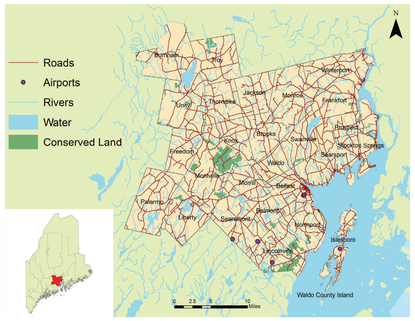
Renewable Energy Siting Analysis of Waldo County, Maine

Project Overview

Anthropogenic climate forcing and rapid fossil fuel combustion have begun to destabilize the climatic conditions that existed during the Holocene during which human civilization has thrived (Hansen et al., 2013). The impacts of climate change are and will continue to be global in scope. These include, but are not limited to: sea level rise, increasing frequency and severity of storms, flooding, droughts, wildfires, crop failures, increased spread of disease, and mass species extinctions. The combustion of fossil fuels is categorically humanity's greatest contribution to rapid and abrupt climate change. Finding alternative energy sources that do not catalyze climate catastrophe is critical for the future wellbeing of all species on Earth.

There is also an increasing body of evidence suggesting that the rate of fossil fuel extraction will be unable to match the global demand for its consumption in the near future (Brecha, 2013). Thus, the energy sources that have powered modernization are more imminently reaching their limits in sustaining the rapid global development characteristic of the twentieth century. This is not to mention the numerous impacts combustion of fossil fuels has on air and water pollution on local and regional scales (Brown, 2011).

Waldo County, Maine



Maine is a particularly oil-dependent state given its proportionally high heating needs during the winter and low population density that necessitates automobile transportation (Peterson et al., 2009). Renewable energy could mitigate the climate impact of the state's energy consumption and increase their energy security. Waldo County is a mid-coast Maine county that could benefit from developing renewable energy sources like onshore wind turbines and photovoltaic (PV) panels.

Methods

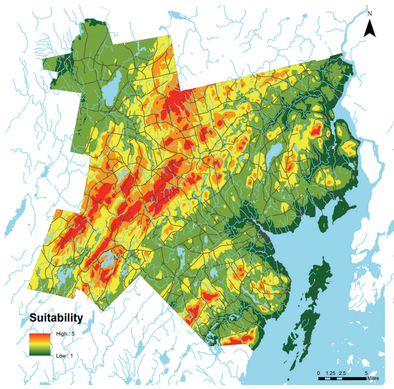
This project examined the potential for installing utility-scale onshore wind farms and PV panels in Waldo County, Maine through two separate analyses for each respective energy source. For the purposes of this study, utility-scale was operationally defined as requiring a minimum site area of 1,000 square meters for both sources. Landcover, roads, water, conserved land, airports, aspect, and slope constituted the photovoltaic site selection constraints. Wind farm site selection incorporated elevation and wind data at 50 meters from NREL in addition to the aforementioned data sets, but excluded aspect data. These data layers were projected in UTM Zone 19N, and clipped to fit the boundaries of Waldo County. The NREL wind data indicated wind classes 1-4 existed in Waldo County; the class 3 and 4 areas were selected out. The Euclidean Distance tool was utilized on the road, water, wind, conserved land, and airports to demarcate different distances away from these features. All of the features were reclassified 1-5, with 5 being most suitable and 1 being least suitable for development of PV or wind. Close proximity to roads but far away from water, conserved land, airports, and most developments received better scores. Given the number of types of landcover and time constraints, the Euclidean distance was not calculated for each type of landcover. Instead, the landcover raster once clipped and projected was reclassified along the same 1-5 scale. Once the data sets were reclassified, the scores were summed together and calculated into a raster using the raster calculator. The suitability scores for wind ranged from 15-45 and 12-40 for solar, with the highest number for each range being the most suitable and the lowest the least. Groups of raster cells with areas greater than or equal to 1000 square meters were selected and converted into polygons.

Project Findings

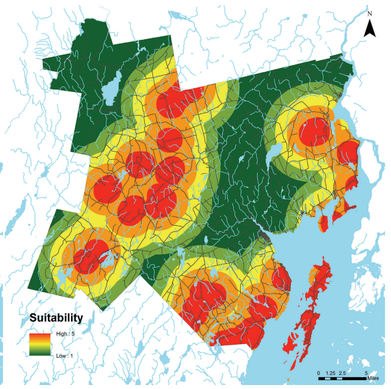
According to this analysis, there are approximately 300 hectares across 534 sites, with a mean area of .56 hectares that are best suited for building wind farms. There are also approximately 6,247 hectares of suitable land to develop PV panels on 11,578 sites, with a mean site size of about .54 hectares. The highest concentration of suitable wind farm sites with areas over 1,000 square meters in Waldo County are in the towns of Knox, Jackson, Thorndike, and Freedom. The towns with the highest concentration of suitable PV sites over 1,000 square meters are in the towns of Burnham, Frankfort, Winterport, and Belfast.

There are a much greater number of ideal sites for PV than there are for wind. I think this is largely due to the limited number of areas where the wind potential class was 3 or 4. A similar restriction to solar did not apply because there was insufficient variation in the global horizontal irradiance data set to merit including it in the analysis. Further studies could explore the zoning and regulatory environment for developing these sites with wind and solar. In addition, ground-truthing each site with orthophotographic data or visiting them in person would further refine this spatial analysis. Other sources of energy not included in this analysis that could be incorporated into future analyses of this area include offshore wind, wave energy, hydropower, and biomass.

Elevation Suitability

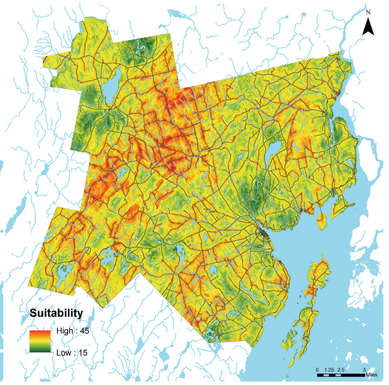


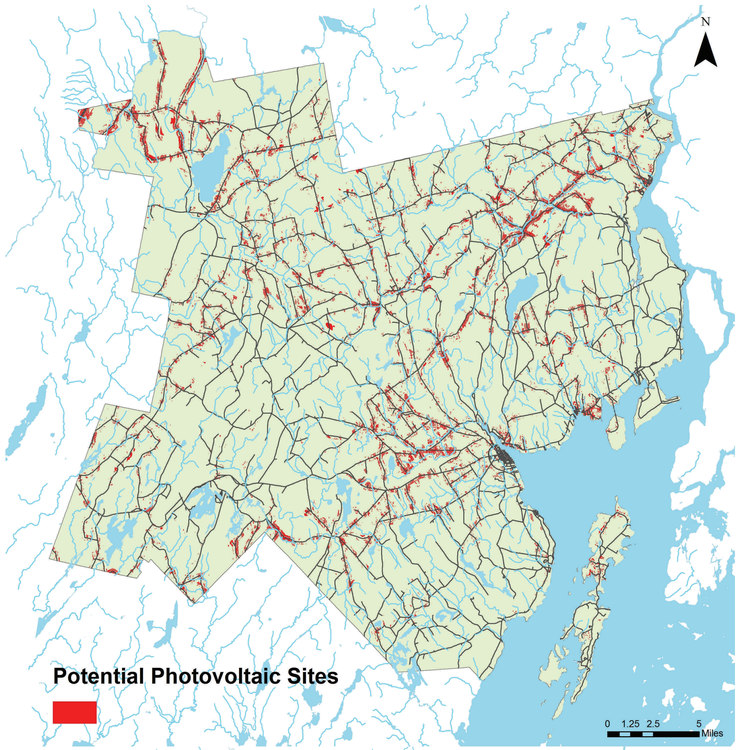
Proximity to High Wind Sites

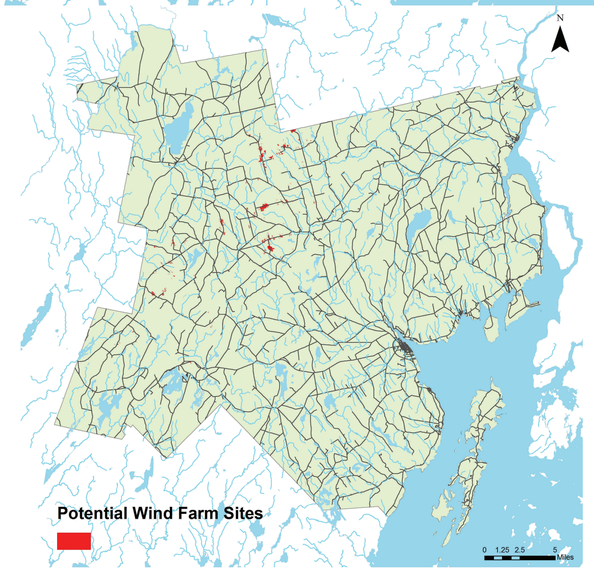


Photovoltaic Site Suitability

Wind Farm Site Suitability







References

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Data Sources: ESRI 2010, Maine Office of GIS 2013, NREL 2013, USGS 2013

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