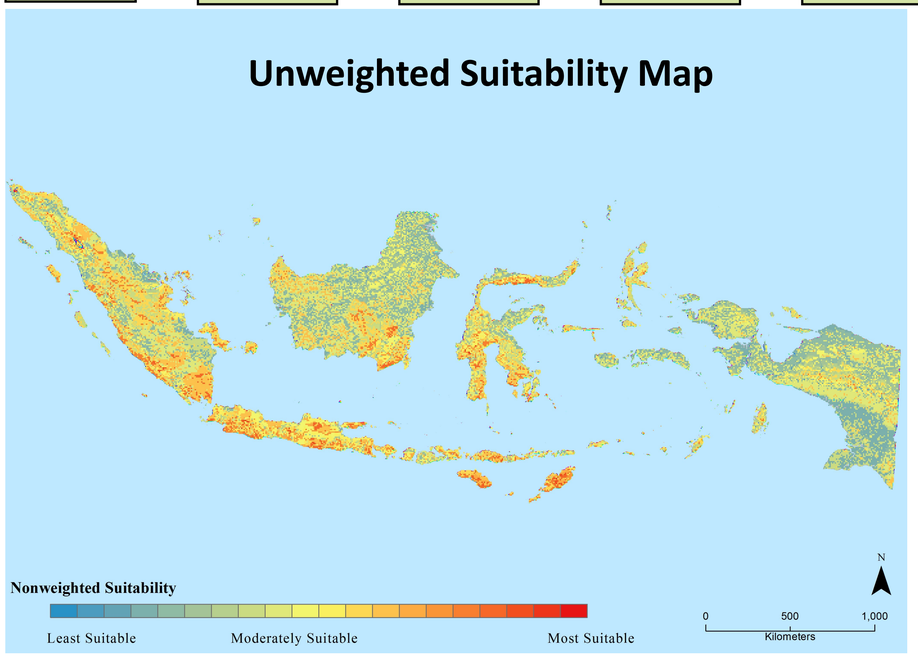
Slope U: 20% W: 20% + Aspect U: 20% W: 20% + Landcover U: 20% W: 10% + Solar Radiation U: 20% W: 40% + Pop. Density U: 20% W: 10%

Variable Name	Criteria	GIS Tools Used
Slope	0-5˚; 5-15˚ suitable	Slope Calc.
Aspect	112.5-247.5	Aspect Calc.
Landcover	No rainforests; only cultivated & sparsely covered areas	Select by Attribute
Solar Radiation (w/m^2)	Max	Solar Radiation Tool (Spatial Analyst)
Population Density ($people/km^2$)	Moderate density, close to high density areas	Select by Attribute

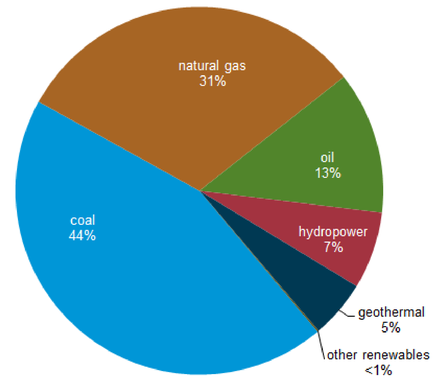
Weighted Suitability Map



Unweighted Suitability Map

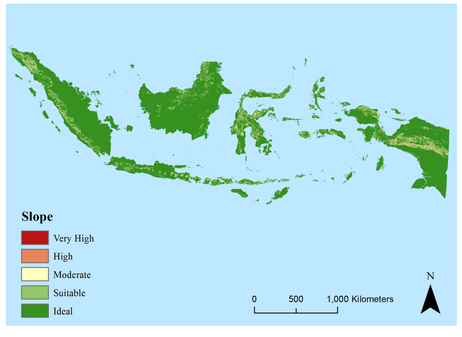


Indonesia power generation by source, 2011

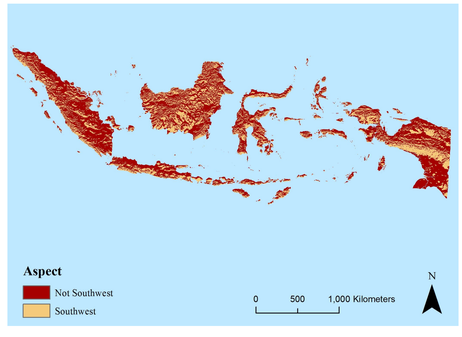


eia Source: Indonesia's Ministry of Energy and Mineral Resources

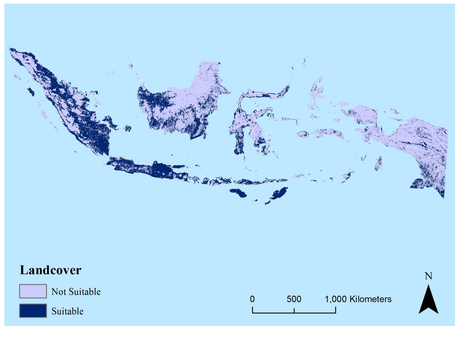
Slope



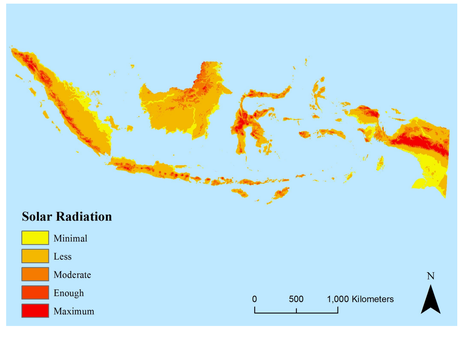
Aspect



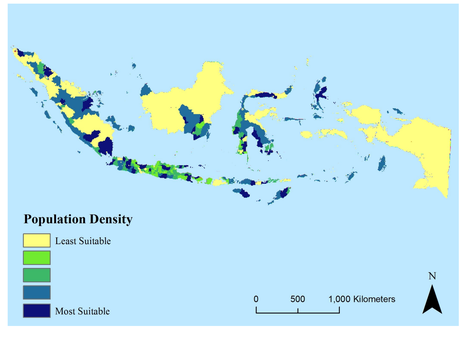
Landcover



Solar Radiation



Population Density



Conclusions Areas around Jakarta and in Western Sumatra are prime places for solar energy in both the weighted and unweighted versions of this map. When we weight the different criteria with heavy favor towards solar radiation, we see that Central Papua also becomes a favorable location—this is most likely due to the smaller weight on population, which is significantly less in Papua than in other parts of Indonesia. This analysis weights moderately-dense population centers as the best sites for solar projects. The most significant limitation to this analysis was finding up-to-date population data at the *kapubatan* (regency) level. Researchers who would like to delve further into this analysis may want to perform Euclidean distance from population centers in order to site projects more precisely — siting projects *close* to large population centers would be an ideal additional analysis. This project shows us that solar *is* an option for many areas of Indonesia and can be seen as a suitable alternative to heavy coal and oil use, especially as these resources begin to deplete.

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Cartographer: Elizabeth Peyton | Spring 2015

Projection: Batavia_UTM_Zone_49S

Data Sources: ESRI Datamaps (GTopo) Census; 2010 Indonesian Census; GLC Global Landcover Map