Financial Analysis of the Suitable Wind Turbine Locations in Massachusetts

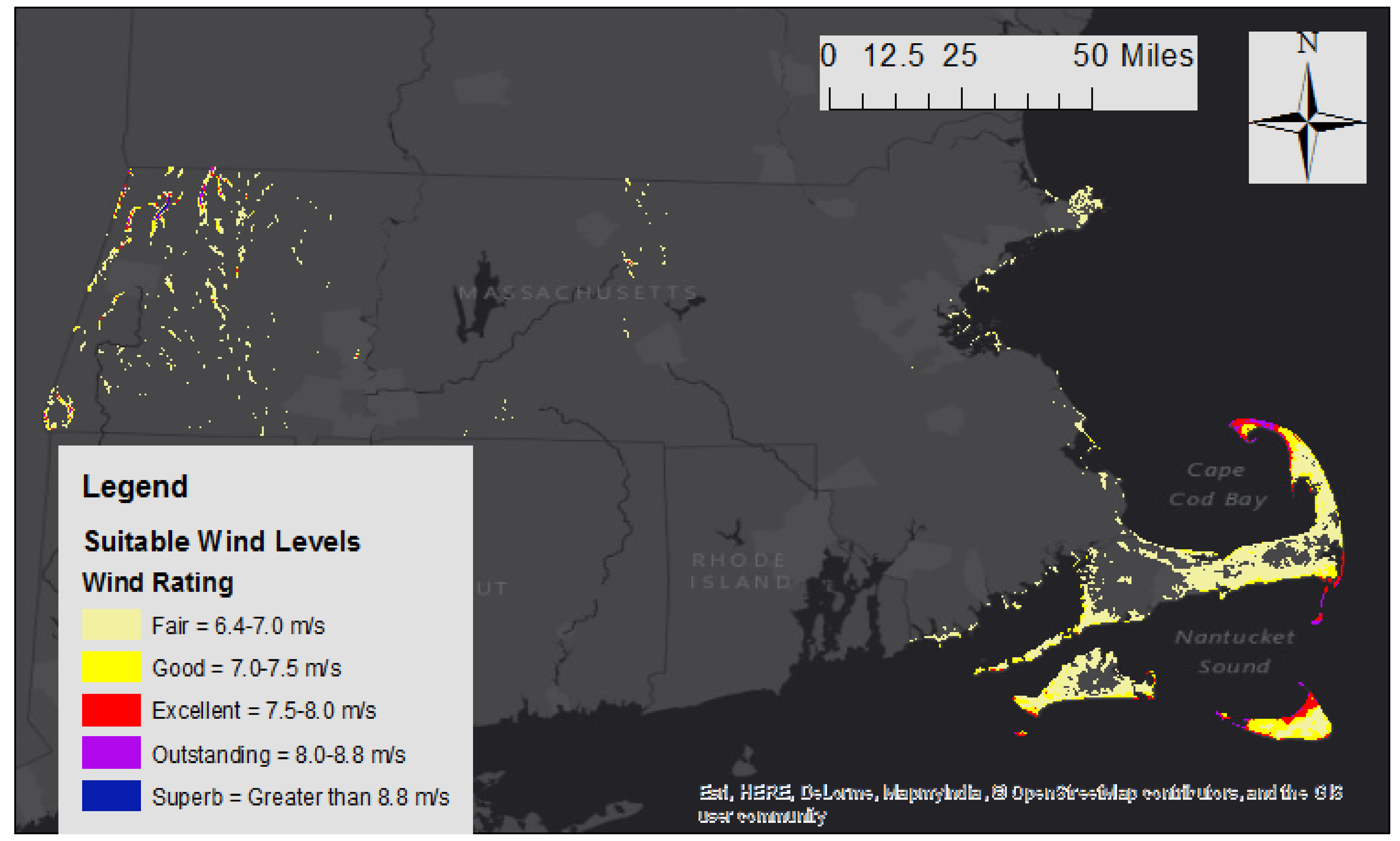
By Sam Bragg

Background:

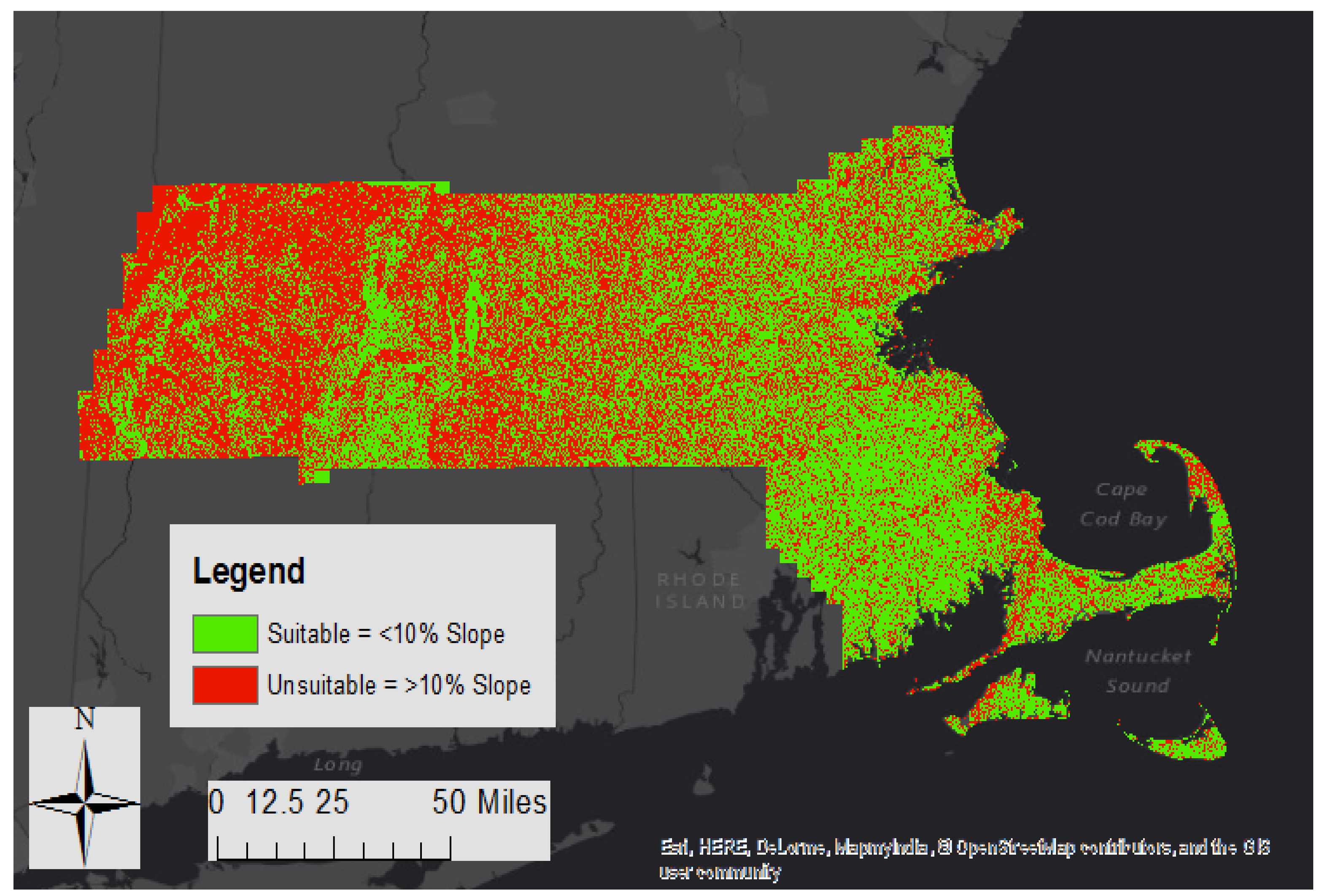
Massachusetts has been a strong proponent of clean energy in the past and continues to be, ranking third in the nation according to the "Clean Energy Momentum: Ranking State Progress" report released in 2017. Clean energy, however, must overcome many obstacles in order to be approved and developed by the government or by businesses and investors. Among the issues, there are environmental regulations, safety precautions, and social understanding or misunderstanding about how clean energy works. In the past, especially in Tufts GIS projects, there have been many variations of suitability analysis for Massachusetts in terms of its wind potential, and each seeks to determine the best way to calculate the best places in Massachusetts to build wind turbines. These are important, and I believe these are a response to people's growing care and concern for the environment and the desire to make a difference by doing what they can to promote clean energy. However, not many of these projects seek to provide businesses with incentives and data to encourage them to actually invest in these suitable wind sites. In this project, I attempt to combine a financial analysis of Massachusetts parcel data with a wind suitability analysis in order to determine not only which parcels contain suitable wind potential, but also which suitable parcels are financially viable and big enough to sustain wind turbine development and construction.

Methods:

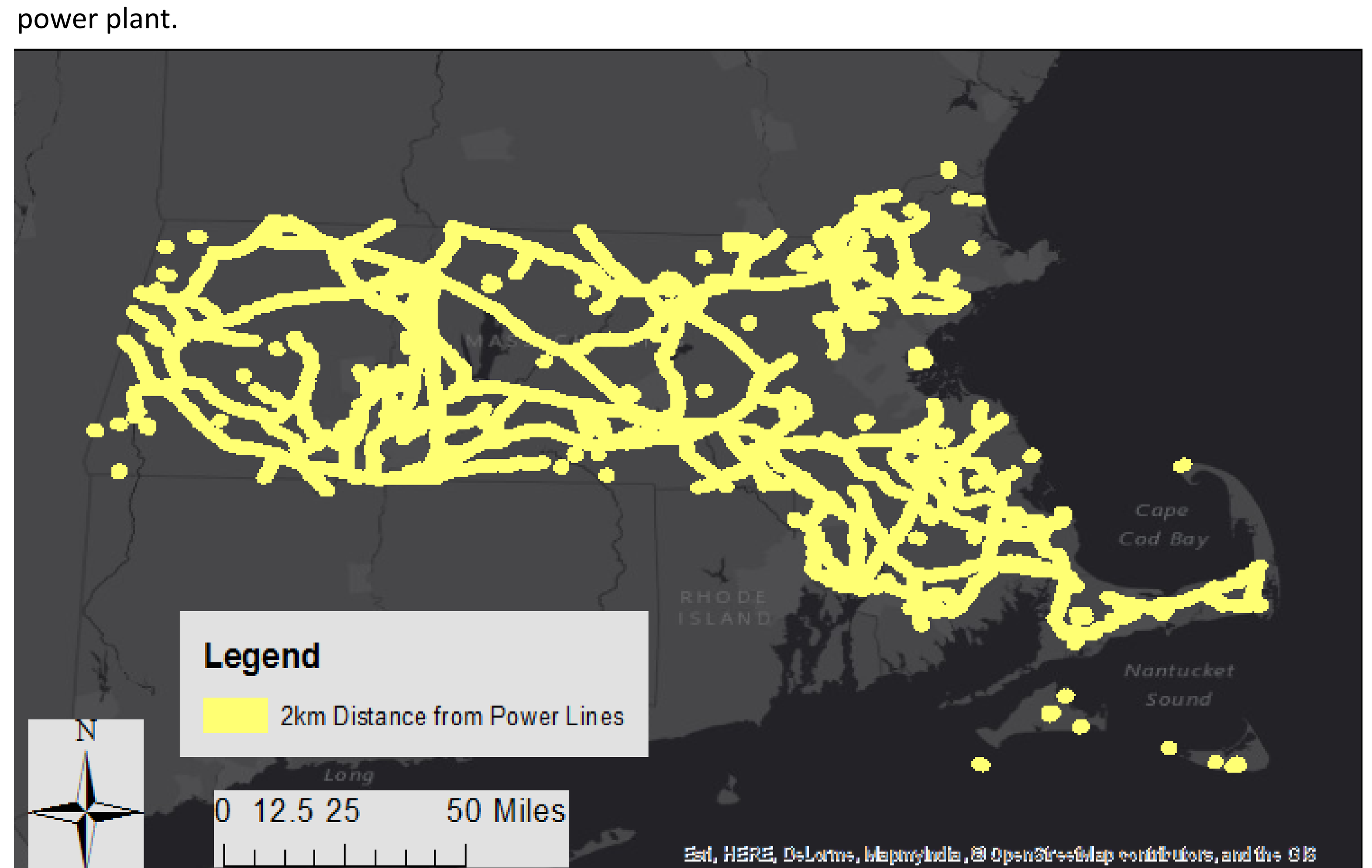
The project began with the creation of the three layers that are shown on the right. These formed the backbone of my project by allowing me to identify the parcels that were suitable for wind development based on their wind suitability. Once I had these layers combined into a single layer showing all the suitable sites in Massachusetts, I used this layer as an outline to clip the parcel data, so that I was only left with the parcels that were present within areas of suitable wind energy potential. This allowed me to begin a financial analysis of the remaining parcel layers. The first parcels that I ruled out were parcels that were smaller than 1.05 million square feet. Based on the National Wind Watch's figures, an average GE wind turbine had rotors of 116ft, and the standard site needed for one of these was 10 rotors of distance in front and 3 rotors of distance on each side, which when calculated (1508ft length and 696ft width) was just about 1.05 million square feet. Once the parcels above 1.05 million square feet were isolated, the parcels with a total value of less than 25 million dollars were isolated within the remaining parcels. This was chosen because in general most of the remaining properties were below 25 million, and the few that weren't often skyrocketed as high as a total value of over a billion dollars, which was not even close to being financially feasible. Finally, in order to determine which large, relatively cheap parcels did not have a significant percentage of building already built on them, a standard of less than 1% building percentage was applied to the remaining parcels to find the few hundred that fulfilled all of these requirements. The remaining parcels were very strong candidates for evaluation by a business, and would save a business or other financial body a significant amount of time to analyze.



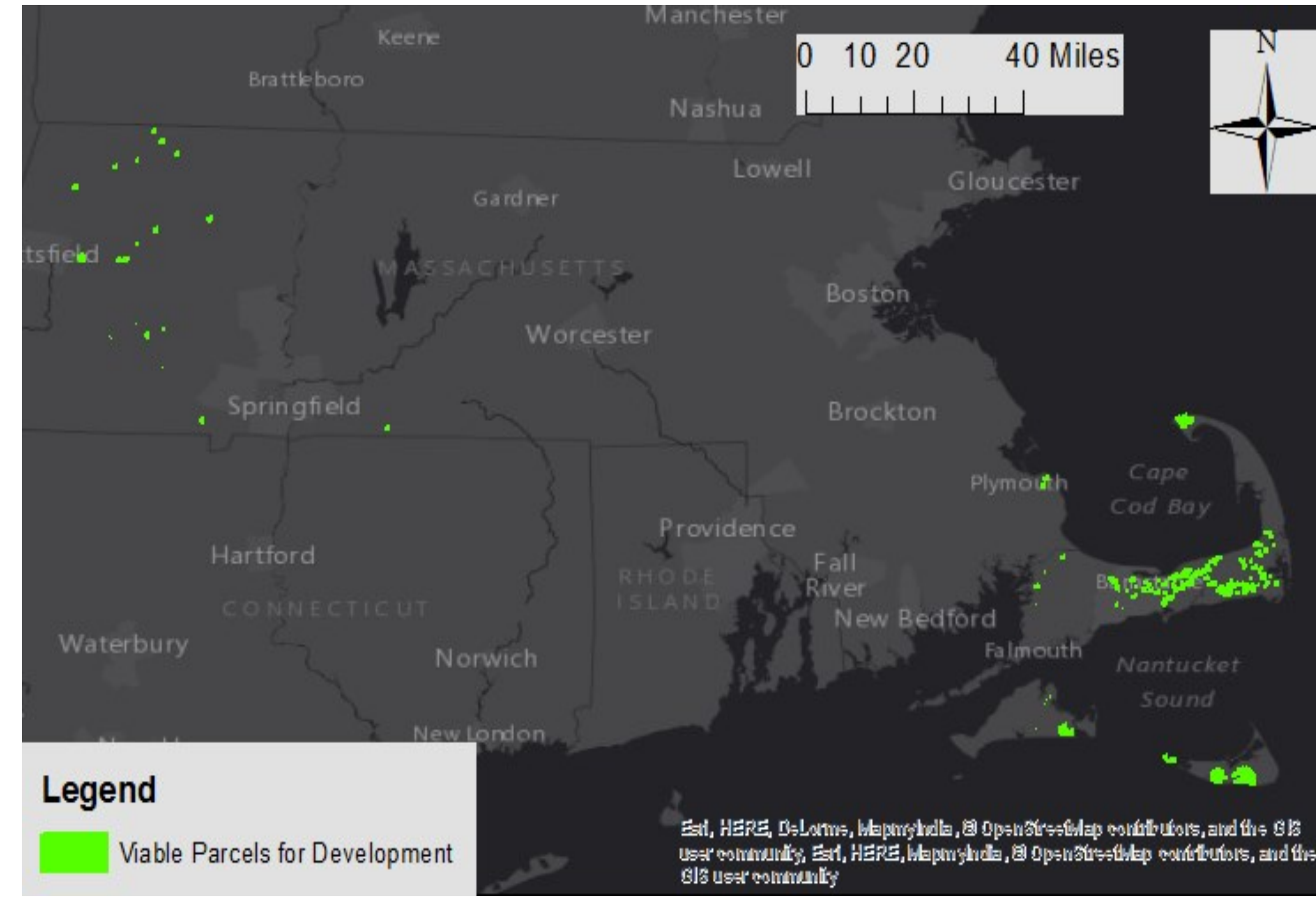
This map was created with the data regarding wind at 50m in Massachusetts provided by NREL. This map gives a baseline for identifying parcels that contain suitable wind levels for construction of a wind turbine by cutting out all of the regions in Massachusetts where the wind quality was either marginal or poor.



This map was derived from MassGIS elevation to find the slope of Massachusetts, and then reclassified into either suitable or unsuitable slopes. This allows for the identification of parcels that not only have reliable wind speeds, but also are on a slope that allows for easy construction of a wind turbine and/or power plant.



This map was created using the existing power lines data in MassGIS. This map was the third of three criteria to determine the viable wind turbine locations. By finding the spaces of suitable wind and slope that were within 2km of a power line, it eliminated the need for the wind turbine locations to have electric infrastructure built to provide access, which would have been expensive for an investor. By combining all three of the above maps, the suitable parcels could be identified for financial analysis.



Financial Analysis of MA Land Parcels for Wind Turbine Construction

Source: MassGIS on the Tufts M: Drive, NREL Wind Data at 50m, Massachusetts Land Parcel Database,

Results:

The designation of a parcel of land in Massachusetts as viable for development by a business or government body consisted of several requirements:

1. Wind speeds that ranked fair or above based on the NREL database
2. Slope that was less than 10% on the parcel's land
3. A distance of less than 2 kilometers from a power line
4. A total land value of less than 25 million dollars for cost minimization
5. A lot size greater than 1.05 million square feet to accommodate for the size of a wind turbine, based on the National Wind Watch's recommendations
6. Less than one percent of the land having buildings constructed

Overall, there were 287 parcels in Massachusetts that survived the rigorous parameters set out by these methods. Of these 287, there were some results that were more promising and some that were potentially less promising. The most promising were the parcels that were either classified as "Industrial Use," "Single Family Properties", "Duplex/Triplex" residential lots, and "Agriculture and Outdoor Recreational Activities" parcels. These parcels seem to indicate the potential for business discussions between a company and a land owner about the construction of wind turbines on or near the lot. On the other side, 157 of the 287 parcels were designated as "Tax Exempt Properties such as Public Properties, Charities and Local Properties." Although these could be very accessible lots as the local or public officials might be very eager to construct wind facilities in their lots, they also might be much more difficult to negotiate, especially with the bureaucracy of the government or the tricky situation of a charity. The total value estimate of the lands also vary greatly and a few were not assigned values by the Metropolitan Area Planning Council, so that the total value of the land may end up being more of a general guideline than an actual price. However, regardless of the individual parcel fluctuation, all of the parcels identified have a strong potential for wind turbine and energy development by a company or investment group and would provide both relatively cheap construction opportunities and reliable wind power for the future development of clean, renewable energy in Massachusetts. Although it was impossible to actually include a table displaying all of the suitable parcels for construction of wind turbine in Massachusetts, some of the potentially best results, as outlined above, are shown below.

Viable Parcels for Development

FID	Shape *	objectid	mapc_id	muni_id	muni	poly_typ	total_valu	ls_price	lot_areaft	pct_imperv	pct_bldg	pct_pave	totv_pac	bldlnd_rat	sqm_bldg
30132	Polygon	711323	711322	59	Chester	FEE	47900	853953	37166517.5246	0.300644	0	0	56.139885	0	-0.9999
30079	Polygon	636450	636450	22	Becket	FEE	63700	0	2117369.63824	0.020334	0	0	1310.480676	0	-0.9999
30160	Polygon	1089233	1089232	190	Monroe	FEE	75600	1	7640406.9959	0.010566	0	0	431.015779	0	-0.9999
30156	Polygon	1089229	1089228	190	Monroe	FEE	111400	125000	4393902.22643	0.328975	0.004597	0.324378	1104.390512	0	18.764429
30075	Polygon	427197	427197	132	Hinsdale	FEE	142500	5000	15524886.1553	0.00789	0	0	399.829019	0	-0.9999
30186	Polygon	1216930	1216929	237	Plainfield	FEE	164300	1	3068976.76106	0.353615	0.047537	0.306077	2332.017531	0.417601	135.537451
30155	Polygon	1089228	1089227	190	Monroe	FEE	191100	300000	3274405.47825	0.193773	0.07194	0.121833	2542.237322	0.876448	218.843473
30149	Polygon	878149	878148	112	Granville	FEE	216678	0	1868980.57327	0.260804	0.177917	0.082887	5050.075677	2.408066	308.924957
30043	Polygon	3130	3130	4	Adams	FEE	217000	0	119673200.129	0.200014	0.011974	0.18804	78.986105	2.224369	1331.234154
30183	Polygon	1197531	1197530	233	Peru	FEE	233300	0	1264334.67377	0.491071	0.183501	0.30757	8037.862119	3.842742	215.540968
30054	Polygon	275084	275084	70	Dalton	FEE	238100	250000	8858298.90527	0	0	0	1170.838341	0	-0.9999
30190	Polygon	1216958	1216957	237	Plainfield	FEE	238900	42500	1293427.41251	0.566446	0.172512	0.393934	8045.66584	2.462319	207.296679
30178	Polygon	1197198	1197197	233	Peru	FEE	270900	0	2910778.80108	1.036094	0.062406	0.973688	4054.036451	2.490421	168.758407
30148	Polygon	878147	878146	112	Granville	FEE	330800	0	1236110.48697	1.206662	0.375108	0.831553	11657.249029	1.523265	430.768202
30047	Polygon	15655	15655	13	Ashfield	FEE	349700	0	2161313.45682	0.478238	0.193408	0.28483	7047.997966	1.859362	388.348696
30062	Polygon	324583	324583	253	Rowe	FEE	368100	1	6407727.77304	0.091699	0.04707	0.044629	2502.359182	1.180687	280.204762
30146	Polygon	878091	878090	112	Granville	FEE	386800	0	1839506.9566	1.416655	0.126428	1.290227	9159.524105	1.984568	216.059943