Is the expansion of onshore wind energy influenced by political developments?

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Introduction

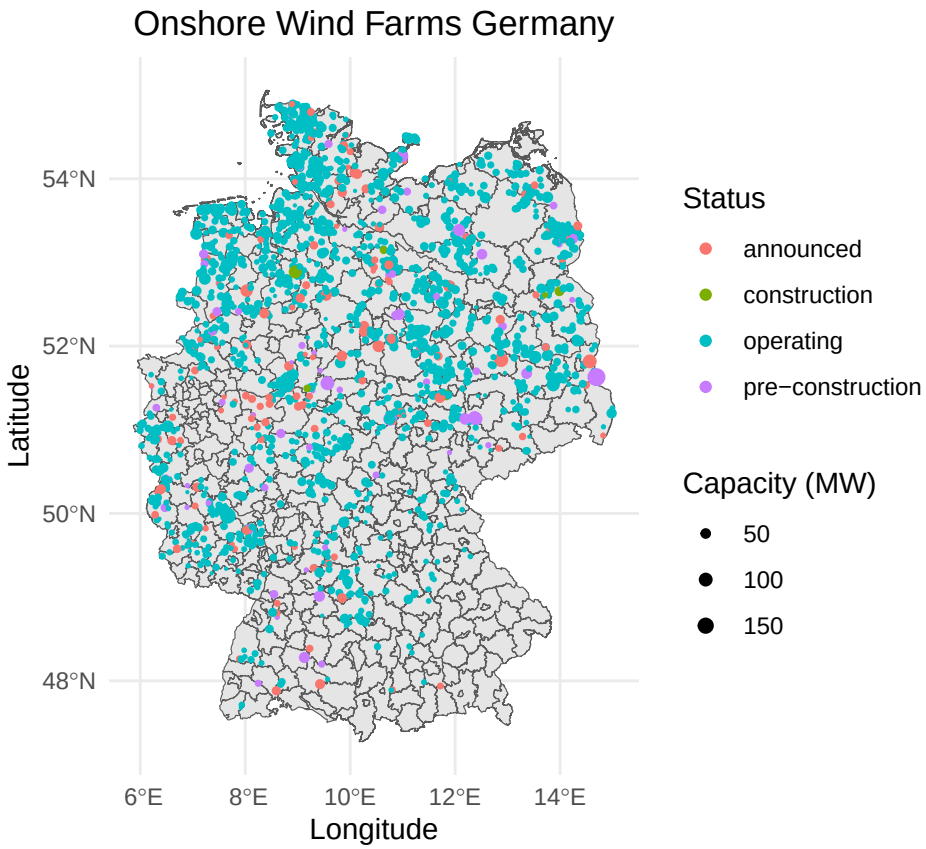
Part of Germany's energy transition strategy to meet mandatory climate targets and reduce carbon emissions is to increase the construction of onshore wind farms, as they are carbon neutral and have a relatively low levelized cost of energy (LCOE). However, with growing support for right-wing parties and a strengthening of the conservative middle, one might wonder how this will affect the continued integration of renewables. Many people doubt the existence of anthropogenic climate change and therefore do not necessarily see the need to build renewables. In particular, there is significant opposition to the construction of onshore wind farms. Therefore, the aim of this project is to investigate whether there is an actual correlation between recent election results at the municipal level, taken as a measure of political orientation, and the existence and construction of wind farms in the respective districts.

Data

Vector Data

For this project two vector data sets are being used. The 2021 federal election results as well as the municipality shapefiles are from https://www.zeit.de/politik/deutschland/2021-09/ergebnisse-bundestagswahl-gemeinde-karte and the district-level of Germany is pulled from https://gadm.org/download_country.html. The wind point layer is created on basis of the most recent international Global Wind Power Tracker accessible under https://globalenergymonitor.org/projects/global-wind-power-tracker/. It has only wind farms with an minimum capacity of 10 MW.

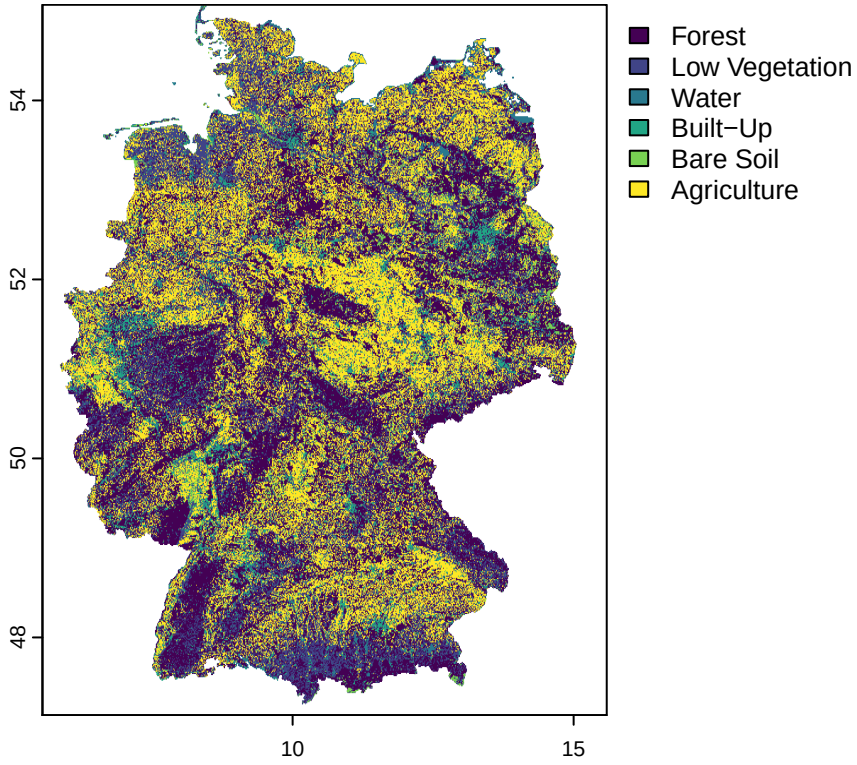
Visualisation of the used wind farm points on the base layer of Germany (district level):

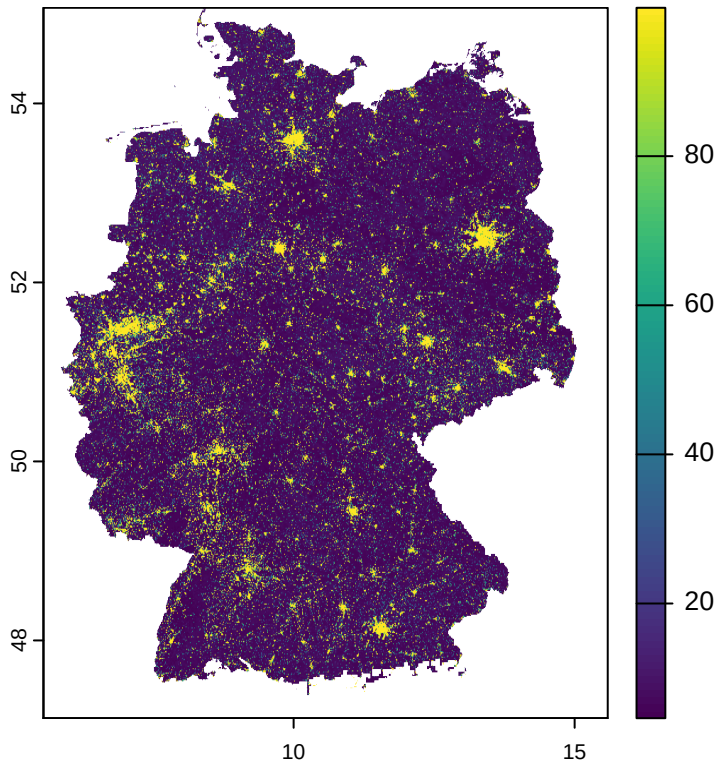


Simple feature collection with 6 features and 12 fields Geometry type: POINT Dimension: XY Bounding box: xmin: 6.0244 ymin: 50.8086 xmax: 12.9269 ymax: 53.6189 Geodetic CRS: +proj=longlat +datum=WGS84 +ellps=WGS84 +towgs84=0,0,0 # A tibble: 6 x 13 `Date Last Researched` `Country/Area` `Project Name` `Phase Name`
1 2022/04/05 Germany AWOMO wind farm RP-2012
2 2022/04/05 Germany Aachen wind farm –
3 2023/04/05 Germany Abens-Nord wind farm 1
4 2022/04/05 Germany Abens-Nord wind farm 2
5 2022/04/05 Germany Ablaß wind farm –
6 2022/04/05 Germany Achmer Vinte Renditefonds ~ –
i 9 more variables: `Other Name(s)` , `Capacity (MW)` , # `Installation Type` , Status , `Start year` , # Operator , `Local area (taluk, county)` , `State/Province` , # geometry <POINT [°]>

Raster Data

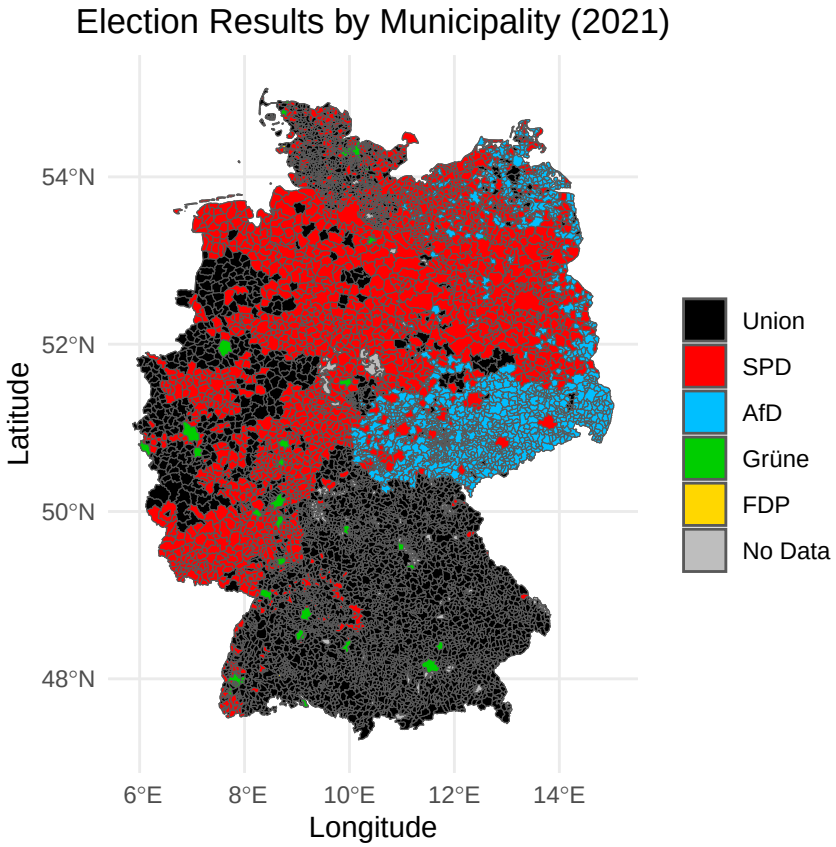
Two raster are included in this project. One is a mean wind speed raster at a height of 140m, which hereby is assumed as the average hub height of future wind turbines in Germany (https://opendata.dwd.de/climate_environment/CDC/grids_germany/). The data comes from a TU Dresden research project examining future wind parameters. Secondly a land use raster is utilized which was constructed on the basis of Sentinel-2 satellite data and categorizes Germany into six categories (https://www.mundialis.de/en/germany-2020-land-cover-based-on-sentinel-2-data/)


Forest
Low Vegetation
Water
Built−Up
Bare Soil
Agriculture
54
52
50
48
10
15



Data Manipulation & Wrangling

In the processing steps the data representing the German federal election 2021 is joined with the corresponding municipalities. Each polygon shows the color of its strongest party in terms of percentage.

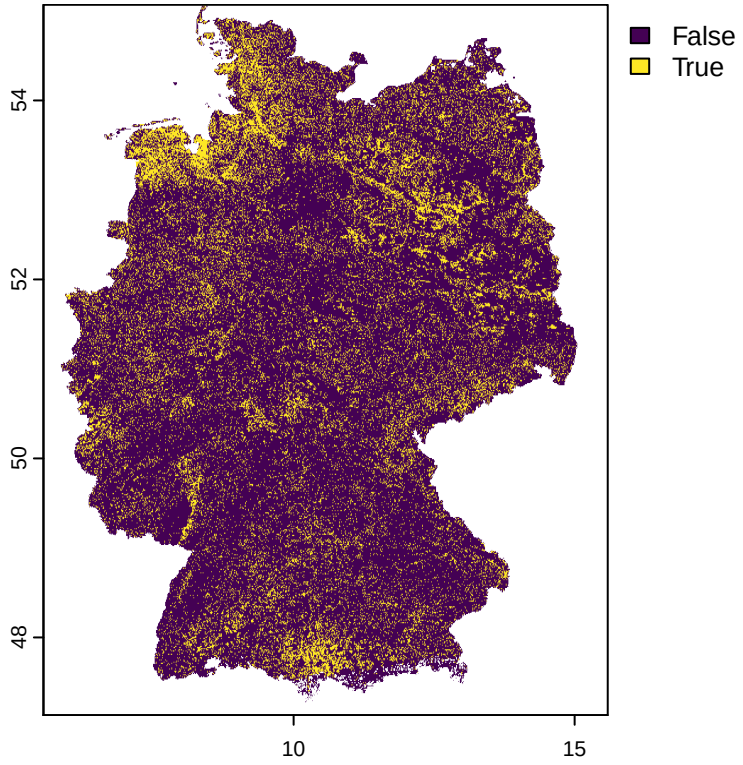


Simple feature collection with 6 features and 11 fields Geometry type: MULTIPOLYGON Dimension: XY Bounding box: xmin: 6.827441 ymin: 49.17285 xmax: 10.95672 ymax: 54.83708 Geodetic CRS: +proj=longlat +datum=WGS84 +ellps=WGS84 +towgs84=0,0,0 # A tibble: 6 x 12 AGS Municipality `Valid votes` Union SPD Linke AfD FDP Grüne Sonstige 1 10010~ Flensburg 50779 14.1 24.6 6.2 5.4 9.4 24.2 16.1 2 10020~ Kiel 139934 14.5 26 6.4 5 10.3 28.9 8.9 3 10030~ Lübeck 117674 17.6 30.7 4.6 6.6 10.2 23 7.3 4 10040~ Neumünster 39971 20.2 32.2 3.3 9.4 11.9 14.6 8.4 5 10041~ Saarbrücken 89092 18.7 38.3 11.2 8.7 11.9 0 11.2 6 10041~ Friedrichst~ 5890 20.3 39.6 6.9 13.2 10.3 0 9.7 # i 2 more variables: geometry <MULTIPOLYGON [°]>, Strongest_party

The main reason for using 2021 federal election data is the different timeframe for regional elections, which would have made comparisons difficult.

In the next steps, the raster data is reprojected and resampled before being converted into a logical raster. The aim here is to make an assumption about where wind farms can be built in the first place and where is sufficient wind. Therefore, the wind speed raster is conditioned on all pixels with a wind speed of at least 7m/s at a (hub) height of 140m, and the land use raster is filtered for all but the areas that fall into either the 'Low Vegetation' or 'Bare Soil' categories, as these can be considered the most suitable for siting wind turbines.

Overlaying the two conditional raster produces this result, with the TRUE-valued pixels representing "suitable" land:

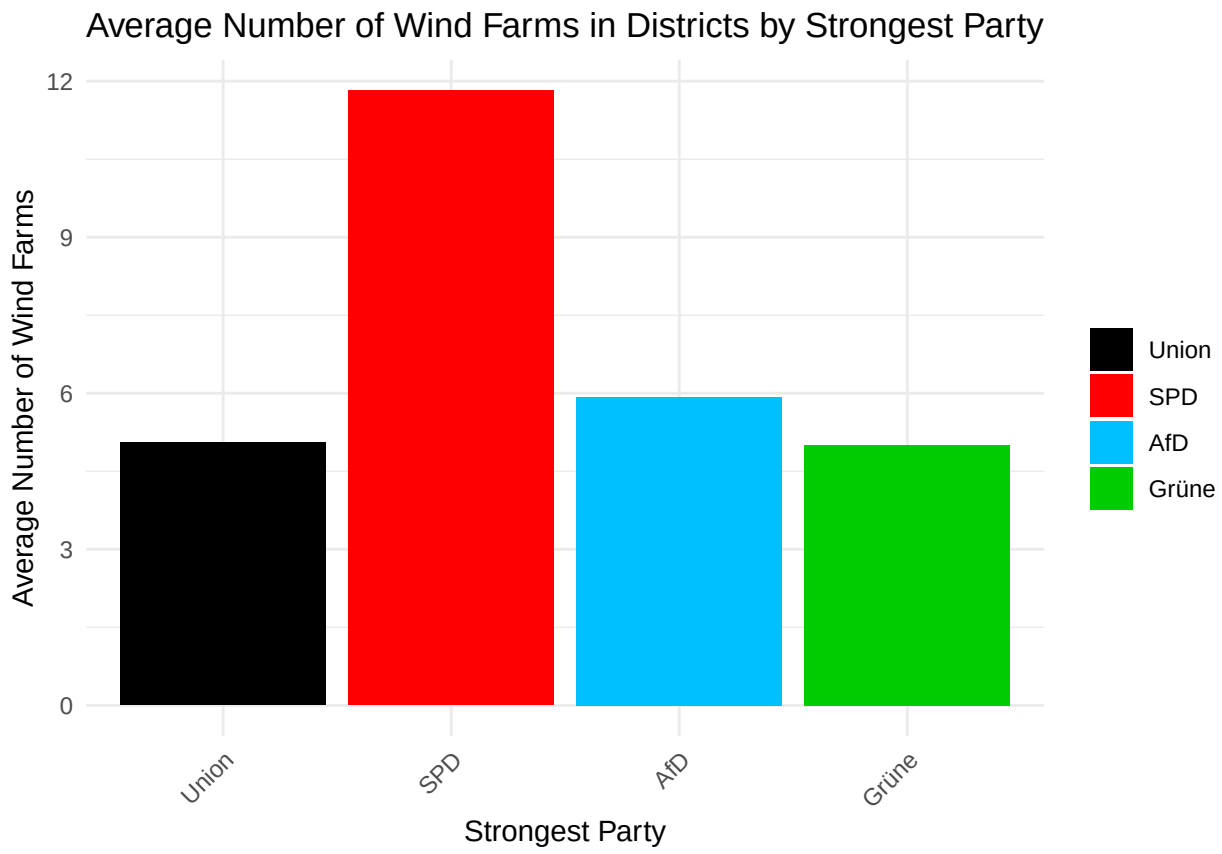


Analysis

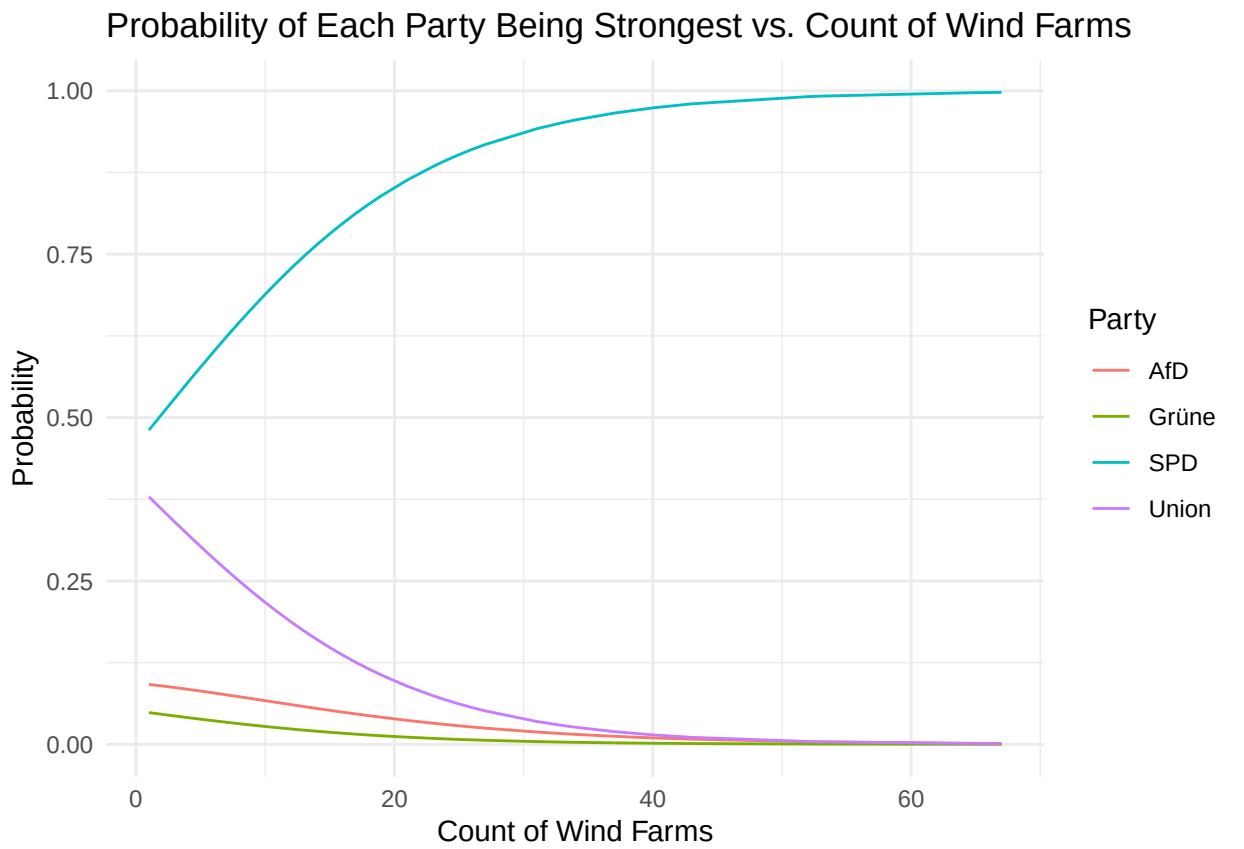
The combined logical raster is now being used to subset the districts vector. Hereby it is presumed that at least 10% of the district area must be considered usable for the district to be included in further analysis.

As the original plan to look at the wind farm distribution at municipal level was discarded due to a lack of wind farm points, the election results are aggregated up to district level instead. The same reasoning applies to the use of all wind farm points. Due to the use of election results from 2021, it would have made more sense to only consider wind farms that were built in the period after that. However, the analysis would be much more difficult due to a lack of data points.

In the final step, two regression / correlation methods are applied to the final results. A basic histogram overview shows that the SPD has the highest average number of wind farms in the respective districts.



As the analysis is carried out with one categorical and one numerical variable, a linear regression model seems rather impractical. Thats why in a second step a multinomial Log-linear model is utilized. The results by both models suggest a weak positive correlation between the presence of wind farms and the likelihood of the SPD becoming the largest party, less so for the AfD and even less so for the Grüne. Implying a significant uncertainty about the impact of wind farms on political dominance. Given the low R-squared values (0.01524), the explanatory power of the model is limited, therefore additional variables would be better suited to explain variations. The p-value of 0.0531 suggests a hint of a positive relationship, but more data and in-depth analyis would be necessary.



A tibble: 2 x 5 term estimate std.error statistic p.value 1 (Intercept) 1.83 0.0606 30.2 1.91e-78 2 count 0.00491 0.00418 1.17 2.41e- 1

Conclusion

In summary, the very comprehensive approach and methodology of this project leaves much room for further research. However, no meaningful conclusion could be drawn here because the analysis was relatively narrow compared to the data processing. The results are only minimally significant and more data and more variables would be needed to make more substantive statements. Besides, to assess the influence of the political variable, more than just the strongest party in each district would have to be taken into account. With a more detailed use of wind speeds, and possibly considering the power capacity of the wind turbines, it would also be possible to develop a more detailed metric. so there is still a lot of room for this topic.