Opportunities for Distributed Solar Technology in India

Introduction

According to the International Energy Agency, 300 million Indians are without modern electricity access, representing over 20% of the global total. As India has experienced, centralized grid systems can be fraught with environmental destruction, security disruptions, and enormous efficiency losses. Distributed energy sources can avoid these problems and provide off-grid electricity to rural, developing communities.

Distributed solar technology is one of the most cost effective methods for providing reliable electricity access to rural communities. Introducing photovoltaic cells in suitable Indian communities can revolutionize India's failed energy distribution system.

Methodology

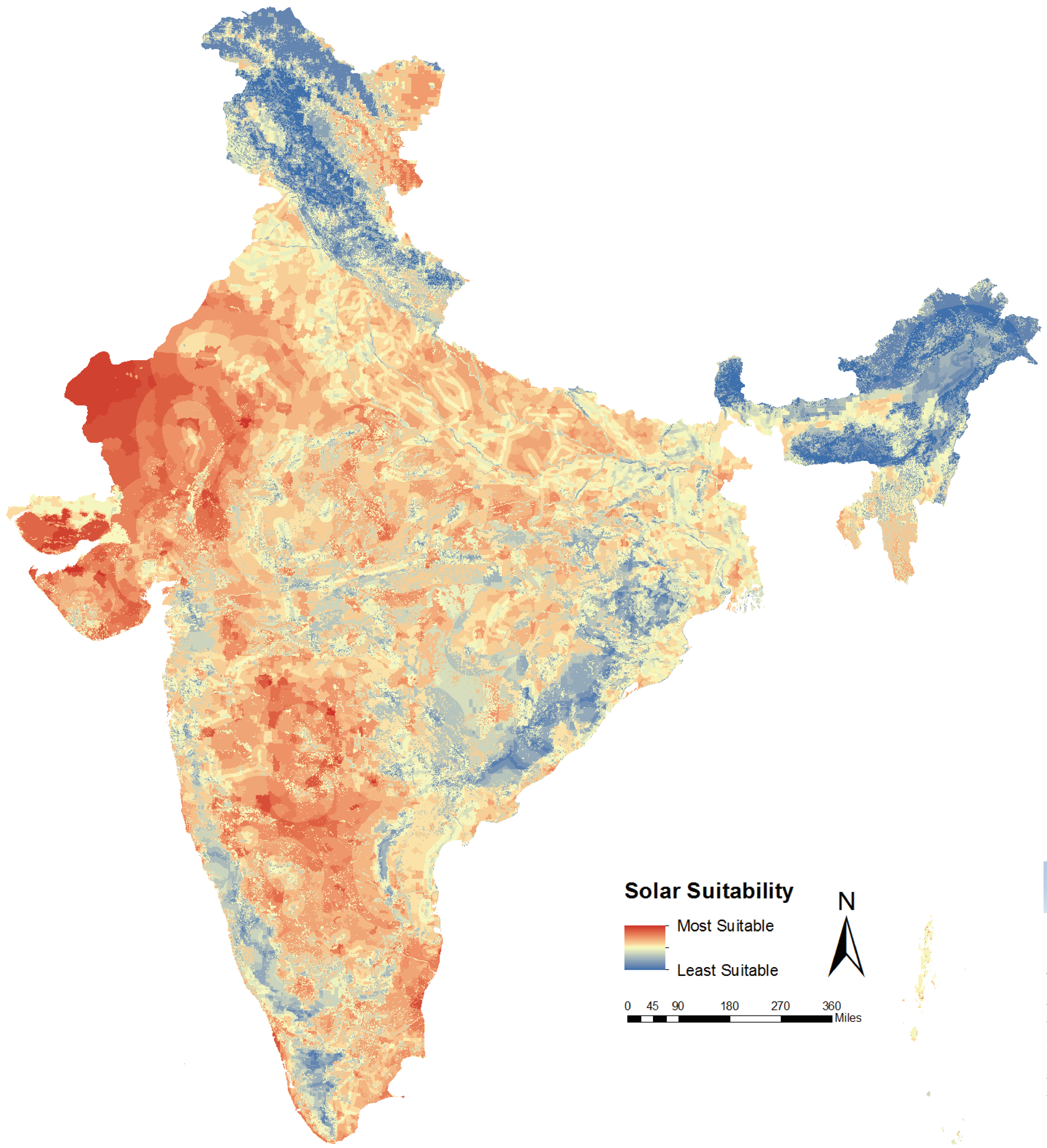
This GIS project analyzes the critical considerations for implementing distributed solar technology: solar irradiance, distance from utility lines, land cover, poverty, and population data. These datasets identify energy demand, solar energy production potential, population, and income levels so that investors and policymakers need to find the best locations for off-grid renewable systems.

This project combines the most important factors for distributed solar technology. I use the following weights in my final analysis: Solar Irradiance (30%), Distance from utility lines (25%), Percentage of non-workers (15%), Population (15%), and Land Cover (15%).

After projecting and converting all maps to raster files, I reclassified all files on a scale of 0-5, with 5 being most preferable environment, and 0 being prohibitive for solar technology.

Below is a list of criteria for each data set:

- *Solar Irradiance (GHI)* – All regions under 4.71 kWh/m^2/day were excluded, as this was the figure cited by the National Renewable Energy Laboratory for the minimum GHI for photovoltaic cells. Regions above this value were given weights 2-5.
- *Utility Lines* – Distances from utility lines were reclassified on a scale of 1 to 5 using 5km, 20km, 75km, and more than 150km. This emphasized regions furthest from the centralized grid system.
- *Land Cover* – Excluded all regions (such as tree cover) that would increase potential for shade, or prohibitive for solar technology.
- *Percentage of Non-Workers* – Zero assigned to areas with below aver age non-worker percentages. Equal breaks in above average regions.
- *Population* – Equal breaks based on data



Limitations

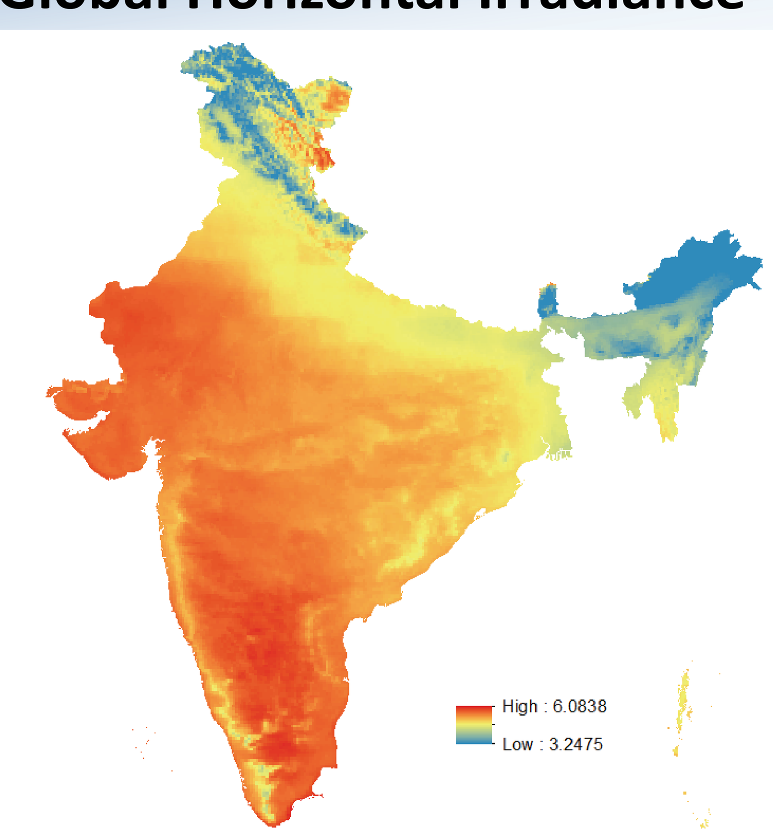
There are two main limitations for this project. First, I was unable to find Indian poverty statistics. Distributed electricity generation is most needed in poorer communities, so I used percentage of non-workers as a substitute. This is problematic, because "non-workers" includes children, the disabled, and the elderly, and is therefore not a perfect indicator of poverty. However, it is the best readily-available data set substitute I could find.

Secondly, I am unable to account for the millions living close to utility lines and in urban areas, but still without electricity access. Due to data limitations, I chose to focus my research on poorer communities away from grid infrastructure as they typically have the highest rates of inaccessibility to electricity.

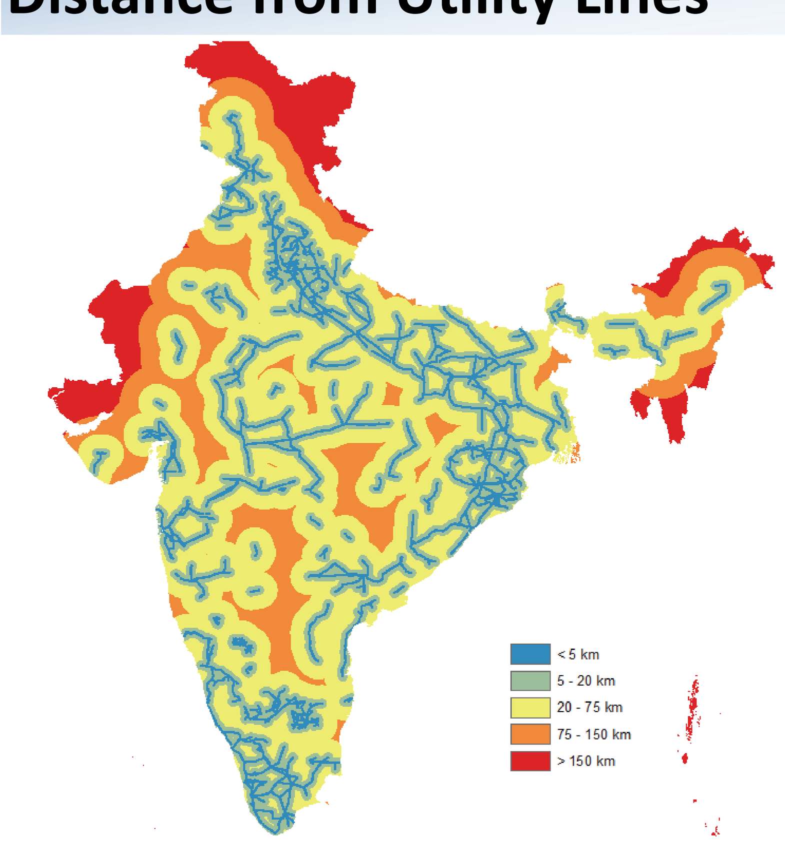
Conclusion

The final analysis identifies the best regions for distributed solar technology in red, and the least desirable regions in blue. It is clear that western and south central India have the optimal combination of factors to support off-grid solar. This information can guide investors, the government, international institutions, and non-governmental organizations as they try to increase electricity access for hundreds of millions of people.

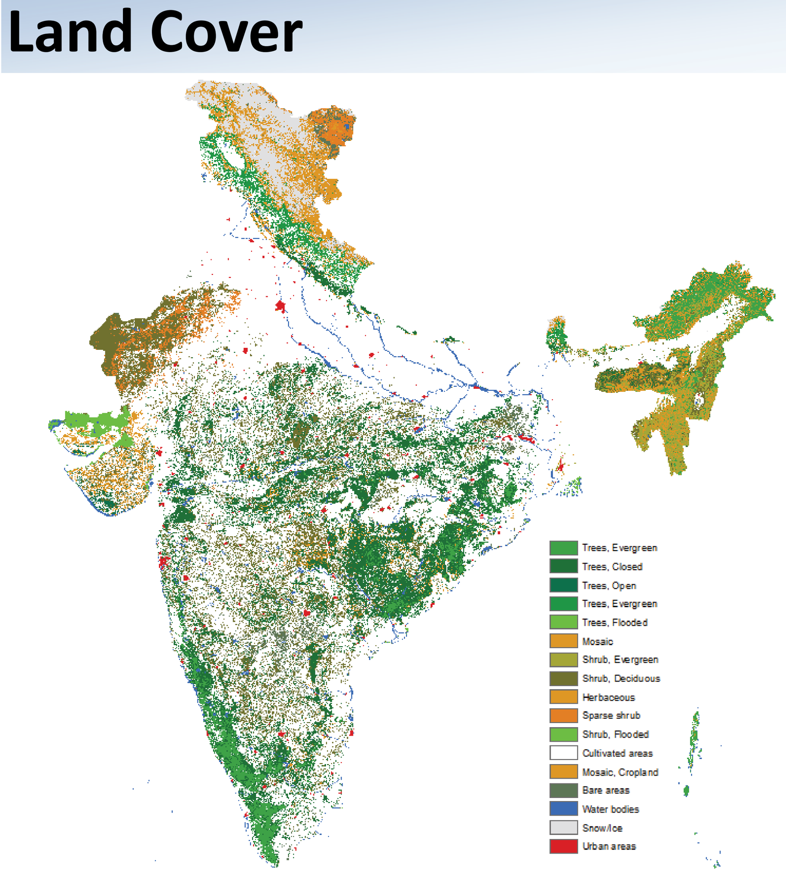
Global Horizontal Irradiance



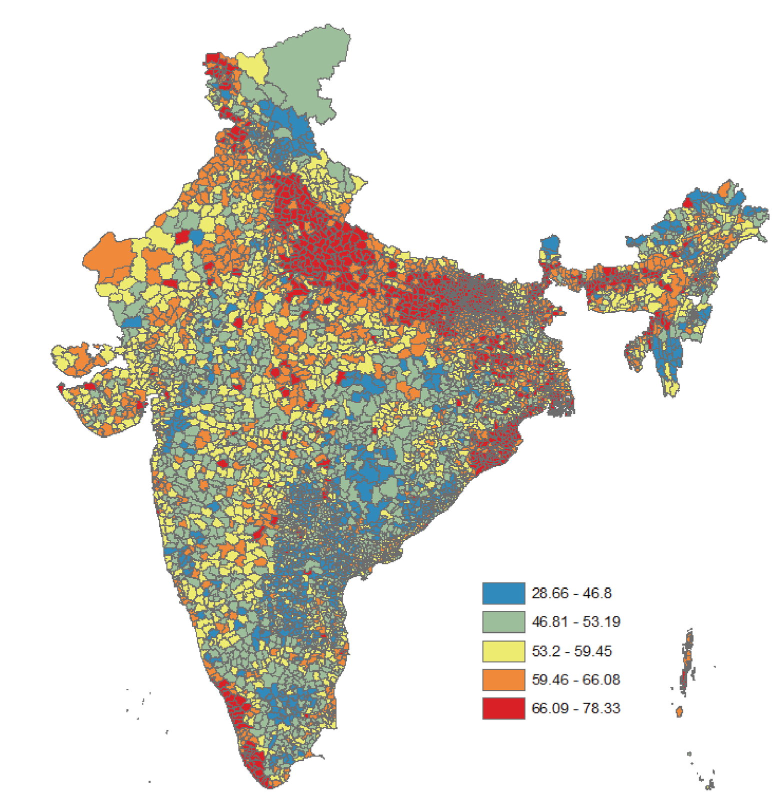
Distance from Utility Lines



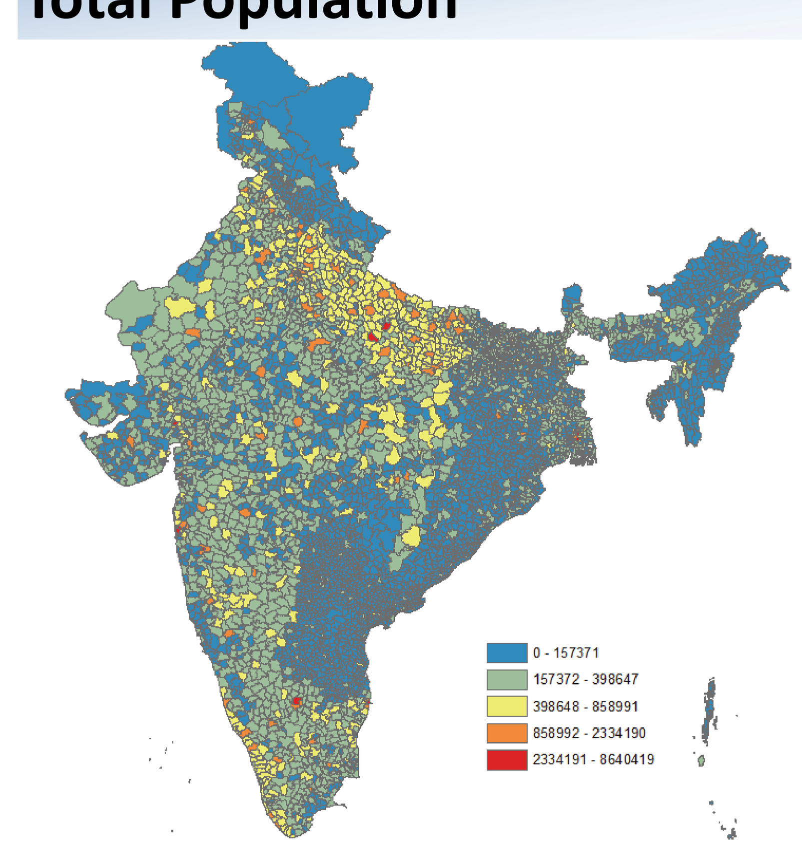
Land Cover



Percentage of Non-Workers



Total Population



Andrew Dahlen | DHP P207 | 2013
NREL (2011) | U.S. NGA (1992) | Tufts University GIS (2001)
The Fletcher School
Tufts University