International Journal of GEOMATE, Dec., 2020, Vol.19, Issue 76, pp. 149–156
ISSN: 2186-2982 (P), 2186-2990 (O), Japan, DOI: https://doi.org/10.21660/2020.76.ICGeo3
Special Issue on Science, Engineering and Environment

GIS APPLICATION FOR DETERMINING POTENTIAL LOCATIONS FOR THE DEVELOPMENT OF WIND POWER PLANTS

*Fachry Dzaky Al Qadri Sabil[1], Astrid Damayanti[1] and Taqyuddin[1]

[1]Faculty Mathematics and Natural Science, Departement of Geography, University of Indonesia, Indonesia

*Corresponding Author, Received: 21 Feb. 2020, Revised: 16 April 2020, Accepted: 28 July 2020

ABSTRACT: The energy demand—in Indonesia in particular—and generally in the world are increasing due to population growth, economic growth, and the pattern of energy consumption. Meanwhile, petroleum reserves are estimated to decrease. Therefore, a solution to diversify electricity power plants with environmental friendly alternative energy sources is wind energy. Gunung Kidul regency is one of the regencies that is suitable as a potential location for wind power plants with an average wind speed of more than 4 m/s and has a frequency of more than 90 days. The purpose of this research is to analyze the most potential locations for wind power plants. The variables used in this research are average wind speed, road network, residential area, slope, altitude, and land use in 2015. The data was collected from agencies such as the Geospatial Information Agency, WindPRO wind energy consultancy, and field surveys. The results are processed using ArcGIS and WRPlot View. Potential location is determined using spatial analysis, and the electricity demand of the potential region is determined using descriptive analysis. The result indicates that the possible site for the development of wind power plants is in Tepus village, Gunung Kidul Regency. The average wind speed was 6,2 m/s, with the dominant wind direction blowing from the southeast and frequencies ranging from 9 to 198 days. The electricity demand in Tepus Village based on survey results in 2019 is up to 308.758 kWh/month, with the highest market coming from the housing sector with a power of 450 VA.

Keywords: GIS Application, Wind Energy, Electricity Needs, Weighted overlay

1. INTRODUCTION

Energy demand—in Indonesia in particular—and generally in the world are increasing due to population growth, economic growth, and the pattern of energy consumption [1]. The increase in national electricity consumption is not proportional to the availability of energy [2].in 2030, renewable energy needs are increased by 25 to 27 percent, in 2050, renewable energy needs are projected to grow 30 – 51 percent, to fulfill the world renewable energy needs, wind energy is predicted to satisfy renewable energy needs by 21 percent [1].

One of the options available in renewable energy in Indonesia is a wind power plant. The wind power plant has several advantages because they are renewable, this explains that the exploitation of this energy source will not make wind resources reduced as does the use of fossil fuels that have an impact on the energy crisis [3]. Wind energy is proven to be the most developed and most environmentally friendly energy when compared to fossil energy [4]. For this reason, renewable energy is a need because the price of fossil fuels is unstable and is feared to cause damage to the world’s climate [5].

For almost ten years, the development of wind energy in the world is swift and sustainable [3]. The use of wind as a wind power plant in Indonesia has only been utilized by 0,0006 percent [6]. In Europe, it is predicted to save costs due to the electricity use of up to 27 million euros in 2020 as a result of the use of wind energy as renewable energy [1]. Related to the national electrical energy needs that are not comparable with the availability of existing energy, efforts to diversify power plants with environmentally friendly alternative energy sources become an urgent matter. This effort is in line with Indonesia’s commitment, as stated in the national action plan for climate change mitigation, as an effort to achieve the target of reducing greenhouse gas emissions by 26 % by 2020 [7].

Regarding Indonesia's target to reduce greenhouse gases, efforts to develop wind power are an urgent matter. Thus the dependence on fossil energy can be reduced. Energy use is also related to choosing the right location to determine the area of wind power generation. Gunung Kidul Regency is one of the districts that is suitable as a potential location for the development of wind power plants in Java. The average wind speed in Gunung Kidul Regency is higher than 2.5 m / s and has an average wind speed frequency of more than 90 days with an average minimum wind speed of 4 m / s [8,9].

2. LITERATURE REVIEWS

Previous researches have used as a consideration for the concepts, variables, and methods of this study. Chaouachi et al. [1] doing off the Baltic-states, using the Analytical Hierarchy Process (AHP) method to find the right location for the development of wind turbines, used three variables in this study namely average wind speed, investment data, and electric charge data. Al-Yahyai et al. [10] researching to find suitable locations for the development of wind power plants in the country of Oman. In this study, six variables used, such as average wind speed, air turbulence pressure, dunes, slope, settlement area, and road network, this study used the AHP method as a consideration for the weight of each variable. Villacreses et al. [11] doing research to find potential locations for the development of wind power plants in Ecuador, used 7 variables in this study, such as residential areas, flood-prone areas, volcanic-prone areas, airport areas, protected forest areas, mangrove areas, and archaeology areas, in this study was used multi-criteria method used to determine the weight of each variables. Mahdy et al. [12], research to find potential locations for the development of wind power plants in the offshore area of Egypt, used five variables in this study, namely exclusion buffer zones, protected areas, residential areas, tourist sites, and wind speed average. Anwarzai et al. [13] researching to find potential locations for wind and solar energy in Afghanistan, used five variables in this study, namely land use, land slope, road network, river network, and residential areas. The method used in this study is the weighted weighting method of Latinopoulos et al., i.e., the weighting of each variable to see where the most potential location [4] researching to finding possible locations of wind power plants in Greece. Five variables used in this study are protected land, archaeological site, road network, wind speed average, and airport area. This study uses a weighted overlay method to find potential locations. Noorollahi et al. researched in Iran to find the place with the most potential for developing wind power plants [14]. Three variables used in this study are average wind speed, distance from electricity, and road network. Next, the weighted overlay method is used to determine the weight of each variable. Ali et al. [9] found a potential location in Thailand for use as an area for developing wind power plan. The variables and their weight value for each variable are used as the basis of this research, used five variables, land use,

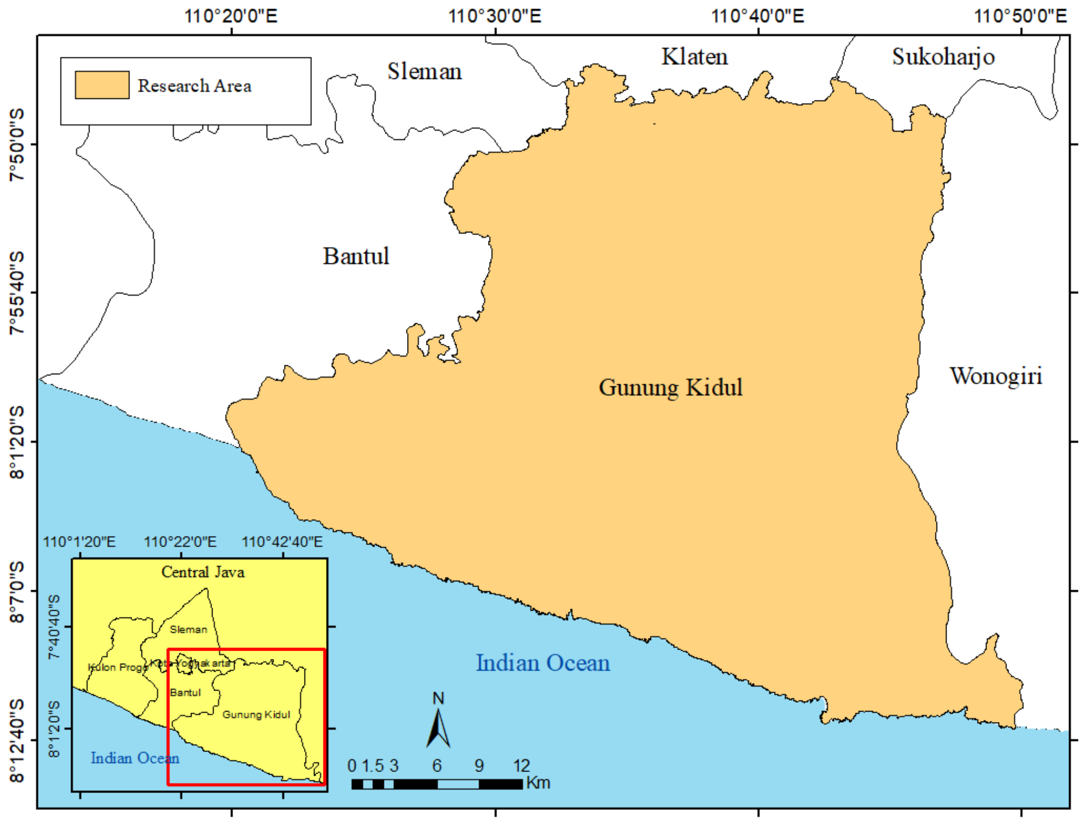

Fig.1 Research Sites of Gunung Kidul

road network, residential areas, slope, and altitude. The method used in this research with a weighted overlay is weighting each variable.

3. METHODOLOGY

3.1 Study Area

Gunung Kidul Regency located in the Special Region of Yogyakarta, and geographically situated at 110° 21' - 110° 50' east longitude and 7° 46' - 8° 09' south latitude (Fig.1). The total area of Gunung Kidul Regency is 1.485,36 km² or equivalent to 46,63% of the total area of all regencies in the province of Yogyakarta, as the largest district in Province of Yogyakarta. Gunung Kidul Regency has 18 sub-districts, 144 villages, and 1431 residents [15]. Gunung Kidul Regency is administratively directly adjacent to several regencies, the northern part bordering Klaten and Sukoharjo Regencies, the eastern region bordering Wonogiri Regency, the southern part bordering the Indian Ocean, the western part bordering Bantul Regency and Sleman Regency. The research sites can be seen in Fig.1.

3.2 Research Framework

Research on energy is always related to the physical, economic, and social aspects [11]. In this study, two main elements examined in seeing how the potential of wind energy produced by wind turbines. The first aspects are the availability of wind energy, and the second aspect based on the electrical energy demand curve. The first aspect, the potential of the wind turbine seen from the variable average of wind speed, distance from the road network, distance from the residential area, land height, land use, and slope. From the six variables, then a potential location map for wind turbine development can be obtained. The second aspect is to analyze the electricity demand curve (electrification ratio). The electricity demand curve in Gunung Kidul Regency can show from the electrification ratio at the district level in potential locations, namely the ratio between the number of household heads who electrified and those who have not electrified. Then, the result of the two aspects is made descriptive analysis to determine where the best location for wind turbine development is for wind power plants.

3.3 Data Processing and Analysis Methods

Data collected from various institutions. Data on average monthly and annual wind speeds in 2015 obtained from international EMD. Land use data obtained from Badan Informasi Geospasial (BIG) or Geospatial Information Agency (GIA) are then reprocessed to get housing areas, as well as road network data, slope, and height in 2015 processed from DEM data collected from BIG. The electrification ratio data obtained from village potential data, which included the ratio of household heads who used electricity to the overall proportion of family heads from the Central Statistics Agency in 2015 in Gunung Kidul Regency.

Data processing is carried out in the form of a weighting and scoring process for each variable with a weighted overlay for making work maps. A working map is made based on secondary data collected as a reference for field surveys and determination of sample points from each region on the work map. Field surveys conducted in villages that were potential areas to obtain primary data in the form of electricity demand figures based on monthly electricity bills. The sampling method is purposive sampling.

The analysis method in this study divided into spatial analysis and descriptive. The weighted overlay is a spatial analysis method using several map overlay techniques related to factors that affect the potential of wind turbine power plants. The overlay technique is carried out to get the results of research in the form of potential areas from the development of wind power plants in Gunung Kidul Regency. Before overlaying, the suitability of each variable made. Furthermore, the suitability comparison matrix is made to determine the location of the wind turbine electricity generator, namely the average wind speed variable 45.46%, the slope variable 8.96%, the high variable 11.96%, the road network variable 9%, the housing variable 13.96 % and land use variable 10.66% [9]. The weight of each variable shows in Table 1.

Table 1 Weight of each variable

No	Variables	Weight
1	Wind Speed Average m/s)	45,46%
2	Slope (%)	8,96%
3	Height (m)	11,96%
4	Road Network (m)	9%
5	Settlement (m)	13,96%
6	Landuse	10,66%

4. RESULT AND DISCUSSION

4.1 Altitude Area

The altitude in Gunung Kidul Regency is divided into four classes based on the classification by Ali et al. [9]. The location of height with a high suitability value with a height of 0 to 50 meters has an area of 22,78 km² or 1,6% of the total area of Gunung Kidul Regency.

Territory heights located in parts of the southern and southeastern part of the district Gunung Kidul. The area of altitude suitability with a medium level is an area with a height range between 51 to 100 meters. Its area is 48.96 km² or equivalent to 3.3% of the total area of the Gunung Kidul Regency and is in the south, southeast, and several regions of the western part of The Gunung Kidul Regency. From the table 2, Gunung Kidul Regency dominated by more than 200 m height range with 55,4 percentage of the total area in Gunung Kidul Regency. This means based on height, the region of Gunung Kidul Regency was dominated by Not Suitable Area for the development of wind power plant, but there's 1,6 percent of total area in Gunung Kidul Regency was clasified as High Suitable Area with total area 22,78 km² of 1472,49 km². The percentage of distribution of the height of the Gunung Kidul Regency seen in Table 2 and Fig.2.

Table 2 Distribution of height

Height Range (m)	Suitability	Total Area (km²)	Area Percentage (%)
0 - 50	High Suitable	22,78	1,6
51-100	Moderate Suitable	48,96	3,3
101-200	Low Suitable	584,92	39,7
>200	Not Suitable	815,83	55,4
Total		1472,49	100,0

Table 3 Distribution of Slope

Slope (%)	Land Suitability	Total Area (km²)	Area Percentage (%)
0 – 7	High Suitable	803,91	54,6
8 – 12	Moderate Suitable	340,46	23,1
13– 15	Low Suitable	100,07	6,8
> 15	Not Suitable	228,05	15,5
Total		1472,49	100,0

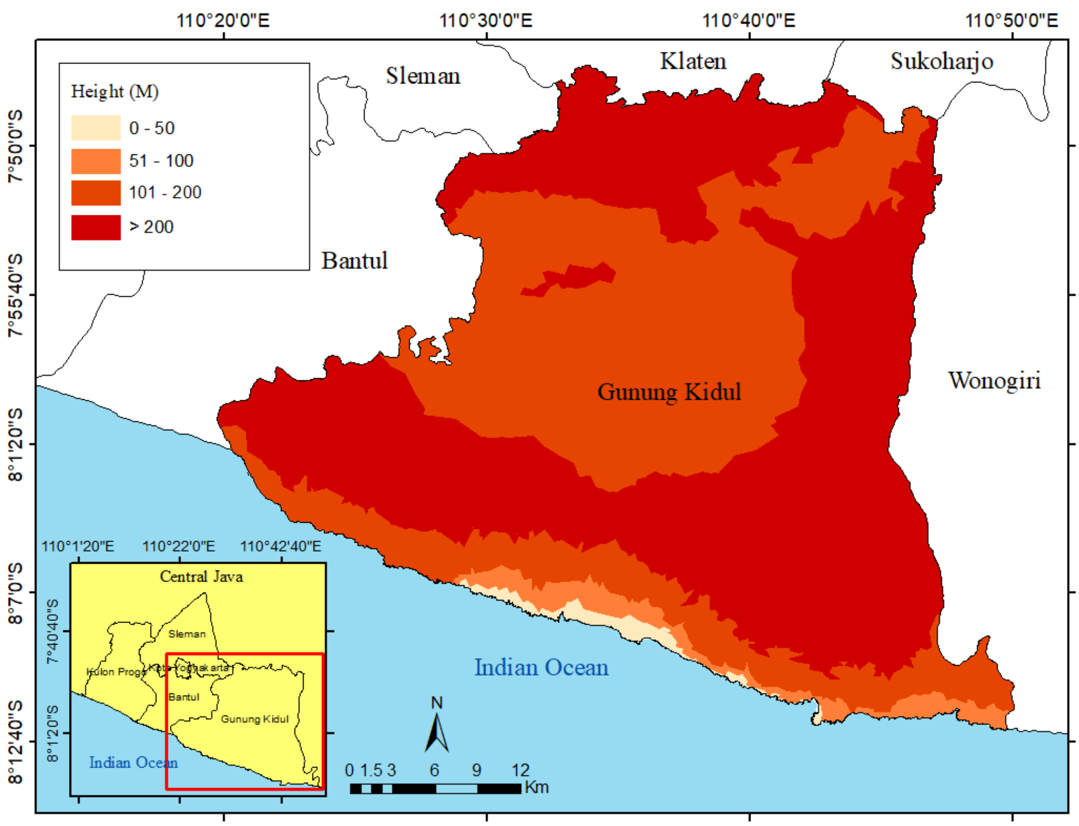

Fig.2 Height Distribution in Gunung Kidul Regency

4.3 Wind Speed Average Area

Wind speed in Gunung Kidul Regency is in the range of 3.8 to 6.3 m/s. The classification of wind speed suitability, according to Ali et al. [9], is divided into four classes. The region whose wind speed is not suitable has an area of 60.44 km² 4.1%, located in the northwestern part and partly also in the northern part of the Gunung Kidul Regency. This region has an average wind speed of under 4 m/s. Areas with average wind speeds included suitability level low has a total area of 649.83 km² or 44.1%, and located in the central, northeastern part and partly situated in the western part of Gunung Kidul Regency. The region has an average wind speed of 4.01 to 5 m/s, which includes a moderate level of suitability, has a total area of 750.51 km² or 51%, located in the south, southeast, and east of Gunung Kidul Regency. The region has an average wind speed of 5.01 to 6 m/s., include the level of conformity High has a total area of 11.61 sq km, or equivalent to 0.78% of the total area region District Gunung Kidul. This region located in the southern part of Gunung Kidul Regency, precisely in the Tepus sub-district. This area has an average wind speed above 6 m / s. This means based on wind speed average area, the region of Gunung Kidul Regency was dominated by moderate suitable Area for the development of wind power plant with total 51 percent area, but there's 0,8 percent of total area in Gunung Kidul Regency was clasified as High Suitable Area with total area 11,61 km² of 1472,49 km². The percentage of slope distribution in Gunung Kidul Regency shows in Table 4.

Table 4 Percentage of Wind Speed Average Gunung Kidul Regency

AVG Wind Speed (m/s)	Land Suitability	Total Area (km²)	Area Percentage (%)
> 6	High Suitable	11,61	0,8
5,01 – 6	Moderate Suitable	750,51	51,0
4,01 – 5	Low Suitable	649,83	44,1
< 4	Not Suitable	60,44	4,1
Total		1472,49	100,0

4.4 Residential Area

Classification of distance variables from settlements based on Ali et al. [9], there are four classes. The high suitability area is more than 3 km from the residential area, which has an area of 5.41 km² or 0.4%, located in the southeastern part of the Gunung Kidul Regency. The suitability level area, which is 2 to 3 km from the residential area, has an area of 22.66 km² or 1.5%, located in the south, southeast, and southwest of the Gunung Kidul Regency. The low suitability area, which is 1 to 2 km from the residential area, has a total area of 96.48 km² or 6.5%, located in the southern, southwest, and western parts of the Gunung Kidul Regency. Territory level of conformity is not appropriate within less than 1 km from residential areas and has a total area of 1347.94 km² or 91.56%, located in the middle and almost all of Gunung Kidul Regency. The percentage distribution of the residential regions in Gunung Kidul Regency seen in Table 5.

Table 5 Percentage Buffer Location Distribution of Settlements in Gunung Kidul Regency

Distance from Settlement (m)	Land Suitability	Total Area (km²)	Area Percentage (%)
> 3	High Suitable	5,41	0,4
2 – 3	Moderate Suitable	22,66	1,5
1 - 2	Low Suitable	96,48	6,5
< 1	Not Suitable	1347,94	91,6
Total		1472,49	100,0

4.5 Land Use

The classification of land use suitability based on Ali et al. [9] there is four classes. High suitability class if land use is a barren pasture. Moderate suitability class if land use is agricultural land. Low suitability class if land use is short vegetation or shrub, and the level is not suitable if the land use is a settlement, an airport, and other areas.

A region with a high degree of suitability has a total area of 7.8 km² or 0.5%, located in the middle, southeast, and south of the Gunung Kidul Regency. Areas with moderate conformity levels have a total area of 1021.73 km² or 69.4%, located in the south, southeast northeast, east, west, and north of Gunung Kidul Regency. The region with the level of conformity of the low has a total area region of 230.68 km² or 15.7%, located in the south, southeast, and southwest of Gunung Kidul Regency. A region with the level of conformity does not conform to a total area of 212.28 km², or 14.44%, located dominant in the central part, which is the Wonosari District, the capital of Gunung Kidul Regency. The percentage of land use distribution in Gunung Kidul Regency seen in Table 6.

Table 6 Percentage of Buffer Distribution in the Settlement Area of Gunung Kidul Regency

Landuse	Land Suitability	Total Area (km²)	Area Percent age (%)
Meadow	High Suitable	7,8	0,5
Agricultural Land	Moderate Suitable	1021,73	69,4
Shrump	Low Suitable	230,68	15,7
Productive Land	Not Suitable	212,28	14,4
Total		1472,49	100,0

4.6 Road Network

Classification of distance variables from the road network based on Ali *et al.* [9] divided into four classes of suitability. The level of suitability is high if the area is 0.5 to 1.99 km from the national road network. The level of suitability is moderate if the area is 2 to 4 km from the national road network. The suitability level is low if the area is 4 to 9 km from the national road network. The suitability level is not appropriate if the area is more than 10 km from the national road network.

Areas with a high degree of suitability have a total area of 795 km² or equivalent to 53.96% of the total area of Gunung Kidul Regency. This region is in the southeast, northeast, and southwest of Gunung Kidul Regency. A region with a moderate level of suitability has a total area of 397.7 km² or equivalent to 26.99% of the total area of Gunung Kidul Regency. This region located in the central, eastern, and western parts of the Gunung Kidul Regency. Areas with low suitability have a total area of 275.11 km² or equivalent to 18.67% of the total area of Gunung Kidul Regency. This region located in the southern and northwestern part of the Gunung Kidul Regency. Areas with no corresponding conformity have a total area of 5.42 km², equivalent to 0.36% of the whole area region District Gunung Kidul. This region located in the southern and northern part of the Gunung Kidul Regency. Percentage distribution of road network buffer in Gunung Kidul Regency seen in Table 7.

Table 7 Percentage Buffer in Gunung Kidul Regency Road Network

Distance from Road Network (km)	Land Suitability	Total Area (km²)	Area Percent age (%)
0,5–1,99	High Suitable	795	53,96
2 – 4	Moderate Suitable	397,7	26,99
4 - 9	Low Suitable	275,11	18.67
> 10	Not Suitable	5,42	0,36
Total		1472,49	100,0

4.7 Potential Area of Wind Power Plant

The map of potential areas of wind power plant locations is the result of overlaying variables of altitude, slope, wind speed, housing area, land use, and national road network in Gunung Kidul Regency. Based on the results of processing using the weighted overlay method with weighting by that formulated by Ali et al. [9], it shows that regions with inappropriate levels have a total area of 29.06 km² or equivalent to 2,0% of the total area of Gunung Kidul Regency.

This region is in the northern part of the Gunung total area of 925.46 km² or equivalent to 62.8% of the total area of Gunung Kidul Regency. This region centered in the northern and central parts of the Gunung Kidul Regency. A region with a moderate level of suitability has a total area of 516.66 km² or equivalent to 35.1% of the total area of Gunung Kidul Regency. This region is in the southern and southeastern part of the Gunung Kidul Regency. Areas with a high degree of suitability have a total area of 1.31 km² or equivalent to 0.1% of the total area of Gunung Kidul Regency. This region is in the southern part of the Gunung Kidul Regency, namely in the village of Tepus. The percentage of the potential regions for the development of wind power plants in Gunung Kidul Regency seen in Fig.3 and Table 8.

4.8 Wind Speed Average and Wind Direction of Tepus Village Gunung Kidul Regency

The results of processing with WRPlot View software showed variations in speed in 2015 from 2.57 m/s to 12.85 m/s with an average wind speed of 6.1 m/s. For the dominant wind direction blowing from east southeast - southeast and southeast - south southeast or 123.75 ° - 146.25 °. The largest average

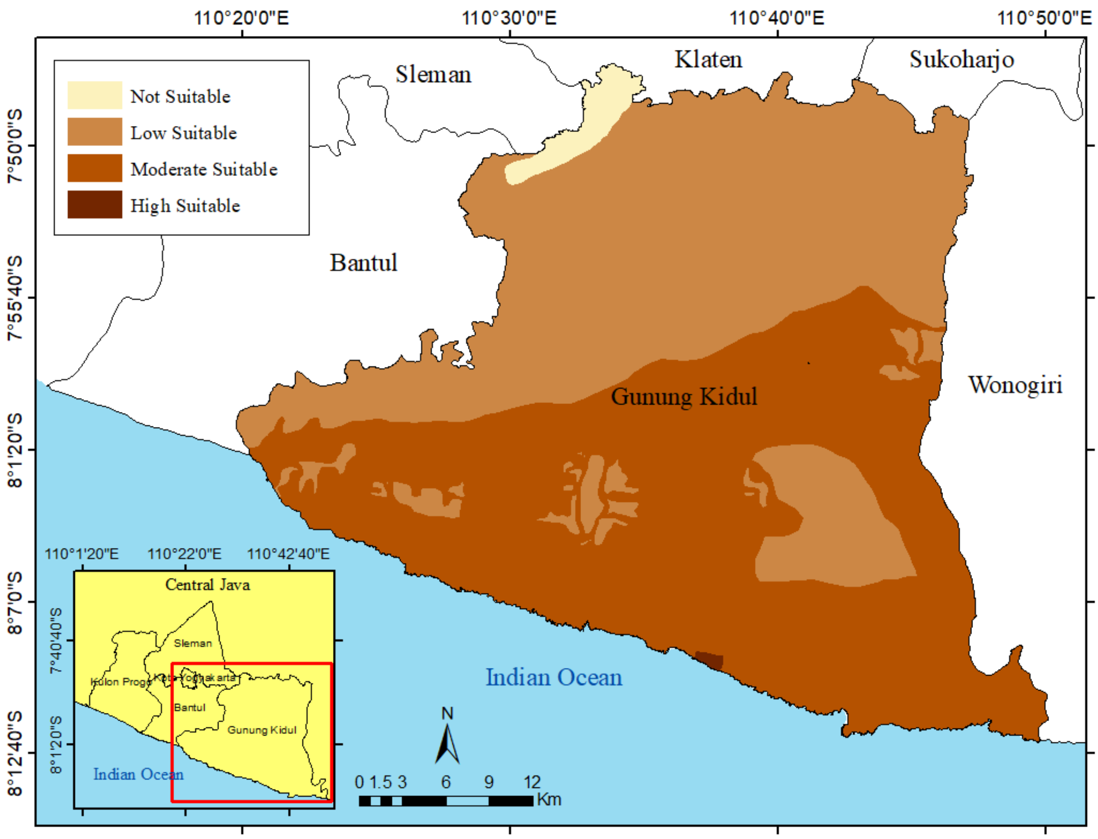

Fig.3 Potential Location for Wind Power Plant in Gunung Kidul

wind speed occurred on 29 December 2015 at 12.85 m/s, and the lowest average wind speed occurred on 24 November at 2.57 m/s with a consistent frequency above the minimum limit of 4 m/s as many 198 days from 19 April to 02 November 2015. Pictures of the wind direction in Gunung Kidul Regency seen in Fig.4.

Table 8 Percentage of Potential Area

Suitability Level	Total Area (km²)	Area Percentage (%)
Not Suitable	29,06	2,0
Low Suitable	925,46	62,8
Moderate Suitable	516,66	35,1
High Suitable	1,31	0,1
Total	1472,49	100,0

4.9 Electricity Demand and Potential Electric Energy of Tepus Village

Based on the Ministry of Energy and Mineral Resources Regulation no. 28 of 2016 [16] explains that the total electricity demand in an area divided into the education, household, government, industry, and religious facilities sectors. The sampling method was carried out utilizing the purposive sampling method in 20 hamlets in Tepus Village, Gunung Kidul Regency.

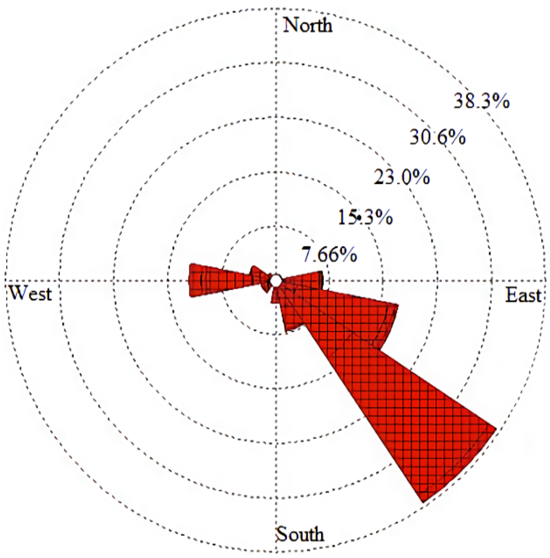

Fig.4 Wind Direction of Tepus Village in 2015

Based on the results of the field survey, in one month, the total electricity demand in the Village of Tepus, Gunung Kidul Regency, is 308,759 kWh / month, calculated based on the total bill in one month divided by the cost price per kWh stipulated in ESDM ministry regulation no. 28 of 2016 [16]. The greatest electricity demand is in the Klumpit Village, Tepus Village, with the most sector consumption in the household sector with 450 VA of power.

Potential electricity in the village of Tepus is produced by the wind at speeds of less than 100 kW [9]. Meanwhile, the electricity needs of Tepus Village are at 308,759 kWh/month (428 kW). Then the percentage of potential energy electricity is available in the village of Tepus amounted to 23.31% of the total demand for electricity in the village Tepus

5. CONCLUSION

Based on overlay analysis by calculating six variables: average wind speed, slope, altitude, distance from residential areas, distance from the road network and land use in Gunung Kidul Regency are in the Village of Tepus, precisely in the coastal area of Poktunggal. Tepus Village, Gunung Kidul Regency is suitable to be installed with wind power plants because it already has an average wind that is sufficient to run wind power plants because it already has a minimum speed frequency that is greater than 4 m / s for more than 90 days. Needs electricity in the village Tepus, Regency of Gunung Kidul most a lot happening in the sector of housing with a power of 450 VA. Whereas Klumpit Hamlet has the highest electricity demand value in Tepus Village, Gunung Kidul Regency. Wind speed that can run wind turbine in 2015 can run the wind with the most extended frequency for 198 days in one year (19 April - 02 November).

6. ACKNOWLEDGMENT

This research is supported by Universitas Indonesia, which has provided an International Publication Grants indexed final project (GRANT PITTA B) for the 2019 fiscal year with contract number NKB-0673 / UN2.R3.1 / HKP .05.00 / 2019.

7. REFERENCES

[1] Chaouachi A., Covrig C. F., and Mircea A., Multi-Criteria Selection of Offshore Wind Farms: Case Study for The Baltic. International Journal of Energy Policy, Vol. 103, Issue, 2017, pp.179-192.

[2] Ministry of Energy and Mineral Resources. Outlook Energi Indonesia 2015. 2015.

[3] www.esdm.go.id/assets/media/content/content-Indonesia-energy-outlook-2015-1vgcv6t.pdf.

[4] Negar A., Chandra A.I., Dylan F.J., David M., A Multi-Criteria Port Suitability Assessment for Developments in The Offshore Wind Industry. International Journal of Renewable Energy, Vol 102, 2017, pp.118-133.

[5] Lationopoulos D., Kechagia K., A Gis Based Multi-Criteria Evaluation for Wind Farm Site Selection: A Regional Scale Application in Greece. International Journal of Renewable Energy, 78, 2015, pp.550-560.

[6] Abdmouleh Z., Alammari R., Gastli A., Review of Policies Encouraging Renewable Energy Integration and Best Practices. International Journal of Renewable and Sustainable Energy Reviews, Vol 45, 2015, pp.249-262.

[7] Kementerian Energi dan Sumber Daya Mineral. National Energy Management Blue Print 2006-2025. 2007. www.esdm.go.id/assets/media/content/Blueprint_PEN 2007.pdf.

[8] BAPPENAS. Presidential Regulation of the Republic of Indonesia Number 71 Year 2010 Concerning National Action Plan for Reducing Greenhouse Gas Emissions. 2011. www.bappenas.go.id/files/8414/1214/1620/naskah_akademis.pdf.

[9] Putra A.P., Potential Locations for Wind Power Plant Development in Java Island. Essay, 2005, Universitas Indonesia, Indonesia.

[10] Ali S., Taweekun J., Techato K., Waewsak J., Gyawali S., GIS-Based Site Suitability Assessment for Wind and Solar Farms in Songkhla Thailand. International Journal of Renewable Energy, 132, 2019, pp.1360-1372.

[11] Al-Yahyai S., Charabi Y., Gastli A., Al-Badi A., Wind Farm Land Suitability Indexing Using Multi-Criteria Analysis. International Journal of Renewable Energy, vol 44, 2012, pp.80-87.

[12] Villacreses G., Gaona G., Gomez J.M., Jijon D. J., International Journal of Renewable Energy, vol 109, 2017, pp.275-286.

[13] Mahdy M., Bahaj A.S., Multi-Criteria decision analysis for offshore wind energy potential in Egypt. International Journal of Renewable Energy, vol 118, 2018, pp.278-289.

[14] Anwarzai M.A., Nagasaka K., Utility Scale Implementable Potential of Wind and Solar Energies for Afghanistan using GIS Multi-Criteria Decision Analysis. International Journal of Renewable and Sustainable Energy Reviews, 71, 2017, pp.150-160.

[15] Noorollahi Y., Yousefi H., Mohammadi M., Multi-criteria Decision Support System for Wind Farm Site Selection using GIS. International Journal of Sustainable Energy Technologies and Assessments, vol. 13, 2016, pp.38-50

[16] BPKP. Profile of Gunung Kidul Regency. 2015. www.bpkp.go.id/diy/konten/835/profil-kabupaten-gunungkidul

[17] Ministry of Energy and Mineral Resources.Minister of Energy and Mineral Resources Regulation no.28 of 2016 Concerning Electricity Fee Provided by PT.PLN. 2016.