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Review Article

Remote Sensing Based Study on Wind Energy's Ecological Effectiveness in Shamakhi District (Azerbaijan)

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Abstract:

Wind energy application is advisable in the local condition of Shamakhi region because of the enough stock. The major wind type is the mountain-valley one for the territory. In the study the latest modern methods were applied to determine the wind energy potential for the region. On the base of the remote sensing method the average annual data on the potential were realized at 2 m. The final materials have been worked for making several dependences for ecological estimation. Dynamics of the total average annual wind energy potential data were defined based on long term remote sensing measurements. At the same time percentage wind directions was revealed depending on the months of a year. The measurement results have been given graphically in the paper. Due to the stochastic character of the wind data interval diapason within the last year (in 2021) were compared with former ones and the advantages were given. The measurement result at 2 m the data have been compared with ones obtained at 10 m for January and was appreciated. Wind potential deference between mountainous territories depending on the height from the sea level was identified and view point height for remote sensing process has been decided. As the first experimental settlement Zarat Kheybar was selected because the location and relief possibilities where the deforestation is higher. On the real forecasting materials (in Map 1. in December 2021 within 5 days) the cold period wind potential of the year was defined for the mentioned village. On the Google Earth based map whole the deforestation sites around the settlement were given in the orographic map in the paper (Map 2).

Keywords: Wind, clean energy, remote-sensing, ecological effectiveness.

1- Introduction

Green energy application has great deal of advantages all over the world today. Up today renewable energy sources have been studied on the base of several methods. In Azerbaijan locally the alternative energy sources (Mammadov et al, 2014) were defined by using traditional methods. Firstly the remote sensing way is being applied for revealing Shamakhi region energy potential. The study area Shamakhi possesses to the total territory of the Mountainous Shirvan. Unlike other regions, the very one is fully included into the total research area.

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As for the local or home literature references, wind energy potential were estimated by the energy point of view in various years for Absheron peninsula, in Shamakhi region for Pirgulu State Preserve (Mammadova, 2012), the concrete area of the Caspian sea for wind park development. And in all researches the relief plastics wasn't taken into consideration. GIS based wind energy potential in the home country aren't met at the same time aerospace study are missing. Taking into consideration the modernest methods and technologies the research possibilities become more than ever. Measurement processes have been done the traditional methods at the existing weatherstations and all the calculations were realized for years by this way. And now all over the world remote sensing method is more effective because of the natural complex relief properties. Sometimes the region having much more renewable energy potentials isn't advisable for the power station to be built. In this case the more optimal version or territory should be selected to gain the necessary result. For the investor the plateau territories and proper potential are so interesting in this energy sector. Because while determining the discount of the project real natural condition has to be taken into consideration. In this case the most effective method is the remote sensing one.

On the base of the wind and sun satellites' radiometric measurements (specially microwave) average annual wind potential, wind direction potential may be easily determined in comparison with the latest five years data and the total hundred years old data base. The scheduled and analized materials of these sources give the opportunity to define the total wind energy stock in the region. On the base of this general potential, the further renewable energy potential can be calculated for technical and eco-energy estimation. The first process is realized due to the weather station measurement. And the second and the following steps have to be done according to the practical calculation on the universal methods based.

The researches in this term haven't fully carried out in the home country for any region. All the four steps leads the complete deed in the expecting fundamental result.

2. Materials and Methods

The current material has been arranged and prepared on the remote sensing based of the long term measurements of Shamakhi region during a year. The radiometers depending on being micrometric or polarimetric in the Windsat give several opportunities (Remote Sensing System Information, 2003) to us to define the viewpoint height. The parameter has great advantage while using the relief plastics to estimate the local renewable energy sources and potentials. There are some micrometric radiometers having different start and activation time such as; Special Sensor Microwave Imager **(**SSM/I) and Special Sensor Microwave Imager Sounder **(**SSMIS) started in 1987, June are acting till present. Some of the instruments acted within exact duration like Technical Microwave Imager (TMI) began in 1997 lasted in 2015, Advanced Microwave Scanning Radiometer (AMSR-2) began in 2012 and is acting now (Windsat Instrument details, 2022).

As for polarimetric radiometers some of them also lasted within the real time. So, Windsat began in 2003 is acting at present. But QuickScat has been acting since 2007. And ASCAT (Metop-A and -B) has been still working since 2009, too. But others have lasted their function yet like QuickScat.

Each instrument has various facilities, majority're dual polarized, conical scanning, passive microwave ones. Depending on the earth location they have been placed near polar orbit to get minimum twice samples within the day. The total band change between 6.93 GHz and 89.0

GHz (Windsat Instrument details, 2022) which allow the polarization (V,H) to be limited based on. Due to the beforehand details given, spatial resolution and footprint size (from km to km) are generally arranged. The variety of the technical parameters in the instruments cause the quality of the remote sensing materials.

As for the annual measurements and the total analyses the following curve was obtained to determine the total wind potential of Shamakhi district only but not high mountainous territories (Shamakhi Weather Forecast, 2022).

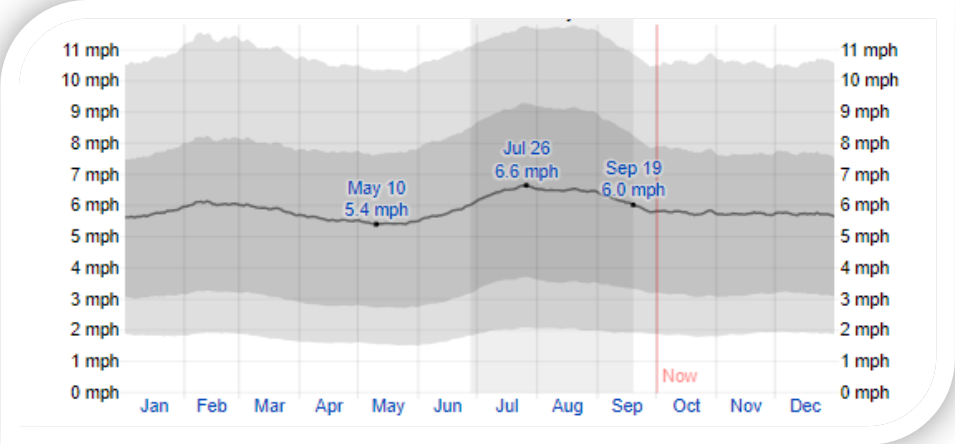


Figure 1. Average annual wind speed in Shamakhi district.

Including speed and direction showings (average hourly wind vector) all measurements in figure 1 were realized at 2 meters above the ground. Mainly the relief plastics has been taken into considration which directly influences to wind speed and direction in the territory. As seen from the graphical results windier period ends dyring 3 months begining from the 27th of June lasts on the 19th of September having 6 mile per hour for a year (Climate data of Shamakhi, 2021). The maximum index has been given on the 26th of July about 6.6 miles per hour. The period without the wind. It is the measurements at 2 m above the earth. But the next measurements are intent to be realized at 10 m which will have the great advantage to calculate the futher energy potentials at 80 m, 100m, 150m due to the wind turbines.

Windsat remote sensing system (Remote Sensing System Information, 2003) gives great opportunity to use the measurements done by these radiometers having the above mentioned technical parameters. The current research has been realized on the aerospace materials obtained by different aerospace agencies and companies. The original data about wind energy potential and direction measured by the satellites' of NASA such as MERRA-2 Modern-Era Retrospective Analysis which collects several hourly weather casts. Elevation data from the sea are based on the Shuttle Radar Topography Mission (SRTM) of NASA's Jet Propulsion Laboratory (Shuttle Radar Topography Mission, 2022). Location names, time zones' information's have been got from the different weather stations and airports of Azerbaijan including Gabala International Airport (UBBQ, 67%, 49 mi, west-1,145 ft elevation change) Heydar Aliyev International Airport (UBBB, 33%, 75 mi, east, -2,244 ft elevation change).

According to the winddy days and relief data, wind energy sector can be built in Shamakhi region. As seen from the graphic the main line begins from 6 miles per hour and lasts in it, too. Wind speed has stochastic charater because this feature changes within the certain

interval. In the graphic it is clear that the most repeated wind speed interval change between 3mph (near 2 m/sec) and 9 mph (4 m/sec). The starting wind speed begins 2-3 m/sec on the earth. The wind power plants' height is 60 m minimum, due to the power and height wind speed potential differ in the territory. Wind potential is formed on the local foehn (fyon-down-slop) winds. This continuous wind flow along the mountains during all the seasons here. The mountain-valley wind is more suitable to generate electricity in wind power plants in the region. Such stations may be settlled on the middle and high mountainous areas. The highest mountainous territory has no advantage in this case as if there's great wind potential because of the unsuitable relief condition. Such natural conditions is never proper to delope the power stations. In the estimation the main factors are suitable energy potential and relief condition. If one of them is absent, so it'snt worthy to appraciate the natural renewable energy sources to establish this energy sector in the region.

Fortunately here both parameters are fitting and advisable. Therefore the future of the energy sector is reliable for technical, economical, energetical and ecological estimation of this field and all aspects promise the perspective for futher times.Wind direction is also the important factor for wind park development generally (Climate data of Shamakhi, 2021).

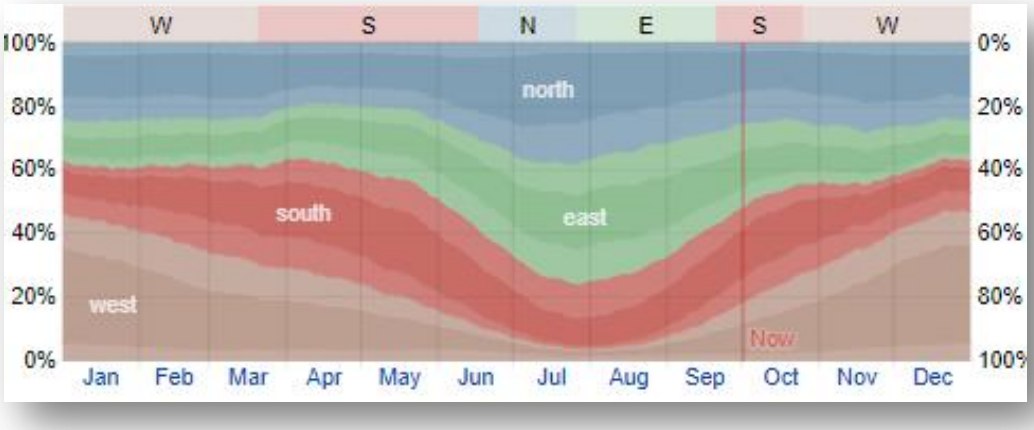
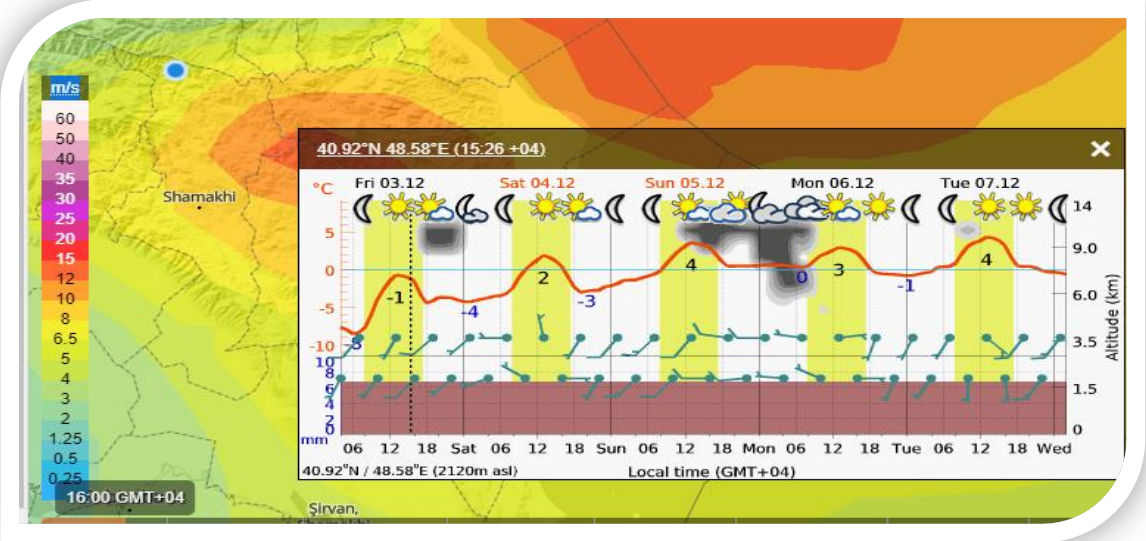


Figure 2. Annual wind energy potential due to the various directions.

As seen from figure 2 the given remote sensing material due to Shamakhi region, four main wind directions differ one another depending on the months along the year. The most active wind direction is the south one. It occurs in the hot period of the year between the 20thof March and the17th of June, also from the 20th of September till the 25th of October. But the maximum index happens on the 13th of May till 37-40%. The west winds blow mostly between the 26 th of July and the 20 th of September including the peak percentage about 39% on the 7 th of August. The west winds are frequently met in the region within near 5 months having top date till 47% (Weather Forecast for Shamakhi, 2022) on the 1 st of January. The west winds arise between the 25 th of October and the 20 th of March especially.

Taking into considration the measurement results according to other souces as the digital wind atlas data and other aerospace measurements average wind speed index is 4.95m/sec at 2 m, 6,29 m/sec at 50 m, 7,09 m/sec at 100 m hieght from the surface. This showing may give opprotunity to generate from 288 W/sec to 512 W/sec power in the district.

The mentiones facts show that wind energy sector should be developed in the territory to protect the woodland areas and to avoid atmosphere pollution. The hourly wind gust happens in the selected settlment due to the geographical location as shown below taken from the online sources (Shamakhi Weather Forecast, 2022).



Map.1. Hourly Wind Gust in Zarat Kheybar Based on Meteogram.

Within 40.93°N 48.58°E (Sharing Earth Observation Resource South Africa, 2022) coordinates in Zarat Kheybar wind gust and temperature distribution on hours have been shown in the map 1. It should be taken into consideration that this the final settlement which is located on the upper land of the district. The data covers 3-7th of December 2021(Weather Forecast for Shamakhi, 2022). The Meteogram shows the real windy days in the region. Thus the rising curve proves practical potential to develop energy potential for this and other settlements in Shamakhi district. Indeed according to the remote sensing materials from different sources the data 20 years ago should be taken into consideration while calculating energy potential of the region. At 10, 50, 100 and 150 m above the earth surface (Global Wind Atlas, 2022). There are historical worthy settlement in Shamakhi region where the population is living at present as before. To supply the energy demand of such villages serves directly to save such settlements to be disappear in the history. Beside the wind potential of the region, other renewable energy stocks including solar, biomass and so on. Among them wind is more interesting because of the relief possibilities.

3. **Results and Discussion**

As seen from the results of the remote sensing processes the south directioned wind consists of 60%, the east directioned is 40% and the north directioned wind happens 20%. But the west directioned wind potention is 80%. Due to the geographical location parameters. The most great poptential (80%) concerns to the west which is the main potential to get the electricity in the wind turbines. While projecting wind farms the west winds are more important stock in the general date base. The marshrout of such winds are the same in the mountaionous places because the mountain-valley wind fyon is characterized to the region which flows always but slowly

(starting 3-5 m/sec). As if according to the remote sensing studies, measurements and analyses the following percentage distribution have been obtained.

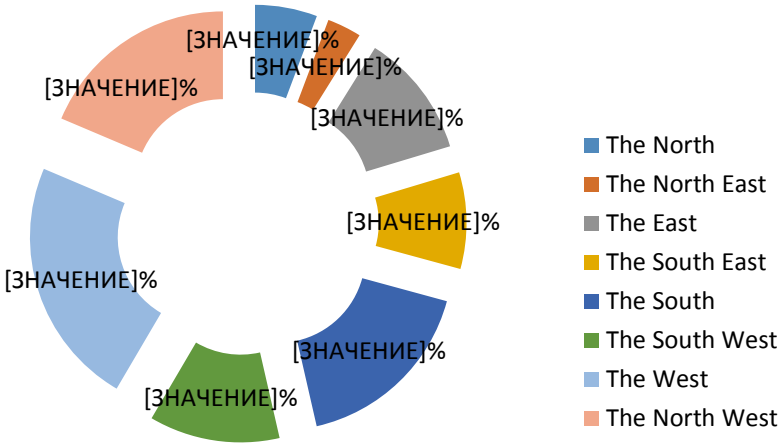


Figure 3. Percentage data of the wind potential due to the directions in Shamakhi

The most important fact is that wind distribution on the directions in the region have been learnt to the long term aerospace measurements in comparison with the 5 years data base beforehand. The average indexes of the total area have been classified as below. By dividing the area into three parts being high, middle and low mountain general wind potentials are gradually changed depending the height of the territory.

Only in January at 10 m the wind speed (Global Wind Atlas, 2022) data has been determined as follows which is the less windy months in the territory.

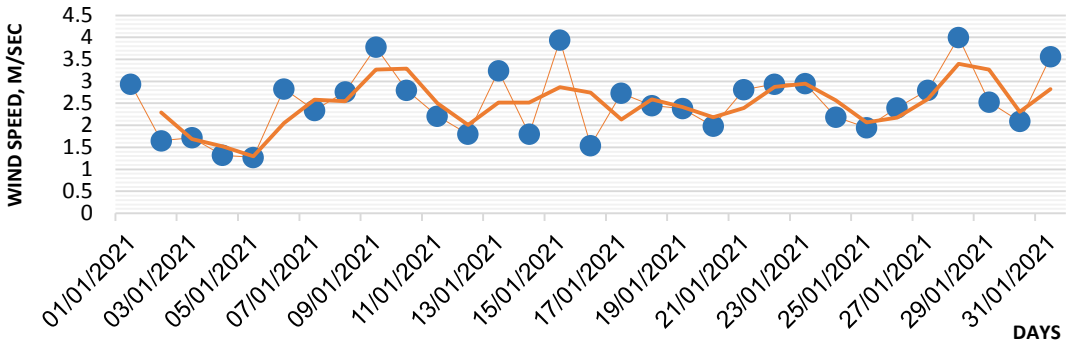


Figure 4. Wind speed for January 2021

From figure 4 it is clear that wind speed average index is 2.5 m/sec being maximum 4,1m/sec. So the windy month have great advantages possessing higher potential.

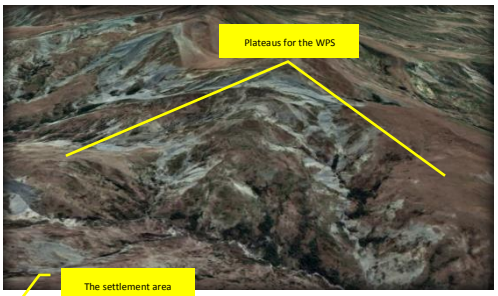
The highest village is Zarat Khaybar located at 1754m above the sea level in which the there are more than 25 houses. The settlement were surrounded with the naked mountains and hills and

large mountain rivers. Deforestation process is seen from the orthophoto materials from Google Earth data. This deforestation leads to the soil erosion on a large scale on the mountainous region where high solar radiation and permanent fyon blow along the year. Flora and fauna of the settlement are under the serious danger. The forest areas have been replaced by the little bushes. The soil cover having no forest is getting to be degraded by several natural factor. Forest wood is being utilized at present in the territory as the only heating source. Thus the cutting process is going on now. The alternative of the forest wood is certainly to be applied for heating the buildings. In this case the real energy source for the settlement is the renewable energy sources including the wind energy potential.

So for stopping desertification, deforestation, cutting the forest wood in the territory frequent planting, landscaping should be realized to reabilitate the historical flora and fauna areal within the forest complex.

1)

Deforestation along the river



.The plateau areas for Wind

2)

3)

FThe geographical location of the

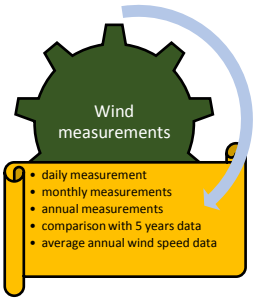
Map. 2. The final (2021 year) space scene of Zarat Khaybar.

From the materials it's clear that the deforestation covered a large scale territory along the river base, on the middle mountains and the hills. The appearance of plateau areas around the village has a lot of advantages in projecting the Wind Power Stations on the mountains. This village is one sample of other ones which needs electricity demand within the borders of Shamakhi region. Because of the height factor To protect the forest lines and ecosystem fully in this region has much more advantages.

4. Conclusions

While summarizing the research the following results and conclusions have been obtained for the territory after the remote sensing investigation. This long term measurements, observations and analyses caused the current graphical and other data. The final conclusions are:

- Satisfied average annual wind speed (6.6 mph at 2 m) for starting the WTs;
- Daily wind sources' possibility for WT's work;
- The empty land stock for station's projecting;
- The limited buildings in the settlement;
- The infinite rout of the wind directions due to fyon;
- Windsat remote sensing system supply;
- Enough total wind energy potential estimation demand;
- Proper relief and wind potential indexes.



Thus the research carried out shows that wind potential of Shamakhi is suitable to be applied in renewable energy sector in the territory. The local wind energy potential is more effective from energy, ecological, economical point of view.

Acknowledgments

In this aerospace materials of WinSAT remote system, Blue.com, Global Wind Atlas, Data Access of NASA, weatherspark.com, Google earth, Remote sensing systems (Climate analyses discussions) and other sources have been used. The research has been started due to the Decree of the President of Azerbaijan Republic signed on the 25th of May 2021 «Renewable energy sources application for electricity generation».

R e f e r e n c e s

Climate data of Shamakhi. https://weatherspark.com/y/104651/Average-Weather-in-Shamakhi-Azerbaijan-Year-Round, 2021(accessed 2021 by Cedar Lake Ventures, Inc)

Global Wind Atlas USA, Wind Statistics Report for Dagligh Shirvan https://globalwindatlas.info/, 2022 (ac. 2022 by DTU)

Mammadov G.Sh. and others. (2014) Azerbaijan National Atlas. Azerbaijan State Land and Cartography Committee, Azerbaijan

Mammadova U.F. (2012) Wind Energy Potential Estimation in Pirgulu Region. American Journal of Environmental Engineering, 2012, 2(4).109-113.

Remote Sensing System information. https://www.remss.com/, 2003 (accessed 2003 by NASA)

Shamakhi Weather Forecast. https://www.gismeteo.com/weather-shamakhi-296796/, 2022 (accessed 2022 by Gismeteo)

Sharing Earth Observation Resource South Africa. Sensor complement for Satellites https://earth.esa.int/web/eoportal/satellite-missions/s/sunsat , 2022 (accessed 2022 by ESA)

Shuttle Radar Topography Mission, https://www2.jpl.nasa.gov/srtm/, 2022 (Last Updated: Feb 2022 by Eric Ramirez

Weather Forecast for Shamakhi. https://www.meteoblue.com, 2006-2022 (accessed 2022 by Meteoblue)

Windsat Instrument details. https://space.oscar.wmo.int/instruments/view/windsat, 2011-2022 (accessed 2022 by World Meteorological Organization)