Ethan Stoneburner / 12 December 2018 / GIS 2

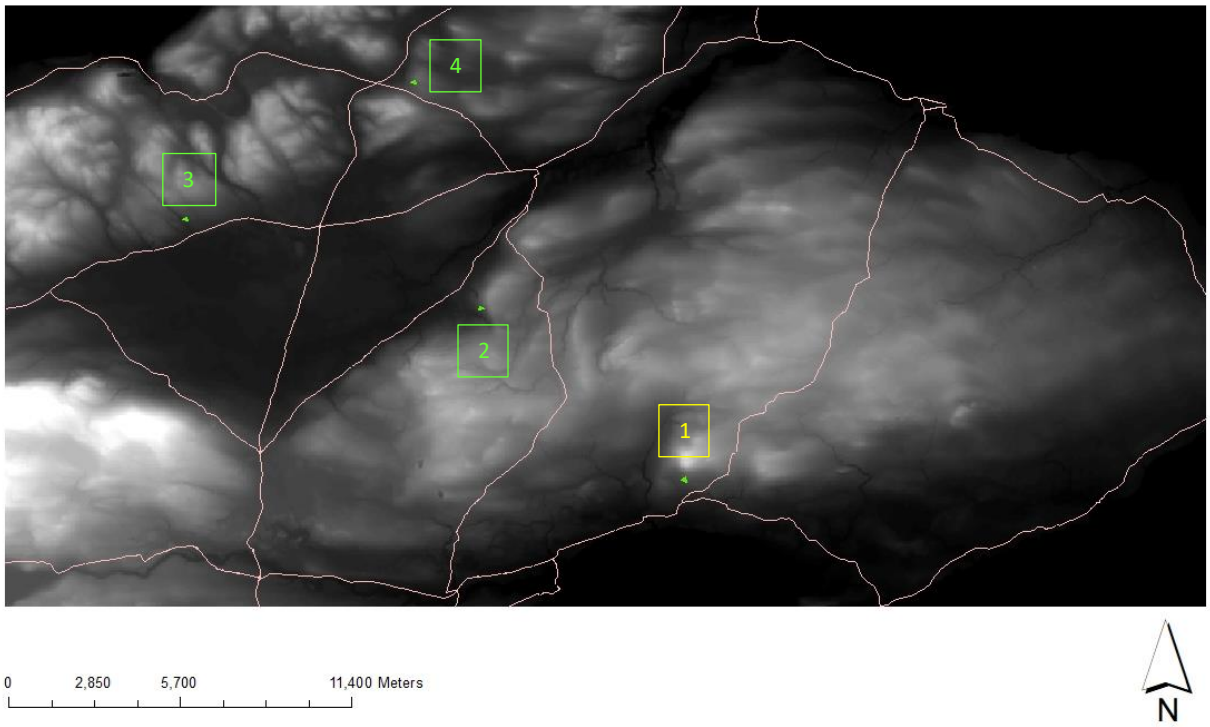
The following geographical study attempts to find the land best suited for a prospective wind farm in a 20-kilometer by 40-kilometer area in Fife, Scotland. Criteria for the initial analysis were as follows: the aspect of the land must face the southwest, the elevation must be at least 50 meters above sea level, wind speed at ground level must be at least 5 meters per second and the slope of the land must be between 8 and 15 degrees. To derive data from these constraints, a digital elevation map was downloaded from DigiMap to cover the assigned area, which can be seen in the data models below. With the data held within the DEM, a simple raster calculation was done to map the land thalis above 50 meters. Also from this map, the aspect function and slope function were run, respectively, to show data concerning aspect and slope. From these two new raster files, another raster calculation was run in order to isolate the southwesterly-facing land, as well as the land lying between 8 and 15 degrees. The data from these three calculations were multiplied together to create a Boolean raster titled “sXaXe”; highlighting the areas that fulfilled all three of the above calculations. For the wind speed analysis, data was downloaded from the National Archives in the form of a spreadsheet. After converting the spreadsheet into an ASCII file and importing the data into ArcMap, the rather large raster was first converted into a point file, with each point containing specific wind speed data, and then bac into a higher-resolution raster file, from which more accurate wind speed data could be derived via the raster calculator.

Additionally, the site would have to be 250 meters from any woodland, 200 meters from any river, 500 meters from an urban area, completely outside of any SSSI conservation area, as well as being at least 500 meters from public road access, and within a kilometer of a major highway, for connections to the National Power Grid. For these criteria, data in the form of shapefiles for all of the above – save for SSSI data – was found on DigiMap. To derive a major highway shapefile – since all that was available was one containing all roads – roads within the shapefile under the value “A-Road” were selected and exported as their own shapefile. From here, a Euclidean Distance raster was created, and raster calculation was done in order to derive a Boolean raster file that highlighted everything within one kilometer of the major roads. The Euclidean Distance to raster file process was repeated for all of the DigiMap-downloaded data, however each with their own respective constrictions. SSSI data was found on the Scottish National Heritage website and downloaded as a shapefile. Since polygon files cannot be easily compared to raster files, the SSSI shapefile was converted into a “Boolean” raster file, where area that the SSSI covered was a “0” and all other area counted as a “1”. With all of the requested criteria now in the form of Boolean raster files, the last step was to multiply each layer together in the raster calculator to get raster file containing the final sites, and to convert that product into a polygonal shapefile.

For the Initial Criteria requested, none of the suitable areas met the minimum area criteria of 25,000 square meters. Three of the top four sites measured at around 8,600 square meters, and the largest site measured in at 17,110 square meters. Points were placed within each site area for the purpose of point-based statistic interpretation. Data concerning the affected population was retrieved by creating a viewshed for each individual point, converting the subsequent raster into a polygonal vector file and thus selecting the census wards that intersected the produced vector file. Finally, the sum of the affected population was found by accessing the Statistics window for the selected wards and organizing by the field “Popcount”, which contains population info from the 2011 census.

(IC)	Area (sq. meters)	Minimum Speed	Maximum Speed	Average Speed	Approx. Population Affected
Site 1	17110.366611	6.6247	6.8078	6.71625	4,655
Site 2	8694.982964	5.79559	5.91703	5.85631	10,931
Site 3	8595.947477	5.50642	5.56872	5.53757	7,602
Site 4	8595.882101	6.29894	6.30065	6.299795	1,153

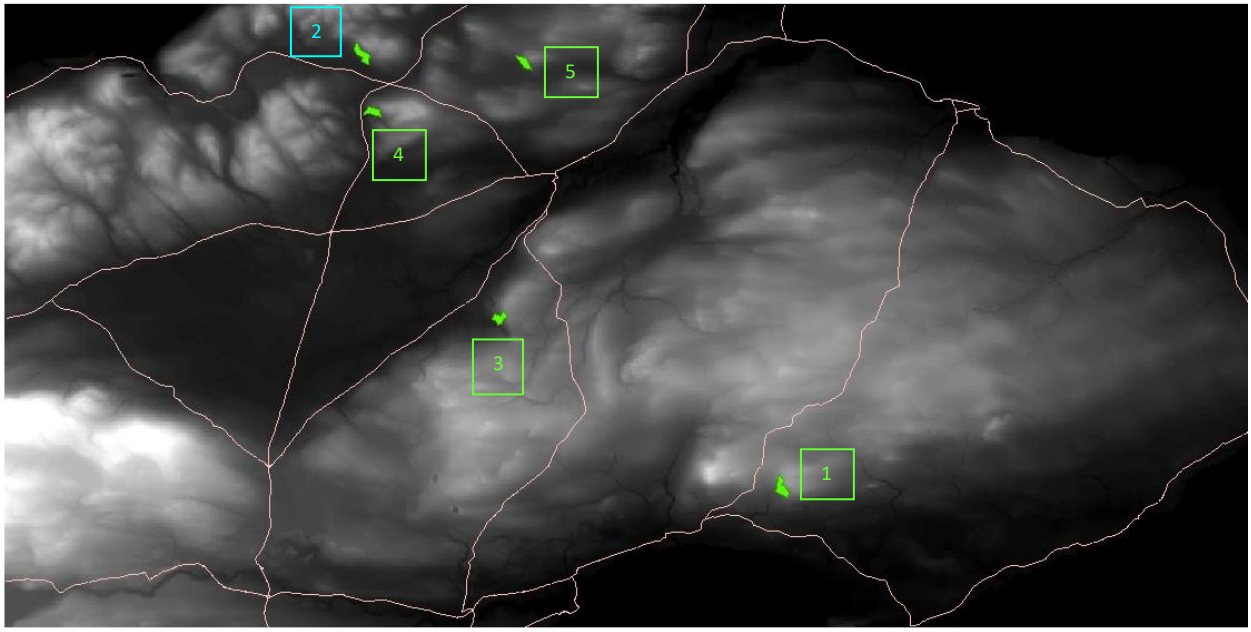
Initial Criteria Model, Final Selection



For the Modified Criteria section of the assignment, the factors of aspect, elevation, slope, wind speed, SSSI area correspondence, road access and distance from urban areas were kept the same. National Grid access was extended from one kilometer to 1500 meters, since the profits from the prospective wind turbines to cover the area override the extra cost of connecting 500 more meters of power supply lines. Necessary distance from rivers was shortened from 200 meters to 100 meters; still a safe distance from water, and non-issue concerning flood problems with the geography of Scotland's hills and valleys. Lastly, since the 250-meter distance from all woodlands curbed the final selection of areas by quite a great deal, that distance was shortened to 50 meters; still a perfectly reasonable and safe distance from any trees that may be in the way.

(MC)	Area (sq. meters)	Min. Speed	Max. Speed	Avg. Speed	Approx. Pop. Affected
Site 1	155709.88	6.6155	7.03387	6.824865	56,533
Site 2	138790.43	6.30688	6.6	6.45344	3,682
Site 3	109069.53	5.67088	6.23841	5.954645	12,453
Site 4	94205.69	6.0019	6.39787	6.199885	9,355
Site 5	90713.13	6.49502	6.5541	6.52456	3,646

Modified Final Criteria, Final Selection



As seen in the final models, when the criteria for certain factors regarding the development of this site (i.e. distance from woodlands) was changed, there were many more sections of land that became available for use; ones much larger than in the initial criteria, as well. In fact, the site with the largest area – and also the highest average speed – ended up being too large for the final factor of area limits. The upper threshold of area allotted for this side is 15 hectares (or 150,000 square meters), and the op site measured in at nearly 15.6 hectares. Therefore, it was determined that the most suitable site for a wind farm to be built in this region is Site #2 in the Modified Criteria dataset, with an area of 13.88 hectares, an average wind speed on 6.45 meters/second and an estimated visibility by only 3,682 people.

Sources:

DigiMap

UK National Archives

Natural Spaces, Scottish Natural Heritage

National Records of Scotland