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Evaluation and statistical analysis of potential wind the wilaya tanger-tetouan

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ABSTRACT

Wind power has experienced strong growth over the last decade in view of its benefits for the environment, technological advances and related government incentive programs. Its characteristic inexhaustible source of energy and clean made it a privileged field of scientific research and development Technological mainly in Europe. The rate of evolution of this technology is about 25%. To reduce its energy dependence, Morocco is oriented towards development including the mobilization of renewable energy sources such as wind power. Indeed, Morocco, its favorable geographic location, has a significant wind energy potential estimated at 6,000 MW. Potential energy solar, geothermal and wind existing in Morocco, their use for economic development of certain regions appear favorable. Of its agricultural, and given the potential wind energy determined by the preliminary study, the implementation of wind turbines pumping in the Wilaya of Tangier-Tetouan becomes an obligation. The choice of a wind inevitably wind characterization of the implantation site, where the attention that must necessarily bring to estimate the local energy potential. The purpose of this subject is the establishment of the wind atlas of the wilaya region Tanger-Tétouan. First, a statistical study of wind measurements based on Weibull distribution which will allow us to determine the annual average wind speeds. This allowed the establishment of a wind map of the study area. The second part is devoted to the estimation of wind energy potential in the valley of Tangier-Tetouan and the delimitation of the atlas of the power density of the region. The results showed that the site (Tetouan-Ksar Sghir) is the windiest of the study area.

KEYWORDS

Renewable energy;
Production concessional;
Weibull parameters;
Wind energy potential;
Mapinfo.

INTRODUCTION

The differential heating of the earth's surface by the sun causes the displacement of large masses of air on the ground, that is to say the wind. Systems for the conversion of wind energy convert wind energy into electricity or other forms of energy. The wind energy has experienced tremendous growth over the last decade, as this energy is recognized as an ecological and economic production of electricity. World energy demand is increasing, instability and uncertainty prices of fossil fuels, electricity market liberalization and increased environmental awareness in recent years have renewed interest in the development of renewable energies. Among them, the wind holds a privileged position thanks to its technological advances and its associated costs comparatively low. Wind energy today is a lot about it and take a little starring role of renewable energies. This is probably due to its dynamism and growth very strong 59% in the world in 2010[18], far beyond all expectations, but also because it touches a sensitive sector in Morocco, the production of electricity, which is also characterized by structural change. By its technical potential, economic and environmental. Morocco, as in other countries can meet certain international commitments, particularly Directive global production of clean electricity. The wind is in it a major part in Morocco, 60% of potential supply, which represents 10 000 to 14 000 MW installed by 2020[8]. The wind is a factor that the study is very complex, its characterization is based on several parameters such as the measurement of wind speed and direction, the effect of soil roughness, obstacles to atmospheric stability, etc.. It is clear that to determine the wind potential of a site, it must pass through the statistical measurements of wind speed. In view of the agricultural region Tanger-Tétouan, it would be interesting to explore the possibilities that can be offered by the use of wind energy for pumping water or other. To do this, we must first quantify the available energy field through the establishment of the wind map of the region.

Wind energy in the word

Since 2009, wind energy is the second largest source of renewable electricity (268.2 TWh)[10] but still very far from the original energy hydrolic. It Represent 1.3% of the total electricity production and 7% of renewable electricity[15]. Nearly half (48.9%) occurred in Western Europe. Other major producing regions are North America (27.9%), the East Asia and Southeast (12.2%) and South Asia (6.7%)[15]. Growth of wind energy is the fastest growing photovoltaic knew after that. Indeed, all regions of the world have a wind industry experiencing double-digit growth over the period 1999-20011. Wind energy is currently the most renewable energy to even concurencer hydro power.

Figure 1 : Producing wind in the world[10]

Wind energy in Morocco

Morocco is particularly well placed in terms of the wind as it offers two large coastlines - those mentioned above - the sea winds, weather patterns as uncorrelated. The wind takes on a new dimension in Morocco The Kingdom has recently acquired the largest wind energy park in Africa. With a capacity of 140 GW (MW)[9], this park has been trained to Meloussa, 34 km north of Tangier. Cost of production: 250 million[5]. Wind energy is one of the durable solutions to the fight against stress energy. Energy based on wind, it is the key to energy development for the countries who hold it. Morocco has to illustrate to great effect by erecting to Meloussa, 34 km from Tangier, the largest wind farm in Africa. Morocco is on track to solve its offerings and expand renewable energy. By 2020, the project will significantly increase the share of renewable energies. This falls within the framework of the strategic vision of Morocco intends to diversify its energy mix.

MATERIALS AND METHODS

Study area

An initial survey of stations located in the region has shown that there are three Stations considered, namely: Tangier, Tetouan-Elkser Sghir, Chafchaoun

(Figure 2). These three sites differ in their respective climate: Mediterranean, mountainous and especially because of the location of the station Chafchaoun in a bowl. I must say that the study was oriented stations that have continuous measurements data sorting times for speed and wind directions (TABLE 1).

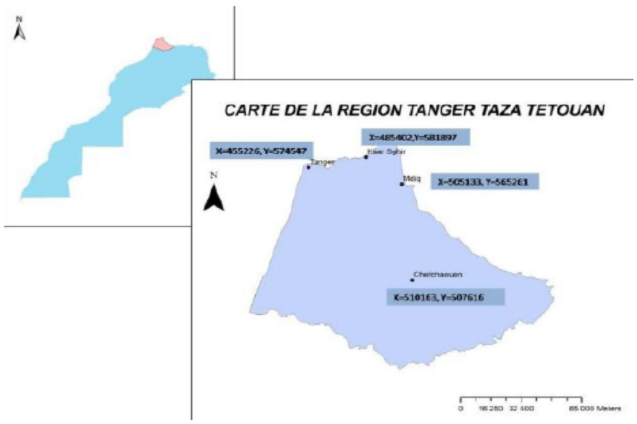

Figure 2 : Coordinates of the stations studied[3]

TABLE 1 : Weather stations ground located in the study area

Site	Longitude (DEG)	Latitude (DEG)	Period measurement (AN)	Mast height (M)
KSAR SGHIR	005°33'34" W	35°50"18" N	5	10
TANGER	005°48'05" W	35°45'54" N	5	60
CHEFCHAOUEN	005°15'47" W	35°09'55" N	5	60

Facilities for wind measurements stations

Figure 3 : Wind measurement station 60 meters installed in the Tangier region

Tlat Taghramt site, located 25 km from the city of Tangier. The wind measurement station 60 meters was installed in May 2006[5]. Annual average wind speed at 60 m: 8.8 m / s wind speed at 60 meters: 23.2 m / s wind measurement stations 10 and 60 meters have 3 to 4 levels depending on the positions of the anemometers, 2 levels of positions weathervanes and Tele-monitoring system with data transmission via GSM and anemometers calibrated by specialized institutes in Germany, measuring devices + the pressure, temperature and humidity. Dataloggers with storage capacities of wind data for one year full measure.

THEORITICAL L STUDY

Weibull distribution

The Weibull distribution[5] can describe the phenomena of life of a material, component or system. It can also model the waiting time of the first failure, or the time between two consecutive failures. So what are the laws of paramount importance in quality control and above all reliability. The model most widely used to translate the variation of wind speed is the law of His Weibull probability density is in the form[17] :

$$f(v) = (\frac{k}{c})(\frac{v}{c})^{k-1} e^{-(\frac{v}{c})^k} \quad \textbf{(1)}$$

By equating the frequencies to probabilities, the probability density f (V) isthe frequency distribution of the measured speeds. k and C are parameters commonly called Weibull parameters. The parameter k (form factor) is dimensionless and characterizes the shape of the frequency distribution while C determines the quality of the wind (scale factor). It has the dimension of a speed. The determination of these parameters allows the knowledge of the distribution of wind for a given site.

Distribution hybrid Weibull

The hybrid distribution Weibull[17] is used when the frequency of calm winds recorded at a given site, is greater than or equal to 15%. Indeed, this ratio can not be neglected and should be taken into account when the site characterization in terms wind. This distribution is written:

$$f(v) = (1 - ff_0)(\frac{k}{c})(\frac{v}{c})^{k-1} e^{-(\frac{v}{c})^k} \text{ at v>0} \quad \textbf{(2)}$$

$$f(v) = ff_0 \text{ at v=0}$$

Where ff_0 represents the frequency of calm winds;

$f(v)$ is the frequency of occurrence; k : The parameter (form factor); c : Determines the quality of the wind (scale factor).

Calculation of average wind speeds

To know the importance of wind at a given point, it suffices to determine the weighted annual arithmetic average speed calculated on a sample of 10 years minimum. The latter gives an order of magnitude of the wind speed at a given site. In addition, winds vary differently depending on the season, day and year. This variation must be determined since it allows to adapt the system sizing wind energy needs, which may vary according to season, day or year. The seasonal variation is determined by the education institution on a monthly scale. The diurnal variation is established in the time scale. Multi variation requires long series dealt across the year. A statistical analysis of data sorting hourly rates and their distributions to data classes were conducted for different sites with the use of the Weibull distribution. To determine the parameters (k, c) which best fit the frequency histogram of observations, usually called the method of moments or the maximum likelihood. Once these parameters are determined, the average wind speed is calculated using the following expression:

$$\bar{v} = \int_0^\infty v f(v) dv \tag{3}$$

Where the following expression:

$$\bar{v} = c\tau(1+\frac{1}{k}) \tag{4}$$

where τ is the gamma function given as follows :

$$\tau(x) = \int_0^\infty \exp(-t).\, t^{x-1} \tag{5}$$

Method of the average velocity and the standard deviation

If the average speed and standard deviation $< v >$& a site are known (they can be estimated from the distribution), the shape parameters, k is determined by asking the following approximation.

$$K = \left(\frac{\sigma}{<v>}\right)^{1.086} \tag{6}$$

The scaling factor is then determined by:

$$c = \left(\frac{< v >}{(1+\frac{1}{k}}\right) \tag{7}$$

Calculation of wind power density

Strong average wind power available, coupled with a mass flow of air at a speed <V> and acting on an area A of a turbine wheel is written:

$$< P >= \frac{1}{2}\rho A < v^3 > \tag{8}$$

ρ denotes the density, parameter varying with latitude and temperature. But generally considered constant and averaging around 1.25 kg/m3 at the following conditions:

T = 20 ° C and P = 1 atm.

The above expression shows that the power available varies with average wind speed Cubic. The latter is determined from Statistics data processing raw wind and the calculation of frequencies than a given threshold speed. The average wind energy available at a given site in a second (power) per unit area of a turbine wheel is:

$$\bar{p} = \frac{1}{2}\rho\overline{v^3} \tag{9}$$

The function of the cubic average speed it is written:

$$\overline{v^3} = \int_0^\infty v^3 f(v) dv \tag{10}$$

As well as average speed, average speed cubic writing:

$$\overline{v^3} = c^3(1+\frac{3}{k}) \tag{11}$$

Spatial interpolation measures

The wind atlas was drawn using the Mapinfo[2] based on information systems (GIS) resulting from the method of analysis Merise. A thematic analysis average speeds is carried out using the method of inverse distance weighting modeled by Mapinfo[2]. It allows the calculation of the value to a node (S0) of mesh by analysis of neighboring point (Si) defined by a search radius. It consists in assigning each score point, held in selecting a weight inversely proportional to the distance between this point and the crude estimate node (S0).

RESULTS AND DISCUSSION

Distribution of the wind speed

The classification of frequency Wind performed on an annual basis for the three sites is represented by the histograms of Figures 4,5 and 6.

First, we present and discuss the results of the distribution of wind sites The study area is noted that for the site-Tétouan ksarsghir, 35% of the data are accumulated in the range of 9 m / s to 11m / s and the range of the velocity distribution extends to 16 m / s. By cons, for the site of Tangier, 23% of data speeds to 7 m / s

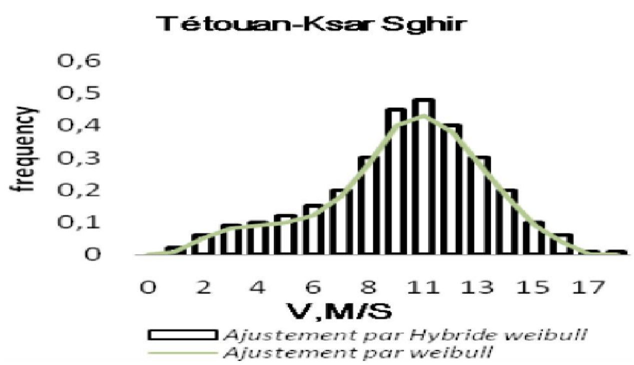

Figure 4 : Wind distribution of site Tétouan-ksar sghir

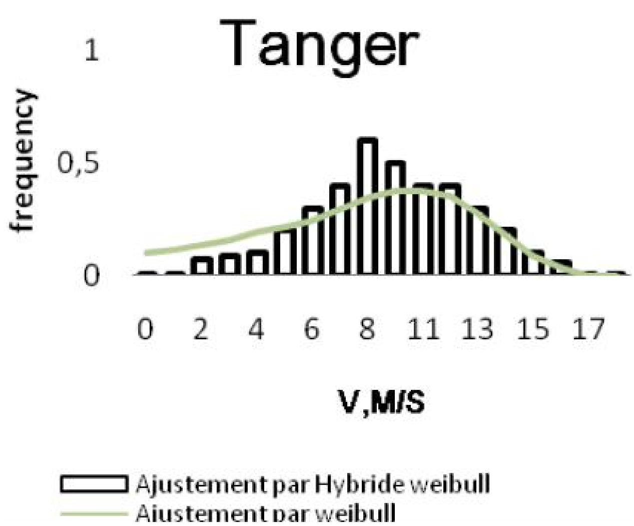

Figure 5 : Wind distribution of site Tangier

and only 9% are in the range of 4 m / s to 7 m / s. As the site Chafchaoun, 24% of the data are recorded in the range of3 m / s to 6 m / s and the speed interval extends slightly to 13 m / s.

Speed and wind power densities available

Using the method of maximum likelihood applied to the distribution, the shape factor k suggests the shape of the curve. A high value of k implies a narrow distri-

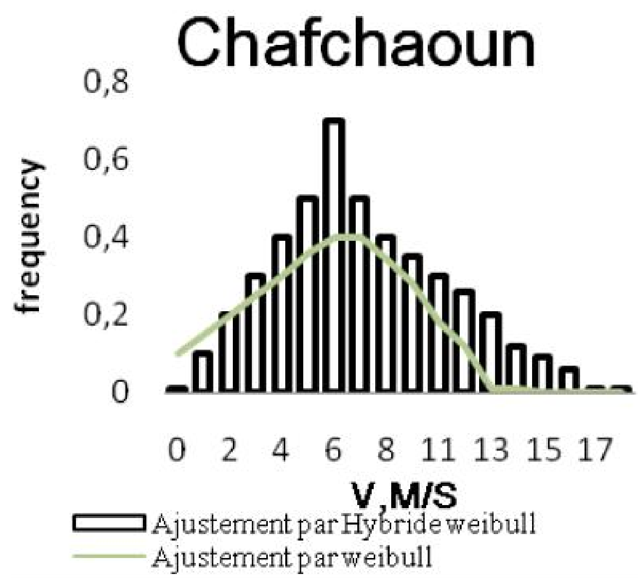

Figure 6 : Distribution wind of site Chafchaoun

bution with winds concentrated around a value, whereas a low value of k implies winds widely dispersed. The scale factor C indicates the position of the mode of the curve, as shown in Figures 4, 5, 6. Its value is high for windy sites and low for low wind sites. values of the parameters k and c for different stations in the region were determined. This allowed the calculation of the average speed and average power density for different sites in the region such as shown in TABLE 2.

Thus, the form factor k suggests the shape of the curve. A high value of k implies a narrow distribution with winds concentrated around a value, whereas a low value of k implies winds widely dispersed. The scale factor C indicates the position of the mode of the curve, as shown in Figures 4, 5, 6. Its value is high for windy sites and low for low wind sites.

TABLE 2 : Résultats de l'étude statistique

Site	K	C(M/S)	V(M/S)	P(W/m2)
ElKsar sghir Tétouan	2.80	8.23	10.129	165.28
Tanger	2.14	7.29	9.764	118,53
Chafchaoun	1.79	5.87	7.122	98,31

We note that the site is the windiest, Elksar sghir with average wind speed of about 9.12 m / s.

The topographical situation Chafchaoun station (located in a bowl) is verified by the low value of the average speed recorded.

Atlas wind speed 10 m

The wind map of the valley of Tangier-Tetouan[2] estimated at 10 m above the ground is shown in Figure 7. A range of variation of the speed average of from 2.5 m / s to 9.4 m / s. The coastal zone of Tangier in the study area is characterized by average wind speeds

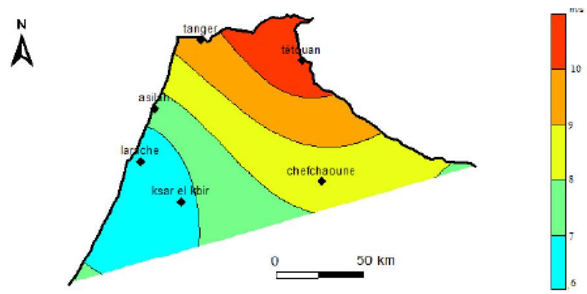

Figure 7: Atlas of the average wind speed in the valley of Tangier-Tetouan estimated at 10 m above the ground SSE. NASA (1983-2012)[3]

above 10 m / s. We note that the neighboring municipalities of, and Elkser Sghir such as Taghramt - Tetouan and Dhar Saadane (whose center is located 22 km south east of Tangier as the crow flies) and the Beni area Mejmel (whose center is located 12 km east of Tangier as the crow flies) have an average speed close to 12m / s. We can say that the windiest area of the valley is the region of Tangier with neighboring municipalities.

Atlas of the power density available at 10 m

It was found that the density of wind power varies between 165.2W/m2 the station-Tétouan ksar sghir and 118.5 W/m2 in the area of Tangier, on the station

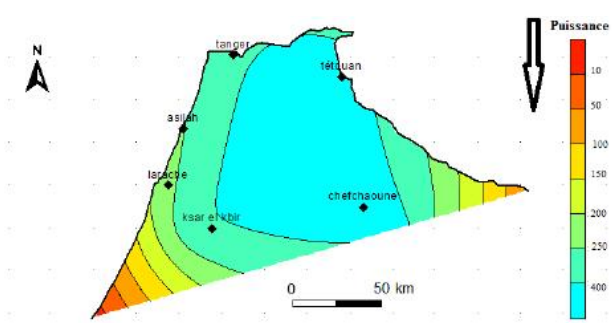

Figure 8 : Atlas of the power density of the wind from the valley of Tangier-Tetouan estimated at 10 m above the ground [3]

Chafchaoun, the average value is 98, 31 W/m2. In other words, the region of Tetouan-ksar sghir remains the most energetic place in the valley.

CONCLUSION

Wind energy contributes to the satisfaction of the needs of the country into electrical energy using a national energy source virtually free and clean. Its main limitation lies in its dependence on wind patterns. Wind energy remains a source of fuel economy that does not guarantee the required power. Note, however, that the repair daily average wind speeds incorporates the daily load curve.Thematic analyzes of the study area showed that the littoral zone, such as Tangier and the surrounding communities such as, Tlat-Taghramt, are the windiest Valley Tanger-Tétouan. Thus we can conclude that Elqser Sghir remains the most appropriate place to implement a profitable and efficient wind turbine system for pumping water for irrigation, as these areas are used for agriculture. Perspective, we will focus on the microclimate of the region Tanger-Tetouan and the influence of all parameters such as soil roughness, the effect of an obstacle on the wind speed region. Morocco has been able, thanks to the new arrangements and the financing obtained, raise the wind energy sector. With this desire to reach 3800 MW of capacity in 2020, a new industrial opportunity is open. After manufacture masts, other components are designed for local production creates jobs, a social asset that adds to the environmental challenge.

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