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Socioeconomic and environmental impacts of wind parks in a municipality of the Médio Sertão Territory of Paraíba

Impactos socioeconômicos e ambientais dos parques eólicos em município do Território do Médio Sertão paraibano

Impactos socioeconómicos y ambientales de los parques eólicos en un municipio del Territorio de Médio Sertão, Paraíba

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Abstract
The investigation has a qualitative approach as a methodological procedure. The objective is to analyze the socioeconomic and environmental impacts of wind parks in the municipality of São José do Sabugi (PB), in the interior of Paraíba. As for the purposes, it consists of a descriptive research. As for the means, the research is characterized as bibliographical and documentary research. The municipality of São José do Sabugi-PB benefited from the collection of the Tax on Services of Any Nature (ISSQN). Income generation was mainly through land leases. Commercial activity was also affected, with the food sector being the most benefited. The forms of social participation took place through the work of the Environmental Protection Council (COPAM). The construction of roads was a positive point, but it became a problem, as vehicle traffic increased, generating the risk of accidents and changes in the daily lives of residents. During the road construction process there were impacts on the region's flora. The generation of noise and alteration of the landscape are also impacts present during the operation of wind parks in the municipality. Positive impacts are perceived in relation to economic factors, such as the collection of taxes by the municipality and land leasing. Environmental impacts were also generated that need to be mitigated, as they put both the fauna and flora of the region at risk.
Keywords: Wind energy; Socioeconomic impacts; Environmental impacts.

Resumo
A investigação tem como procedimento metodológico a abordagem qualitativa. O objetivo é analisar os impactos socioeconômicos e ambientais dos parques eólicos no município de São José do Sabugi (PB), no sertão paraibano. Quanto aos fins, consiste em uma pesquisa descritiva. Quanto aos meios, a pesquisa se caracteriza como pesquisa bibliográfica e documental. O município de São José do Sabugi-PB se beneficiou em relação a arrecadação do Imposto sobre Serviço de Qualquer Natureza (ISSQN). A geração de renda se deu principalmente pelo arrendamento de terras. A atividade comercial também foi afetada, sendo que o setor alimentício o mais beneficiado. As formas de participação social ocorreram por meio da atuação do Conselho de Proteção Ambiental (COPAM). A construção de estradas foi um ponto positivo, porém se tornou um problema, pois o tráfego de veículos aumentou gerando o risco de acidentes e mudanças no cotidiano dos moradores. No decorrer do processo de construção das estradas houve impactos a flora da região. A geração de ruídos e alteração da paisagem também são impactos presentes durante o funcionamento dos parques eólicos no município. Percebe-se impactos positivos em relação aos fatores econômicos, como a arrecadação de impostos pelo município e o arrendamento de terras. Também foram gerados impactos ambientais que precisam ser mitigados, pois colocam em risco tanto a fauna como a flora da região.
Palavras-chave: Energia eólica; Impactos socieconômicos; Impactos ambientais.

Resumen

La investigación tiene un enfoque cualitativo como procedimiento metodológico. El objetivo es analizar los impactos socioeconómicos y ambientales de los parques eólicos en el municipio de São José do Sabugi (PB), en el interior de Paraíba. En cuanto a los propósitos, se trata de una investigación descriptiva. En cuanto a los medios, la investigación se caracteriza por ser una investigación bibliográfica y documental. El municipio de São José do Sabugi-PB se benefició de la recaudación del Impuesto sobre los Servicios de Cualquier Naturaleza (ISSQN). La generación de ingresos se realizó principalmente a través del arrendamiento de terrenos. La actividad comercial también se vio afectada, siendo el sector alimentario el más beneficiado. Las formas de participación social se dieron a través del trabajo del Consejo de Protección Ambiental (COPAM). La construcción de carreteras fue un punto positivo, pero se convirtió en un problema, ya que aumentó el tráfico de vehículos, generando el riesgo de accidentes y cambios en la vida cotidiana de los residentes. Durante el proceso de construcción de la carretera hubo impactos en la flora de la región. La generación de ruido y la alteración del paisaje también son impactos presentes durante la operación de los parques eólicos en el municipio. Se perciben impactos positivos en relación a factores económicos, como la recaudación de impuestos por parte del municipio y el arrendamiento de tierras. También se generaron impactos ambientales que deben ser mitigados, ya que ponen en riesgo tanto a la fauna como a la flora de la región.

Palabras clave: Energía eólica; Impactos socioeconómicos; Impactos ambientales.

1. Introduction

The global population increase has intensified the demand for goods and services, so it began a search for sustainable alternatives that meet the current needs of the population and at the same time does not compromise future generations (Farias, 2016), by addressing the conscious use of natural resources available on the planet, observing the economic, social and environmental dimensions, in the face of scarcity and current environmental crises.

The climate crisis has included the replacement of fossil fuels with alternative energy sources and technologies that can minimize the harmful effects of global warming. Therefore, the energy transition to renewable sources is the main alternative for reducing the use of fossil sources (Carvalho & Coimbra, 2018).

The concern with environmental issues has become the main vector for the search for cleaner options in energy generation. Among these options, wind energy has been gaining visibility in recent decades (Simas & Pacca, 2013), by not generating greenhouse gases the wind source has become essential for the mitigation of climate change (Peri, Becker & Tal, 2020).

Knowing that the Brazilian energy sector is based on the construction of large hydroelectric plants, however, this type of source causes impacts both locally with the flooding of forests and globally with the emission of pollutants such as carbon dioxide and methane. In addition to compromising the use of this source during periods of drought, putting at risk the energy security of the country. Therefore, it is necessary that other sources have greater participation and energy production than hydroelectric plants, such as wind and biomass sources, for example, because the wind and sugarcane production regime is opposite to the water regime (Lopes, 2015).

The growth of renewable sources can be with wind energy, which in 2019 was the third source with the largest share in the Brazilian electricity matrix, behind only hydraulic sources and natural gas (National Energy Balance Report, 2020). Altogether there are more than 8,000 wind turbines in operation in the country, distributed in 12 states. In 2020 the installed capacity reached 17,747 MW (Abeeólica, 2021). Thus, it can be seen that generation from wind source is growing in the country, one of these expansion factors would be the economic viability of wind source, making it competitive with fossil fuels (Dantas et. al, 2019).

The Northeast region of Brazil is the one that concentrates the greatest potential for energy generation from wind source. States such as Rio Grande do Norte and Bahia have together about 371 parks in operations, totaling an installed capacity of 10,033.8 MW.

Paraíba has an installed capacity of 157.2 MW distributed in 15 parks (Abeeólica, 2021), located on the coast of the state in the municipality of Mataraca, and in the sertão in the municipalities of Santa Luzia, São José do Sabugi and Junco do

Seridó (Silva & Gorayeb, 2019). In addition to these parks the Wind Atlas of Paraíba cites that the state holds seven areas of potential use of wind energy for the production of electricity, these are: Mataraca (area where the city of Mataraca is located), Curimataú, Serra da Borborema, Seridó Oriental, Seridó Ocidental (the cities of Santa Luzia, São José do Sabugi and Junco do Seridó are inserted in this area), Serra de Teixeira, São João do Tigre and Camalaú (Shcubert, 2017).

It is remarkable the potential of Paraíba for the installation and operation of wind parks, but before starting such projects, it is necessary to know the positive and negative aspects that lead to the diffusion of wind energy, aiming to recognize the advantages and challenges of its implementation (Farias, 2016), since such process occurs by the involvement of three main actors, the companies responsible for the project, the local community and public entities (Dantas et. al, 2019) that are prone to the positive and negative impacts of these facilities.

Adeyeye, Ijumba, and Colton (2020) reinforce that it is essential that further research be done in order to know the advantages and disadvantages on the environment and economy that are provided by wind energy so that it becomes an environmentally friendly and sustainable alternative. Given the above, and the growth scenarios that the state of Paraíba presents, it is necessary to understand the socioeconomic and environmental impacts of the implementation of wind parks in the state.

Therefore, this research was conducted in the municipality of São José do Sabugi, located in the sertão of the state, which together with the municipalities of Santa Luzia and Junco do Seridó form the parks Canoas, Lagoa I and II. Each park has 15 wind turbines that total an installed capacity of about 90MW (Cartaxo, 2020).

Seeking to highlight the issues concerning energy management in the sertão of Paraiba, the following question is posed: What are the impacts of the installation of wind parks in the medium sertão paraibano and the potential effects for local development in São José do Sabugi (PB), considering the economic, social and environmental dimensions?

For this, it is aimed to analyze the socioeconomic and environmental impacts of wind parks in the municipality of São José do Sabugi (PB), in the sertão of Paraíba.

2. Theoretical Background

The Industrial Revolution caused the growth of population and large urban centers, consequently there was an increase in energy consumption. As a result of these factors, energy production mostly occurs through the use of non-renewable sources that harm the environment (Silva & Carmo, 2017). The large consumption of non-renewable sources, specifically fossil fuels, emit greenhouse gases during their operation, and these gases are harmful to the planet, leading to climate change.

In order to reduce the impacts caused by fossil fuels, the need to diversify the world's electricity matrix was created, opting for sources that cause less impact on the environment, but that at the same time ensure the production and distribution of energy. Two justifications given by countries and international organizations for the diversification of energy sources are

> The search for less dependence on fossil fuels, given their finiteness, which could threaten the security of these countries; and the environmentalist-based discourse, which has been encouraging the reduction of the emission of pollutant gases into the atmosphere through the replacement of fossil fuels with sources considered renewable and clean (Traldi, 2018, p.2).

Renewable sources emerge in this context as the main way for energy matrices to become as sustainable as possible. Renewable sources are considered those that come from renewable natural resources, which over time are responses in nature, with wind and sunlight being examples of this type of source (Lopes, 2015).

Wind energy was already used for other purposes such as pumping water and milling grain, but the generation of electricity from this source intensified from the 1970s with the international oil crisis that caused an increase in investments for

the use of wind energy on a commercial scale (Aneel, 2005), with the first wind turbine installed in Denmark in 1976, and currently Germany and the United States stand out in wind energy production, for covering most of the projects involving this source.

In Brazil, the first contact with this source for energy generation occurred in the Fernando de Noronha archipelago, where towers were installed in order to measure the local wind speed (Alves, 2010). The Brazilian wind energy potential began to be explored after the energy crisis that hit the country in 2001. After this event, several investments began to emerge with the aim of establishing and spreading wind power plants in the country.

> Wind energy is the kinetic energy contained in moving masses of air (wind). Its use occurs by converting the kinetic energy of translation into rotational kinetic energy, with the use of wind turbines, also called wind turbines, for electricity generation, or windmills, for mechanical works such as water pumping (Aneel, 2005, p. 1).

Wind power stands out in energy generation among renewable sources (Lima, Santos & Moizinho, 2018) having been one of the main factors in the modification of the Brazilian energy matrix, contributing to the energy security of the country and to contain the impacts of climate change.

Therefore, the Brazilian energy matrix is one of the cleanest in the world, according to data from the National Energy Balance Report (2020), in the year 2019 about 46.1% of the energy produced in Brazil comes from renewable sources. The participation of wind source in electricity production reached the mark of 8.6% in the year 2019 surpassing generation from biomass. In the year 2015 it had already surpassed nuclear generation, according to data from the National Energy Balance Report (2020). This growth trend is not only perceived here in Brazil, in the rest of the world the wind power industry has presented expressive numbers. According to data from Abeeólica in the year 2019 installations equivalent to 60.4 GW were made, this being the second year in history regarding production through wind source.

In Brazil, most wind parks are located in the Northeast region of the country, of the 695 parks in the country, 599 are located in the Northeastern territory, especially in the states of Rio Grande do Norte, Bahia, Piauí and Ceará, which together account for approximately 77% of the wind power produced in the country, specifically Paraíba concentrates 15 parks in operation totaling 157.2 MW of installed capacity (Abeeólica, 2021), this detailing of the distribution of parks and capacity can be seen in Table 1.

Table 1. Installed Capacity and Number of Parks per State.

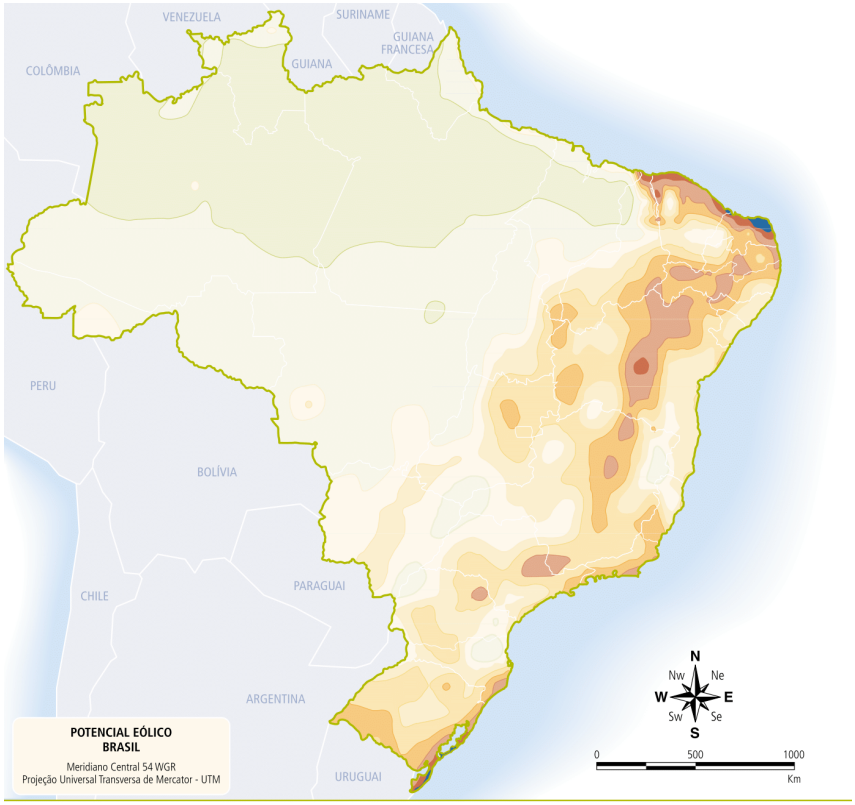
State	Power (MW)	Parks
Rio Grande do Norte	5.154,2	182
Bahia	4.879,6	189
Piauí	2.275,9	79
Ceará	2.179,3	84
Rio Grande do Sul	1.835,9	80
Pernambuco	798,4	34
Maranhão	426,0	15
Santa Catarina	238,5	14
Paraíba	**157,2**	**15**
Sergipe	34,5	1
Rio de Janeiro	28,1	1
Paraná	2,5	1
TOTAL	18.010,1	695

Source: Abeeólica (2021).

For presenting great potential in the use of wind for energy generation, the Northeast region was the target of most of these investments, distributed along the coast of the states of Rio Grande do Norte and Ceará. It is worth mentioning the creation of incentive mechanisms for renewable sources such as the Emergency Wind Power Program (Proeólica) created by Resolution 24/2001 of the Electric Energy Crisis Management Chamber, aiming to provide the establishment of 1,050 MW by December 2003, through wind power source (Alves, 2010). Another milestone of great relevance is the Incentive Program for Alternative Sources (PROINFA), created by Law No. 10.438 in the year 2002, considered the main vector for the growth of the wind market in the country (Simas & Pacca, 2013).

The large percentage of wind generation in the Northeast is due to good environmental conditions, such as wind speeds that favor the implementation of this type of energy, which can reach an average annual speed of 50 meters high, as seen in Figure 1.

Figure 1. Mean annual wind speed at 50m height.



Source: Aneel (2005).

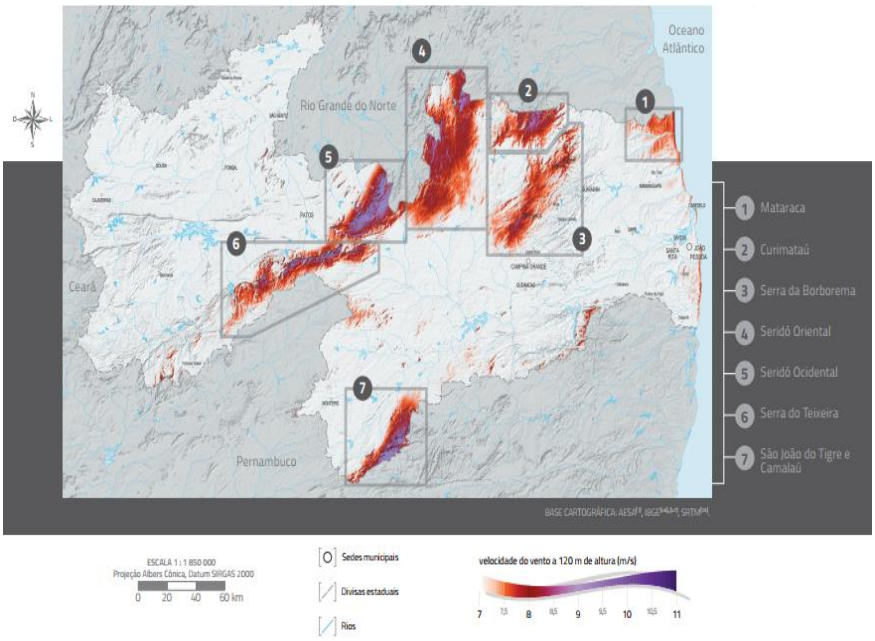
It can be noted that in addition to the coastal strip, some inland areas of Paraíba, Pernambuco and Bahia also demonstrate potential use of wind power. Another state that also has the capacity to produce from wind power is Rio Grande do Sul, which currently has 80 parks in operation (Barcella & Brambilla, 2012) (Table 1).

Despite its capacity for the development of projects involving wind energy, the state of Paraíba does not yet concentrate a large number of parks in relation to other states in the Northeast, such as Rio Grande do Norte. Possessing Wind parks in the municipalities of Mataraca, Santa Luzia, Junco do Seridó and São José do Sabugi (Silva & Gorayeb, 2019).

In Paraíba some incentives that contribute to the implementation of parks are the State Policy of Incentive to the Generation and Use of Solar and Wind Energy (the Law n. 10.720/2016) and the publication of the Wind Atlas of Paraíba (2018) that bring relevant information that help in the understanding of promising areas in the state for wind energy production (Silva & Gorayeb, 2019).

The Wind Atlas of Paraíba presents bases that can be used by companies to recognize the potentialities of the state. The document points out the regions of the state that have the capacity to use the wind source (Shcubert, 2017) and in this wind mapping of the state seven zones were indicated as potential promising areas for wind energy use in Paraíba, according to Figure 2.

Figure 2. Main promising areas for wind power development in Paraíba.



Source: Shcubert (2017).

Area 1, known as Mataraca, is located in the Northern Coast of the state, the main access is BR-101, 104 km from João Pessoa. The wind energy potential is concentrated in the municipalities of Mataraca and Rio Tinto, which together have a population of 30,383 inhabitants, mostly urban. The average annual wind in the region is 7.38 m/s at 101.6 meters high (Shcubert, 2017).

Area 2, Curimataú is located north of the West and East Curimataú microregions, the region has its main accesses by state highways PB-111, PB-133 and PB-135. The wind capacity encompasses the municipalities of Araruna, Cuité, Damião and Cacimba de Dentro, which count a population of 60,505 inhabitants. The average annual wind in the region, is 8.08 m/s at 101.6 meters high. Located between the microregions of Esperança and Brejo Paraibano (Shcubert, 2017).

Area 3, called Serra da Borborema has as its main access the BR-104 highway, distant 166 km from João Pessoa. The wind potential of the region is comprised between the municipalities of Pocinhos, Puxinanã, Montadas, Areial, Esperança, Remígio, Algodão de Jandaíra, Casserenguê, Arara, Solânea, Bananeiras, Dona Inês and Areia, which add up to a population of

195,098 inhabitants. Regarding the average annual wind the estimated value is 8.5 m/s in the best areas, at a height of 120 meters (Shcubert, 2017).

Area 4, called Eastern Seridó is located in the Eastern Seridó microregion, its access is through PB-177, which cuts it in the North-South direction. Three other important road connections are the PB-137, PB-151 and PB-167. The main municipalities in this region are Picuí and Juazeirinho. Besides these the municipalities of Baraúna, Frei Martinho, Nova Palmeira, Pedra Lavrada, Cubati, Seridó, Tenório and Nova Floresta contemplate the wind power potential of this region. The average annual wind is equivalent to 8.5 to 9.0 m/s in the best areas, at 120 meters high.

The Western Seridó, area 5 is situated in the microregion of the Western Seridó, the region has its main access by BR-230. The potential of the region is in the municipalities of São José do Sabugi, Santa Luzia, Junco do Seridó, São Mamede, Areia de Baraúnas, Passagem and Quixabá, which together have a population of 38,979 inhabitants, In the best areas of the region the average annual wind reaches 9.5 m/s in the best areas, at 120 meters high (Shcubert, 2017).

Area 6 understood as Serra de Teixeira is located in the microregion of Serra do Teixeira, the two main roads that serve the region are BR-110 and PB-306. The region's potential includes the municipalities of Jurú, Água Branca, Imaculada, Catingueira, Mãe d'Água, Maturéia, Teixeira, Cacimba de Areai, Cacimba and Taperoá. Together, the population of these places totals 84,857 inhabitants. The average annual wind expectation is 6.88 m/s at a height of 101.5 meters (Shcubert, 2017).

Finally area 7 which is called São João do Tigre and Camalaú, is located in the microregion of Western Cariri in the south of the state. The wind capacity is concentrated in the municipalities of and São João do Tigre and Camalaú which have a population of 10,145. The region in terms of average annual wind has 9.2 m/s in the best areas, for 120 meters of height (Shcubert, 2017).

In view of the above, it is possible to note that Paraíba has scenarios for production growth in the coming years, but these possibilities bring with them social and environmental challenges. Despite being a renewable and inexhaustible source, and thus an alternative to supply consumption in society, it is necessary to understand the implementation processes of these sources, based on an orderly environmental planning. Therefore, this becomes the main challenge of the energy sector, to understand the social and environmental impacts of the implementation of these parks (Silva & Gorayeb, 2019).

As wind energy is considered a renewable source, it presents positive characteristics in relation to the impacts generated to the environment. Regarding the socioeconomic benefits brought by renewable energy, regional and local development and job creation are some of the advantages of using this type of source (Simas & Pacca, 2013). Regarding environmental benefits, wind energy contributes to the following points: it reduces the emission of greenhouse gases (Pinto, Martins & Pereira, 2017), it causes less environmental impact than other energy sources (Araújo & Moura, 2017).

Despite these benefits in relation to other means of producing energy, it also has some negative aspects that can interfere and harm various environments such as the social, physical, such aspects must be taken into consideration when starting the installation of a wind park. Therefore, the impacts (positive and negative) of these parks must be taken into consideration and with responsibility of the company in charge when seeking ways to mitigate them, whether they are the society or the fauna and flora of the region (Araújo & Moura, 2017).

Studies on wind parks have shown externalities and potentialities within the social, economic and environmental scope, as shown in Table 2.

Table 2. Weaknesses and Potentialities of wind energy.

WEAKNESSES	POTENTIALITIES
Noise (Araújo & Moura, 2017; Kaspary & Jung, 2015; Pinto, Martins & Pereira, 2017)	**Job Generation** (Carvalho & Coimbra, 2018; Simas & Pacca, 2013)
Temporary Jobs (Moreira, Mariano & Teixeira, 2018)	**Low CO2 emission** (Araújo & Moura, 2017; Kaspary & Jung, 2015)
Visual Impacts (Damasceno & Abreu, 2018; Farias *et al* 2020; Gomes & Henkes, 2015; Peri & Tal, 2020)	**Generates fewer impacts compared to other sources** (Araújo & Moura, 2017)
Deforestation of local vegetation (Araújo & Moura, 2017; Carvalho & Coimbra, 2018)	**Development of the local economy** (Carvalho & Coimbra, 2018; Simas & Pacca, 2013)
Fauna Damage (*risk of animal accidents and alteration of their habitat*) (Araújo & Moura, 2017)	**Creates alternative revenues for farmers who lease their land** (Gomes & Henkes, 2015; Araújo & Moura, 2017)
Electromagnetic Interference (Pinto, Martins & Pereira, 2017)	**Wind energy generates tourism for local communities** (Gomes & Henkes, 2015)

Source: Authors (2021).

Among the potentialities of wind energy use, the perspective of employment and income generation is widely discussed in the literature. Adeyeye, Ijumba, and Colton (2020) mention that the implementation of wind energy affects the economy of the region in which it is inserted, and that the economic impact brought by it is an essential factor for society's acceptance.

According to Simas and Pacca (2013) rural communities that lack economic development and have high unemployment rates are advantageous places for the diffusion of renewable energy. Also in the authors' view, despite the emergence of opportunities for these communities, it should be noted that most of the jobs generated are of a temporary nature, requiring policies to increase or ensure the development of projects each year.

According to Sastresa et al (2010) technological development linked to the growth in the number of renewable energy projects helps to create stable jobs. In addition, the qualification and training of professionals is a fundamental tool to increase the local workforce, making the company competitive and facilitating the generation of investments and business.

Another factor that generates income for the residents of the region where the wind parks are located is the leasing of land for the construction of the parks, creating alternative income for the owners (Gomes & Henkes, 2015). However, in Traldi's (2018) view, there is an imbalance in these contracts resulting from landowners' losses due to the long terms and the payment of unilaterally established fines; in addition, landowners cannot renegotiate the amount received for the use of their land due to a confidentiality clause.

Still in relation to the economic aspects surrounding wind energy, the development of the local economy is also observed. In research conducted in the state of Pernambuco, in the city of Araripina-PE, Carvalho and Coimbra (2018) mention the emergence of new ventures, mainly in the food and hotel business, such ventures arise with the aim of supplying the demand provided by the arrival of wind parks in the city.

Besides the economic factors involved in projects for the use of wind energy, its development contributes to the formulation of public policies, and to the discussions that involve actions related to the welfare of the community or city in which the parks operate.

Due to all these factors presented, it is necessary the analysis of wind power enterprises in search of possible damages and benefits, allowing debates that go beyond the academic sphere, involving the public power and especially the communities (Moreira, Mariano & Teixeira, 2018).

A mechanism that can help in advance the control and reduction of damage to the environment is the environmental licensing, established as an instrument of the National Environmental Policy (MMA, 2018). In the year 2011, the complementary Law No. 140 was enacted with the objective of clarifying the attributions of the Union, States, and

Municipalities regarding environmental licensing. With the decentralization of licensing activities, it is expected the decrease in the delay of processes and the end of competence conflicts between environmental agencies (Brazil, 2011).

In the state of Paraíba, the agency responsible for issuing licenses is the Superintendence of Environmental Administration - SUDEMA. To support SUDEMA in issuing licenses the Environmental Protection Council (COPAM) will suggest the maintenance, revocation, or alteration of such licenses in accordance with the norms, guidelines, instructions, in accordance with the criteria and standards relating to the control of pollution and the maintenance of the quality of the environment, with a view to the rational use of environmental resources in the state of Paraíba, observing the applicable legislation. This agency was created by Law 4.335 of December 16, 1981 and is a collegiate body and is part of the State System of Environment. Its functions are related to the control and protection of the environment and the conscientious use of the state's natural resources (Conselho de Proteção Ambiental, 1981). Article 3 of COPAM's Internal Regulation determines which members are part of the council:

> I – o titular da Secretaria e que a SUDEMA esteja vinculada, qualidade de Presidente tendo como substituto o Superintendente da SUDEMA, na falta deste, será substituído pelo seu Secretário Executivo; II – cinco representantes do Conselho Regional de Engenharia e Arquitetura, de áreas de conhecimento distintas; III – cinco representantes da Superintendência de Administração do Meio Ambiente; IV – um representante da Associação Paraibana dos Amigos Natureza; V – um representante do Instituto Brasileiro do Meio Ambiente e dos Recursos Naturais Renováveis; VI – um representante do Ministério público Estadual; VII – um representante do Instituto do Patrimônio Histórico e Artístico do Estado da Paraíba; VIII – um representante da Associação Brasileira de Engenharia Sanitária e Ambiental (ABES); IX – um representante do Centro das Indústrias do Estado da Paraíba (CIEP); X – um representante da Federação das Indústrias do Estado da Paraíba (FIEP); XI – um representante da Secretaria de Estado do Desenvolvimento da Agropecuária e da Pesca – SEDAP (Paraíba, 2000)[1].

The council will establish the issuance of the preliminary license (LP), installation license (LI), and operation license (LO), which are important instruments for the installation of activities with actual or potential capacity to generate pollution. Collaço and Bermann (2017) mention that participatory planning is fundamental, because the decisions that surround the energy area bring consequences for several spheres such as environmental, social, and economic.

3. Methodology

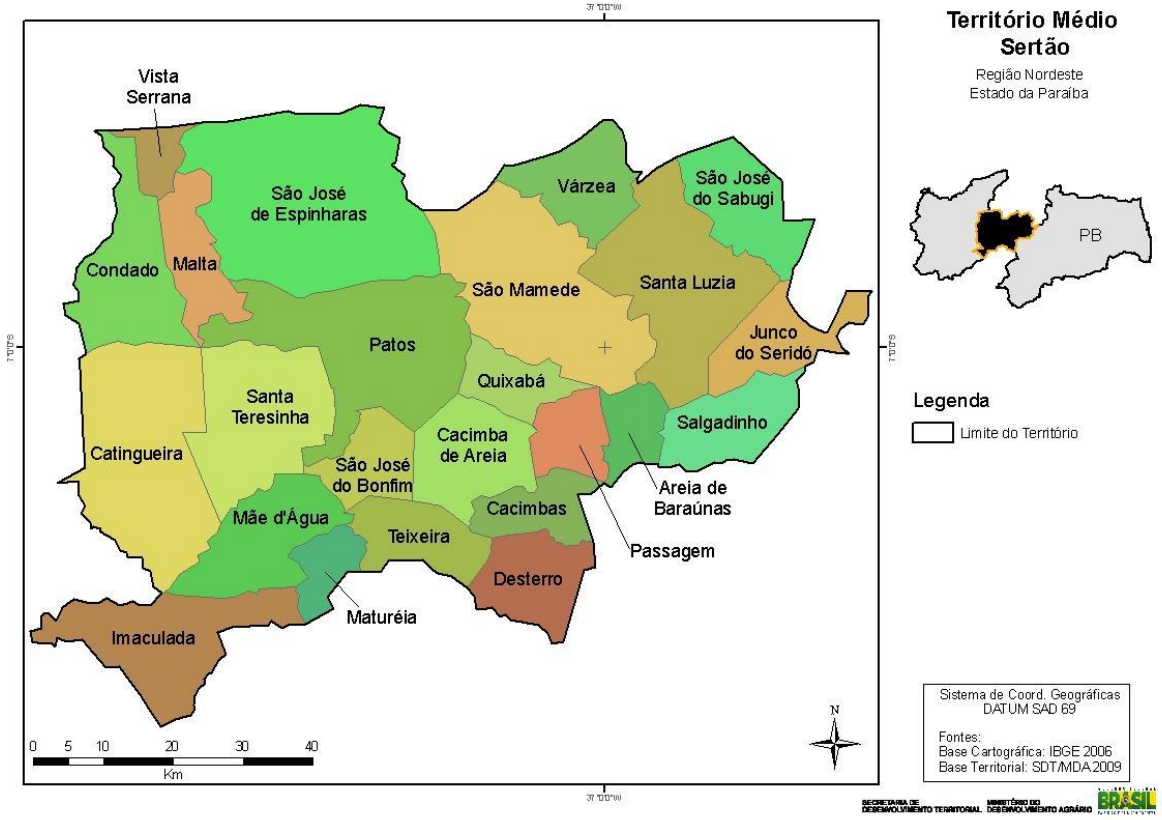
The investigation will be configured as an empirical research, having as methodological procedure the qualitative approach (Vergara, 2011), when seeking to describe, explain and/or criticize the context of the problem and phenomena manifested in the social reality. The methodological classification of the research will start from the taxionomy used by Vergara (2011), in the aspects: As for the ends, it will consist of a descriptive research. As for the means, the research will be characterized as bibliographic and documentary research.

3.1 Object of investigation

[1] I - the holder of the Secretariat to which SUDEMA is linked, as Chairman, with the SUDEMA Superintendent acting as substitute; in his absence, he will be replaced by his Executive Secretary; II - five representatives from the Regional Council of Engineering and Architecture, from different areas of knowledge; III - five representatives from the Superintendence of Environmental Administration; IV - one representative from the Paraiban Association of Friends of Nature; V - one representative from the Brazilian Institute of the Environment and Renewable Natural Resources VI - one representative from the State Public Ministry; VII - one representative from the Institute of Historical and Artistic Heritage of the State of Paraíba; VIII - one representative from the Brazilian Association of Sanitary and Environmental Engineering (ABES); IX - one representative from the Center of Industries of the State of Paraíba (CIEP); X - one representative from the Federation of Industries of the State of Paraíba (FIEP); XI - one representative from the State Secretariat for the Development of Agriculture, Livestock and Fishing - SEDAP (Paraíba, 2000).

The object of the investigation will be the municipality of São José do Sabugi-PB, located in the Territory Médio Sertão defined by the State Council for Sustainable Rural Development (CEDRS), which has a total area of 6037. 7000 km², composed of 24 municipalities (Areia de Baraúnas, Cacimba de Areia, Cacimbas, Catingueira, Condado, Desterro, Imaculada, Junco do Seridó, Mãe d`Água, Malta, Maturéia, Passagem, Patos, Quixabá, Salgadinho, Santa Luzia, Santa Teresinha, São José de Espinharas, São José do Bonfim, São José do Sabugi, São Mamede, Teixeira, Várzea, Vista Serrana). The total population of this territory is 232,585 inhabitants, with an urban population of 176,878 inhabitants (76.05%) and a rural population of 55,707 inhabitants (23.95%) (MDA, SIT, 2019).

Figure 3. Médio Sertão Territory (PB).



Source: MDA, SIT, (2019).

The three parks are part of a complex located in the municipality of Santa Luzia, São José de Sabugi, and Junco do Seridó, i.e., in the Médio Sertão-PB Territory. Each park has 15 Gamesa wind turbines and were inaugurated throughout 2017 (The Windpower, 2018). The complex has a total of 45 wind turbines and installed power totaling 94.5 MW. The works were executed "by the company Força Eólica do Brasil, with the support of the Federation System of Industries of the State of Paraíba (FIEP) through the Regional Department of SENAI of Paraíba in National Network with the Regional Department of SENAI of Bahia" (FIEPB Apud Câmara, 2016).

The choice of the municipality of São José do Sabugi in the Médio Sertão Territory-PB is explained in function of its different physical, economic, environmental and sociocultural identity characteristics. As far as the environmental motivations are concerned, it occurs due to the presence of the wind park in the locality and the diversification of natural resources, as well as the environmental problems and impacts caused by anthropic actions and climate variations that have triggered a process of desertification, degradation (of the semi-arid zones), droughts and environmental injustices. By socio-political motivations,

having in view that the Center of Exact and Applied Social Sciences (CCEA), Campus VII, of the Paraíba State University (UEPB) is located in a municipality (Patos-PB) that makes up the Médio Sertão Territory and by the Group of Studies and Research in Socio-environmental Administration (GEPAS), of the Administration course, having among its perspectives of studies research involving management, participation and education in the process of formulation of social and environmental policies, thus the need to produce science about/for/in the territory of Médio Sertão.

3.2 Documental research and data treatment

The documental research occurred from official data in websites, rendering of accounts, minutes, laws, economic-financial reports (income, employment, projects, royalties, etc., environmental impact reports, resolutions, council minutes and other public or private documents that regulate, describe or present information about the participation and socio-economic representativity of the social actors involved, before, during and after the implantation of the wind parks in the territory.

A bibliographical survey specialized in the area was used as a basis as well as to choose possible indicators of socioeconomic and environmental impacts of the energy sector of wind parks implemented in the region.

The treatment and analysis of the obtained data occurred through the Excel program (Microsoft Corp., USA), in which the results obtained will be demonstrated through graphical data and tables (numerical and/or percentage).

4. Results and Discussion

The Canoas and Lagoa wind complex is composed of the Canoas, Lagoa I and II parks. The enterprise is developed by Força Eólica do Brasil (FEB), in total 45 wind turbines are to be installed through this project. The wind complex is located in the Northeast region of the country, in the state of Paraíba, in the cities of Santa Luzia, São José do Sabugi and Junco do Seridó. The Western Seridó region in which the municipalities are located has great potential for harnessing the power of the wind to generate energy (Costa, 2018).

The 45 wind turbines are distributed as follows: 14 wind towers are located in the rural area of the municipality of Santa Luzia, 28 wind turbines in the rural area of the municipality of São José do Sabugi, finally we have that in the municipality of Junco do Seridó are allocated 3 wind turbines also in the rural area (Costa, 2018). For the purposes of this study, the municipality of São José do Sabugi will be used as a reference.

The municipality of São José do Sabugi is located in the Mesoregion of Borborema and in the Microregion of Seridó Ocidental Paraibano. It has an estimated population of 4,147 inhabitants in 2020, and a demographic density of 19.38 inhabitants/km². The territorial area of the municipality is 213.555 km² and the predominant biome in the region is the caatinga (IBGE, 2021).

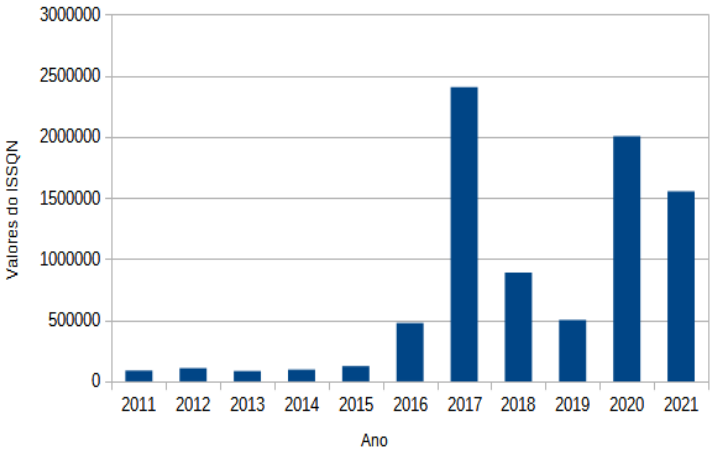
The first point to be addressed will be the socioeconomic aspects surrounding the implementation of wind energy in the municipality of São José do Sabugi. We consulted the municipality's collection of the Tax on Services of Any Nature (ISSQN), and data regarding the municipality's revenue.

The Tax on services of any nature is based on the Federal Constitution of 1988, where in its article 156, III we have that: "Art. 156. Compete aos Municípios instituir impostos sobre: III – serviços de qualquer natureza, não compreendidos no art. 155, II, definidos em lei complementar" (Brazil, 1988)[2]. Complementary Law 116 of July 31, 2003 also addresses ISSQN issues and defines a list of services that will contribute to the collection of the tax (Brazil, 2003).

[2] Art. 156. It is up to the municipalities to establish taxes on: III - services of any nature, not included in art. 155, II, defined in complementary law" (Brazil, 1988)

Graph 1 presents the variation in ISSQN collection in the municipality of São José do Sabugi in the period from 2011 to 2021.

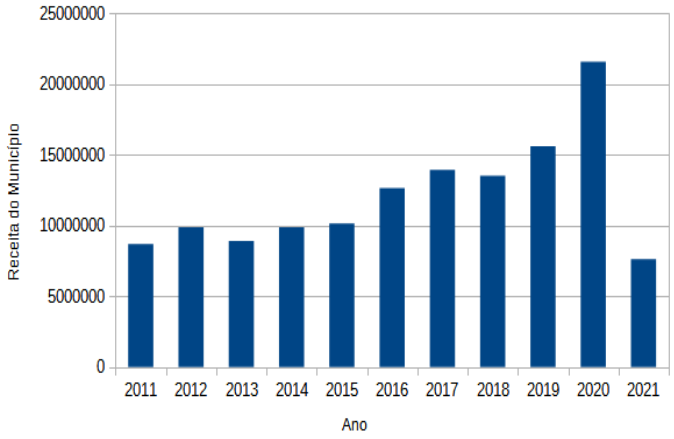
Graph 1. Tax on Services of Any Nature (ISSQN) in the municipality of São José do Sabugi



Source: Sagres (2021).

From 2011 to 2015, the average tax collection in this municipality was R$ 99,831.566. In the following year the amount of tax collected was higher than the average of previous years reaching R$ 476,751.91. However, the year 2017 has the highest amount collected in this 10-year period, the amount collected was R$ 2,405,058.8. In this year began the works for the implementation of the wind park in the municipality of São José do Sabugi. After 2017, the municipality's tax collection remained high compared to previous years (Sagres, 2021). Graph 2 shows the revenue of the municipality for the period between 2011 and 2021.

Graph 2. São José do Sabugi Municipality's Revenues.



Source: Sagres (2021).

From what is shown in graph 2 it is possible to see that until 2015 the municipality's revenue was a maximum of R$10,000,000.00. From the year 2016, this mark was exceeded, in the year 2019 the municipality exceeded the mark of R$ 15,000,000.00 of revenue collection. The period between 2017 and 2019 also coincides with the construction process of the wind park (Sagres,2021).

In the state of Paraíba some policies have been emerging to encourage the use of renewable sources such as solar photovoltaic and wind energy. In 2016, Law No. 10,720 was created to establish the State Policy of Incentive to the Generation and Use of Solar and Wind Energy in the State of Paraíba. Among the objectives of this law are: to encourage investments and implementation of environmentally friendly solar and wind energy systems; create alternative employment and income; mitigate negative impacts on the environment, among others (Paraíba, 2016).

At the municipal level, in the municipality of São José do Sabugi, Municipal Law No. 522 was established in the year 2017, which will address the mandatory hiring of labor from the municipality by mining, construction, energy supply, and other companies of any nature that are established in the municipality. In its article 1 it is determined that 70% of the staff of these companies must be composed of professionals domiciled in the city (São José do Sabugi, 2017).

Thus, in relation to the socioeconomic impacts of the implementation of the wind park in the municipality of São José do Sabugi, it is worth noting the prospect of generating jobs and income for the population. To address these points, the research developed by Costa (2018) that presents the socioeconomic impacts of the wind park operation will be used as a basis.

The first point to be addressed is the monthly income of the research participants. In the municipality of São José do Sabugi-PB, 36% of respondents have a monthly income of up to one minimum wage, while 25% have an income between one and two minimum wages (Costa, 2018). According to IBGE data the monthly wage of formal workers in the year 2018 was 1.7 minimum wages (IBGE, 2021).

Still in the perspective of Costa (2018) regarding the respondents who were benefited with the implementation of wind parks in the municipality of São José do Sabugi-PB, we have that 82% of respondents were not benefited, with that 18% responded that they were benefited. Regarding the way this benefit was generated, land leasing is the main way. It is worth mentioning that the leasing of land benefits both rural and urban dwellers.

> It is notable that with regard to land leases, there are people who receive a certain amount for this type of benefit on a monthly basis, and others who receive it annually; this difference between the periods is due to the form of these land leases. When they are leases for the installation of wind turbines or measuring towers, the beneficiary receives per monthly period, whereas when the lease is only for the passage of wires that connects the towers to the substation inside people's lands, an annual amount is received. (Costa, 2018, p.54)

The commercial activity was also affected with the development of wind energy in the municipality of São José do Sabugi-PB, according to the research of Costa (2018), 71% of the traders interviewed did not obtain benefits, on the other hand 29% responded that they had benefits with the implementation of the wind park. When asked about the expectations of the coming of the wind park to the municipality the answer is almost unanimous, that the expectation is for an increase in the sale of their products and services, as a result of the movement of people. The sector that was most favored was the food sector (Costa, 2018).

Another highlight was the development of the region due to the presence of the parks "enables the installation of educational units with technical and technological level courses, in the area of renewable energy" (Cartaxo, 2020, p.84). This can be observed in the municipality of Santa Luzia that was contemplated with the installation of a campus of the Federal Institute of Paraíba (IFPB), among the courses offered is the Subsequent Technical Course in Renewable Energy Systems that started to be offered in the year 2020 (Pinto, 2017).

The second aspect to be discussed are the forms of representativeness and social participation in the process of implementation of wind parks. Initially, a search was conducted on the website of the São José do Sabugi municipality in order to find any document or minutes that represent the participation at the municipal level. Thus, we can see that the participation took place at the state level, with the activities of the Council for Environmental Protection (COPAM).

As previously mentioned COPAM is a collegiate body that will act in the prevention and control of pollution, aiming at the protection, conservation, recovery, and improvement of environmental resources (Conselho de Proteção Ambiental, 1981). Among its functions we have that "Art.2, III- Authorize the implantation and operation of establishments and activities that use environmental resources, considering them effective or potentially polluting;" (Environmental Protection Council, 1981, p.3).

In order to carry out this function, Chapter IV, Art. 5, VII of State Decree 2120 of 20th June 2000 states that the body will approve environmental licensing for the categories of preliminary, installation and operational licenses, for activities which require Environmental Impact Studies/Environmental Impact Reports EIA/RIMA, or when SUDEMA deems it necessary for COPAM to intervene (Paraíba, 2000).

Table 3 presents information about the licenses issued during the construction and installation process of the wind park in the municipality of São José do Sabugi.

Table 3. Licenses issued related to the São José do Sabugi wind park.

LICENSE TYPE	LICENCE NUMBER	ISSUE DATE	PROCEEDING NUMBER	COPAM DELIBERATION	LICENSED ACTIVITY
Environmental Authorization (AA)	495/2017	03/13/2017	2016-007777/TEC/AA-4991	N. 3770	Installation of a construction site for the construction of wind parks Lagoa 1, Lagoa 2 and Canoas, on the site Lagoa da Redinha, municipality of São José do Sabugi
Preliminary License (LP)	1376/2018	06/12/2018	2018-003274/TEC/LP-3094	N. 3923	Implementation of the Lagoa 3 Wind Park, composed of 10 wind turbines and a total installed capacity of 34.7 MW, located in the rural zone of the municipalities of Santa Luzia and São José do Sabugi-PB.
Preliminary License (LP)	1345/2018	06/11/2018	2018-003275/TEC/LP-3095	N. 3923	Implementation of the Canoas 4 wind park, composed of 10 wind turbines and a total installed capacity of 34.7 MW, located in the rural zone of the towns of Junco do Seridó, Santa Luzia, and São José do Sabugi-PB.
Installation License (LI)	820/2019	04/09/2019	2019-000860/TEC/LI-6590	N. 4004	Implementation of Canoas 4 Wind Park, composed of 10 wind turbines of 3.465 MW, totaling an output of 34.7 MW, located in the rural area of the municipality of São José do Sabugi-PB.
Installation License (LI)	818/2019	04/09/2019	2019-000864/TEC/LI-6593	N. 4004	Implementation of the Lagoa 3 wind park, composed of 10 wind turbines of 3.465 MW, totaling an output of approximately 34.7 MW, located in the rural area of São José do Sabugi-PB.
Environmental Authorization (AA)	2147/2019	10/07/2019	2019-005229/TEC/AA-6003	N. 4053	Installation of a construction site, with a 15,000-liter aerial tank vehicle refueling station and portland cement concrete plant, for the construction of the Lagoa 3, Lagoa 4, Canoas 2, Canoas 3, and Canoas 4 wind parks, in the rural area of the municipality of São José de Sabugi-PB.
Installation License (LI)	1958/2020	11/26/2020	2020-004988/TEC/LI-7411	N. 5052	Lagoa 3 wind park, composed of 10 wind turbines of 3.465 MW, totaling an output of 34.7 MW, occupying a total area of 0.9 ha, located in the rural area of the municipality of São José do Sabugi-PB
Installation License (LI)	1960/2020	11/26/2020	2020-005004/TEC/LI-7415	N. 5052	Canoas 4 wind park, composed of 10 wind turbines of 3.465 MW, totaling an output of 34.7 MW, occupying a total area of 0.9 ha, located in the rural area of the municipality of São José do Sabugi-PB
Environmental Authorization (AA)	480/2021	03/15/2021	2020-009077/TEC/AA-6410		Construction site, 15,000-liter aerial vehicle fueling station, and Portland cement concrete plant for the construction of the Lagoa 3, Lagoa 4, Canoas 2, Canoas 3, and Canoas 4 wind parks in the rural area of São José de Sabugi-PB.

Source: SUDEMA (2021).

Having discussed the socioeconomic aspects, as well as the forms of social participation of the wind park implementation in the municipality of São José do Sabugi-PB, we have as the last part of the discussion the weaknesses and potentialities (positive and negative externalities) of the wind park implementation.

In a survey conducted in the community Riacho Fundo, rural area of the municipality of São José do Sabugi (PB), located 19 km away from the Lagoa I Wind Park (Nascimento, et al, 2020), presents the positive and negative socio-environmental impacts of the wind park implementation for the community. The research participants when asked about the expectations of the wind park, mentioned job generation as the main one. However, the community residents were dissatisfied with their expectations, which were not met. Another negative point, is that the properties of the community residents were not contemplated with the leasing of land. After the implementation of the park, the positive point mentioned by the interviewees was the construction of roads, which, despite being a benefit, also generated problems for the community (Nascimento, et al, 2020).

> The residents report that the roads increase the movement of company cars and that it generates some risks. Because there have been accidents, and because the transport travels frequently and sometimes at high speed, it leaves the people of the community on alert, restricting the environment that used to be part of leisure (Nascimento, et al, 2020, p.106).

The emission of noise caused by the movement of the propellers can also be a problem for the community. The residents argue that at the beginning of the operation of the wind park they were bothered by the noise generated, but as time went by they were used to it (Nascimento, et al, 2020).

Regarding environmental impacts, the interviewees explain that there was damage during construction of access roads to the wind park, especially plants native to the semi-arid Northeast, such as the Umbuzeiro tree (*Spondias tuberosa*). In addition to the impacts to the environment, these plants are a source of income for the residents of the community at a certain time of the year, from the harvest of umbu (the fruit of the umbuzeiro), in addition to damage to vegetation, there were also impacts on the income of community residents. Finally, we have that people are aware of the impacts caused by the implementation of the wind park, but sometimes consider them irrelevant, because the company in charge of the project carries out reforestation practices in order to minimize the damage caused at the site. Another way to reward the impacts generated is through compensation (Nascimento, et al, 2020).

Regarding the emission of noise generated by the operation of wind parks, (Silva & Abrantes, 2019) prepared a study on the emission of noise in wind turbines of wind parks Canoa and Lagoa. Table 4 presents the noise levels established in Brazil according to ABNT Standard N. 10151.

Table 4. Noise levels allowed in Brazil according to ABNT standard 10151

TYPE OF AREAS	MORNING	NIGHT
Areas of parks and ranches	40 dB	35 dB
Strictly urban residential area or hospital or school area	50 dB	45 dB
Mixed area, predominantly residential	55 dB	50 dB
Mixed area, with commercial and administrative vocation	60 dB	55 dB
Mixed area, with recreational vocation	65 dB	55 dB
Predominantly industrial area	70 dB	60 dB

Source: NBR 10151 (2000).

Table 5 shows the noise levels obtained by measuring the wind turbines of the Canoa and Lagoa Wind Park. When comparing the noise levels of the wind turbines with the levels established by ABNT it is possible to identify that the noise generated by the wind park exceeds the noise levels allowed for the "rural area", which are a maximum of 40 (dB) during the daytime period and 35 (dB) during the nighttime period (Silva & Abrantes, 2019).

Table 5. Noise levels of wind turbines at the Canoa and Lagoa Wind Complex.

AEROGERADOR	VOLUME DE RUÍDOS EM (dB)
1º	67,6
2º	72,1
3º	75,2
4º	69,4
5º	70,3

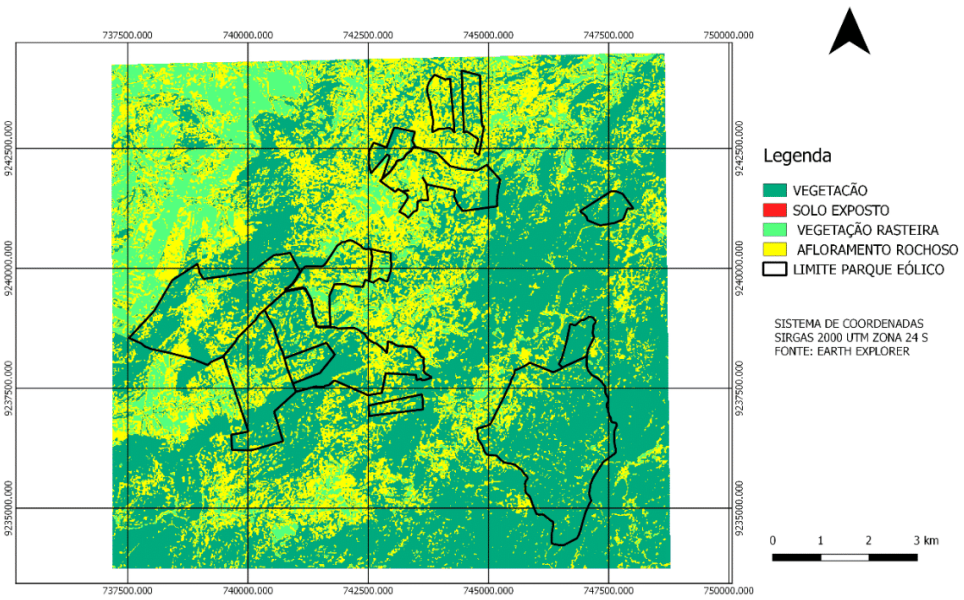
Source: Silva & Abrantes (2019).

According to (Lima, 2015) the noise caused by wind turbines can harm individuals who reside near the wind turbines. So that this problem can be mitigated (Silva & Abrantes, 2019) suggest that

> Monitoring campaigns are very important since noise levels vary depending on the specific characteristics and weather conditions at the site and the noise caused by the wind turbine can increase due to the aging of the mechanical components of the wind turbines and deficiencies in its maintenance (Silva & Abrantes, 2019, p.13).

According to Araújo and Mendes (2019) the implementation of a wind park can cause the ecological fragmentation of the area where it will be installed. The authors conducted a study about the area where wind parks were built. For this, figures were prepared to represent the area before and after the construction of the park (Araújo & Mendes, 2019). Figure 4 and 5 present the construction areas of the wind complex.

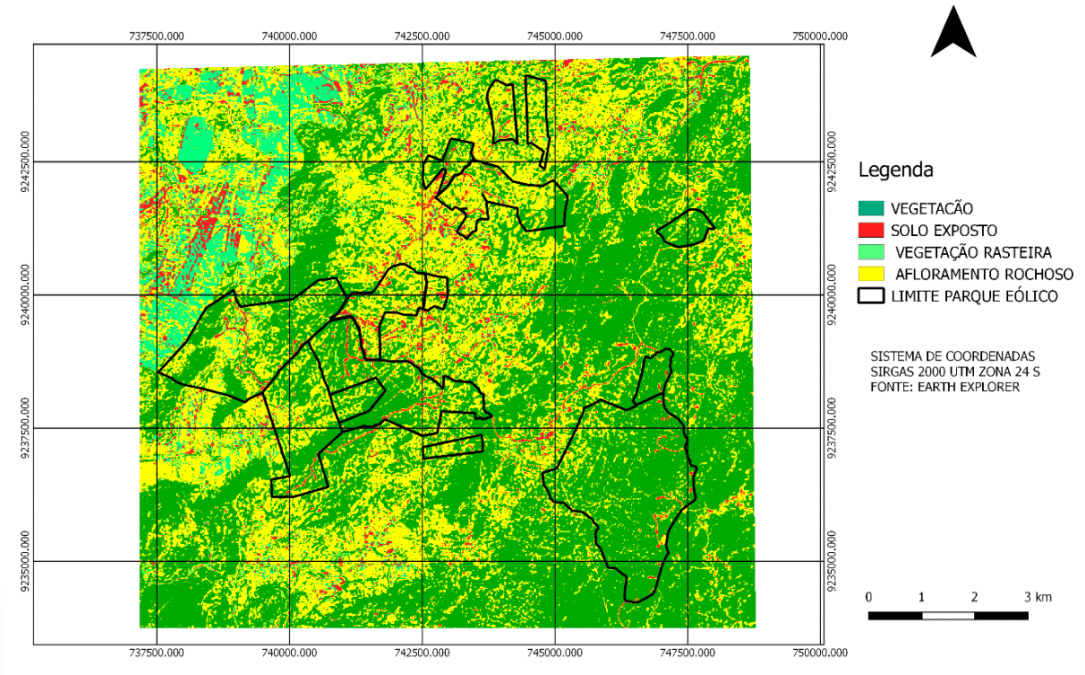
Figure 4. Wind park area before deployment – 2013.



Source: Araújo & Mendes (2019).

The delimited areas represent the limits of the Canoa and Lagoa wind parks. At the top of Figure 4, we have the area of the municipality of São José do Sabugi-PB where the wind turbines are located. Below we have two more regions delimited one to the left and another to the right that configure the location of the park in the municipalities of Santa Luzia and Junco do Seridó respectively (Araújo & Mendes, 2019).

Figure 5. Wind park area after deployment- 2018.



Source: Araújo & Mendes (2019).

Based on the images it is possible to conclude that there has been landscape alteration, which can result in the fragmentation of the area where the wind parks are located. Among the impacts caused in the area of implementation of the wind park it is possible to mention the deforestation for the installation of the turbines, the frightening of the local fauna, and the exposure of the soil, such problems harm the functioning of the ecosystem in the region, resulting in an imbalance in the area (Araújo & Mendes, 2019).

For Firmino *et al* (2018) the recognition of the impacts generated by a wind park can assist in the search for mitigation measures for such impacts, making the natural resources of the installation area of wind parks, be better managed.

5. Conclusion

In the midst of climate change, and the search for reduction in the emission of greenhouse gases, renewable sources emerge as an option for mitigation of such processes, being used for the production of clean energy. Among the renewable sources, wind energy has been gaining prominence, not only in Brazil but also in other countries. The Northeast region presents the greatest potential for the development of this source in Brazil, especially on the coastline, as well as in some inland areas.

The state of Paraíba has seven areas with capacity for energy generation through wind power, however, only two have their potential utilized, these are the Mataraca region and the Western Seridó. Therefore, this work seeks to analyze the socio-

economic and environmental impacts of the wind parks in the municipality of São José do Sabugi (PB), in the sertão of Paraíba, located in the region of Western Seridó.

Regarding the socioeconomic impacts we have that the municipality of São José do Sabugi-PB benefited in relation to the collection of the Service Tax of Any Nature (ISSQN), because in the year in which the implementation of the park began the amount collected from the tax increased considerably, consequently the revenue of the municipality also grew.

The generation of income was mainly due to the leasing of land for the implementation of the wind park, favoring residents in urban and rural areas. The commercial activity was also affected, and the food sector was the most benefited.

The forms of representation and social participation in the wind park implementation process in São José do Sabugi occurred at the state level, through the Environmental Protection Council (COPAM), which analyzes the licenses issued by SUDEMA, in order to authorize the operation of activities with potential pollution effects.

In relation to the weaknesses and potentialities of the implantation of the wind parks it can be seen that the construction of roads was a positive point, but at the same time it became a problem for the communities located in the surroundings of the wind park, since vehicle traffic increased, generating the risk of accidents and changes in the daily lives of the residents. Also from the perspective of road construction, the residents mention that there has been damage to the local flora in the course of this process. Another problem is the generation of noise that is above the levels allowed by the Brazilian Association of Technical Standards (ABNT) for rural areas.

Finally, there has been a change in the landscape in the areas where the wind parks are located, this situation can cause the ecological fragmentation of the area. In addition, problems such as deforestation, frightening the local fauna and exposing the soil should also be mentioned.

From what was exposed it is possible to conclude that the implementation of wind parks in São José do Sabugi-PB presents positive aspects in relation to economic factors, such as the collection of taxes by the municipality and the leasing of land.

Although social participation occurs at the state level, it is important to involve the municipality's residents in order to recognize the positive and negative aspects of the construction of wind parks.

The implementation of the park also generated environmental impacts, which need to be mitigated, because they put at risk both the fauna and the flora of the region.

The diversification of the Brazilian energy matrix is necessary, to the detriment of energy security, and the reduction of the impacts caused by already existing sources. Brazil has great potential for the development and use of wind power, but it also has negative factors, but to a lesser extent compared to other sources. This diversification process must be based on the balance between the environmental, economic, and social spheres in order to be effective and contribute to the country's reality.

For future research we suggest interviews with residents of São José do Sabugi-PB, and the analysis of socioeconomic and environmental aspects involving the wind farms located in the municipalities of Santa Luzia and Junco do Seridó.

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