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ARTIGOS

ANÁLISE QUALITATIVA, COM O SOFTWARE QGIS, DE LOCAL PROPÍCIO PARA IMPLANTAÇÃO DE UM PARQUE EÓLICO E SOLAR NO DESERTO DO SAARA, CONTINENTE AFRICANO

QUALITATIVE ANALYSIS, WITH THE QGIS SOFTWARE, OF A SUITABLE LOCATION FOR THE IMPLEMENTATION OF A WIND AND SOLAR FARM IN THE SAHARA DESERT, AFRICAN CONTINENT

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Resumo

Devido ao aumento populacional, muitos países da África apresentam uma demanda crescente de energia elétrica. Do ponto de vista de negócios, o continente africano apresenta uma oportunidade única, pois quase dois terços da demanda energética adicional necessária em 2030 ainda não foi construída. Em particular, o deserto do Saara apresenta espaço de grande potencial para geração energética sustentável. A partir dessa necessidade e considerando atender as diretrizes da Agenda 2030 da Organização das Nações Unidas, o presente trabalho objetivou relatar uma experiência didática do uso de geotecnologias para investigar quais seriam as áreas mais vocacionadas para a implantação de um parque eólico e solar dentro do deserto do Saara. O Método consistiu na realização de uma experimentação prática das ferramentas geotecnológicas, por meio de uma análise qualitativa e do procedimento pesquisa-ação. Concluiu-se que a ferramenta QGIS tem grande potencial para auxiliar na tomada de decisão através dos recursos ilustrativos que facilitam a compreensão das divisões administrativas e de vegetação dentro das regiões geográficas.

Palavras-chave: Energia Solar; Energia Eólica; Deserto.

Abstract

Due the population growth, many countries in Africa have presented an increasing demand of electric energy. From the business point of view, the African continent presents a unique opportunity, as almost two thirds of the additional energy demand needed in 2030 has not yet been built. In particular, the Sahara desert presents a space with great potential for sustainable energy generation. Based on this need and considering the need to meet requirements from the 2030 Agenda of the United Nations, this paper objectives to report a didactic experience using geotechnologies to investigate which areas would be more suitable for the implantation of a wind and solar farm within the Sahara desert. The Method consisted of a practical experimentation with geotechnological tools, through a qualitative analysis and the action research procedure. It was possible to conclude that the QGIS tool has great potential to assist in decision making through illustrative resources that facilitate the understanding of administrative and vegetation divisions within geographic regions.

Keywords: Solar energy; Wind Energy; Desert.

INTRODUCTION

The engineering and geography researchers use the QGIS remote sensing program as a useful tool to assisting in decision-making on the most diverse subjects, including those related to the environment (SALES; OLIVEIRA; JUNIOR, 2020). The QGIS is a geotechnology of remote sensing that obtains geographic data, usually associated with the acquisition of digital images by orbital satellites. It is a free program and available to the public (FERNANDES; SILVEIRA; OLIVEIRA, 2017).

The research considered the studying geotechnologies as a didactic resource to learn concepts from maps and obtaining cartographic information. The present work uses the free software QGIS, and explains the didactic experience of its use in the qualitative analysis of the best hypothetical region for implementing a wind farm and a solar farm. The Sahara desert is a good choice as the hypothetical region due to the existence of available cartographic data on wind and solar incidence. In addition, it is because of the possible benefits of such an undertaking in the chosen region.

Due the population growth, the Libya presents increasing demand of electric energy (MOHAMED et al., 2015). It has been observed in many countries in Africa. In addition, as almost two thirds of the additional energy demand needed in 2030 has not yet been built in the Africa continent. The continent can benefit from recent global progress and cost reductions in the generation of renewable energy in technologies. In addition, to skip the development path taken by industrialized countries and move directly to a renewable base system. The magnitude of the investments would imply a public-private partnership. But, due to the political structure of some countries, this partnership does not attract investors (IRENA, 2012).

In order to preserve the environment and ensure a higher quality of life for living beings, policies are beginning to be aimed at the production and consumption of electricity from renewable sources. It with the objective of mitigating environmental impacts and, consequently, are propellants for the generation of employment and income to the population. Therefore, the implementation of a wind farm will depend on labor for services such as production, installation, maintenance, among others (KOENGKAN; FUINHAS; MARQUES, 2017).

The choice to install a solar farm in the Sahara desert is due to the lower impact and lower disadvantages of this type of energy source. The presence of visual pollution to the biotic environment due to the reflection of light in the solar panels can be minimized for human visual effect in this choice of location, as it is far from urban areas. It does not cause the increase in soil erosion due to the removal of vegetation in the place where the panel would be installed. In addition, the coverage by the panel of the light reception of a previous vegetation, as the land is already cleared, would not occur. Figure 1 below shows how these panels could be arranged in the desert.

Figure 1: Solar panels in the desert.

Source: (PORTAL SOLAR, 2018)

Regarding the implementation and a wind farm in the Sahara desert, it would also generate less environmental impact. The implementation of aero generators has some limitations, such as the minimum distance of 200 meters from the homes due to noise, visual impact, the need to be used in an open place so that buildings do not block the passage of winds, can cause electromagnetic interference, in addition to the recommended distance between generators. All these “disadvantages” are mitigated in an open and sparsely populated space, as is the case in the Sahara desert.

Evidently, there will still be disadvantages, such as the need to dispose of the electronic waste produced by solar panels and the impact of generators for birds. But comparing with other forms of energy, the solar and wind source presents more benefits and, at the site chosen for implementation, less disadvantages.

One issue to be raised to make this project viable is to think about how this energy could be distributed to consumers. And its transmission viability beyond the African continent, encompassing Europe. Another issue that needs to be discussed is the presence of the sand that would be lifted by the wind that could cover the solar panels, requiring regular cleaning.

In India, the desert regions of Rajasthan and Gujarat are preferred for the installation of photovoltaic (PV) solar energy and concentrated solar thermal systems (CST) due to a high level of solar radiation components. However, these regions present substantial challenges in terms of dust, a high ambient temperature and water scarcity (BODDUPALLI et al., 2017). These characteristic conditions make it difficult for workers to maintain equipment, requiring locations, such as guardhouses, with adequate temperature and available water for these workers.

In the current scenario, where many regions in African countries have no electricity power at all, this type of enterprise is positive. It is because of the gain offered to the local population. This would possibly benefit negotiations between the company and governments, to reduce government charges. From the moment that the populations start to have electric energy available, even if it comes from non-renewable energy, negotiations and possible implementation of this type of undertaking become more difficult, because it would require to change the energy supplier.

The desert is inside the domain of certain countries, being possible the use of a tax on the energy supply company, paid to philanthropic organizations, to minimize any social and / or environmental need existing in each country that shares the desert, as long as it does not make the project unfeasible. As the Sahara desert comprises several countries, individual action by each country would be necessary to develop internal transmission networks and a partnership to connect them with the networks of neighboring countries. This cooperative action is included in the United Nations (UN) Agenda 2030.

In 2015, all signatory countries of the United Nations (UN) Agenda 2030 took on the challenge of promoting prosperity combined with the well-being of all the populations living in their territory in order to meet the seventeen sustainable development objectives (Figure 2).

Figure 2: The seventeen sustainable development objectives of Agenda 2030 of the United Nations.

Source: (UN, 2015)

The seventeenth UN sustainable development objective is “Partnerships and means of implementation”(UN, 2015). Therefore, a cooperation pact could be created between the supply of energy beyond Africa, where the project was originally conceived, but also for Europe.

The UN's eighth and tenth sustainable development goals are “decent work and economic growth” and “reducing inequalities”, respectively (UN, 2015). The Sahara desert comprises at least 13 countries on the African continent. Thus, with the generation of jobs with the use of mandatorily local workers, and giving this population the opportunity through the technical knowledge necessary to develop in the profession, through courses and training, the development of this project can assist in fulfilling the 2030 agenda propose. Furthermore, the reduction of inequality will result in a decrease in emigration in these African countries.

For a large-scale project to be developed, the company must comply with the legislation, land use, politics, distance from the consumer market and public safety in the countries in which the farm will be implemented. This type of analysis is known as Multicriteria Analysis and can be done using remote sensing features (YUSHCHENKO et al., 2018; CASTRO et al., 2015; FIRMINO BARBOSA; FURRIER; RODRIGUES VIANA DE LIMA, 2013) or computer programming (SALIHU et al., 2015). It is advisable to complement this research, a Multicriteria Analysis with an overview of legal and political issues, within the huge areas conducive to the implementation of the wind and solar farm. It is also suggested that this analysis be carried out at a date close to the possible installation, as these issues tend to change over time.

In some case, the public authorities may be left out of the negotiations. It occurred in municipality of Marcolândia, state of Piauí, Brazil. In the municipality of Marcolândia contracts were made directly with the owners of the lands where the wind farm was implemented. Thus, the owner, when leasing his land, signs a contract in which he will receive R$ 1,200.00 for each tower installed on his land during the 20-year period, which may be extended for another 20 years. There are currently 92 signed contracts in which approximately R $ 1,000,000.00 is paid monthly by the responsible company to the owners (CAMPÊLO, 2016).

Despite the reflection brought about the viability of the enterprise, this work does not aim to analyze the viability of the wind and solar farm. In addition, this introduction sought to bring the benefits of choosing the region of study as a motivation. The real objective of this paper is explain the didactic experience of its use in the qualitative analysis for implementing a wind farm and a solar farm in the Sahara desert.

The research was carried out through the practical experimentation of geotechnology tools. The experiment consisted of investigating which areas within the Sahara desert are most suitable for the installation of a wind and solar power generation plant, which is based on the clean generation of electricity, and the sustainable development of the region.

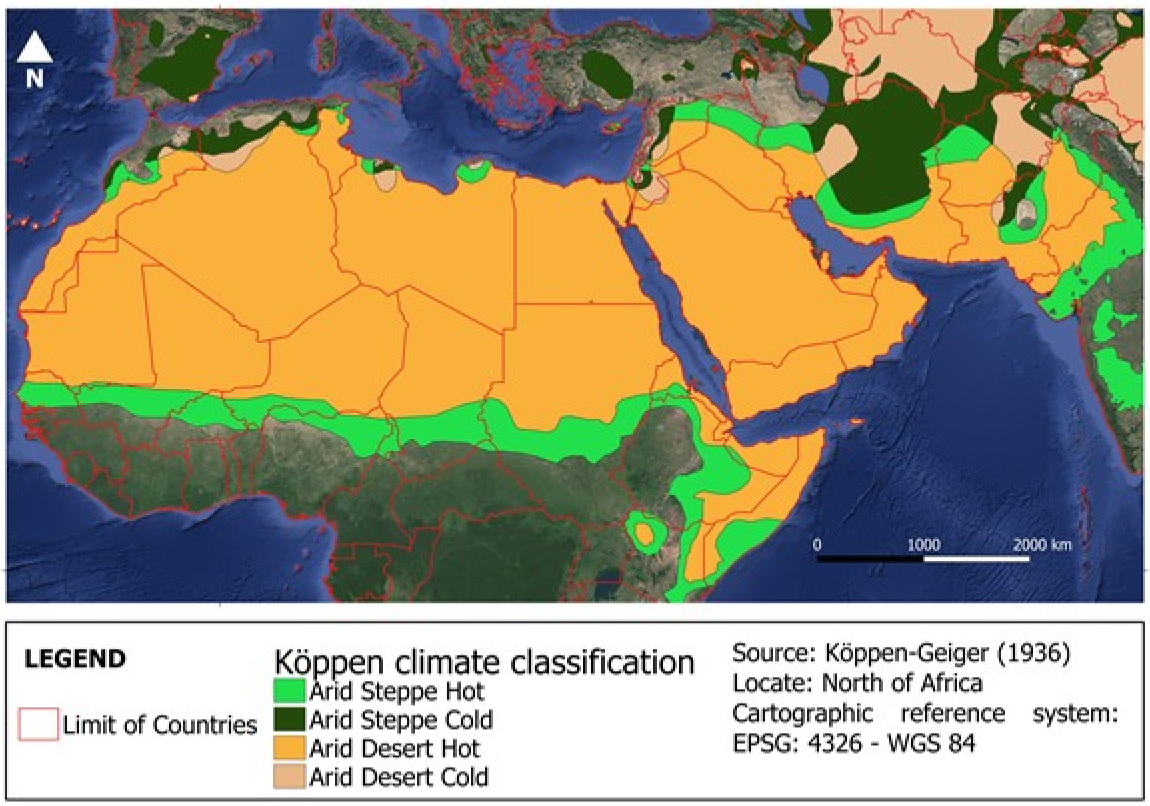
MATERIAL AND METHOD

This research has a qualitative approach, in which it uses illustration as a resource to produce new information, and its procedure is called “action research”, in which the authors of the research participate in the action they study (GERHARDT; SILVEIRA, 2009). The Action research is a form of investigation based on self-reflection by the participants in the action with the aim of improving the understanding of social and educational practices. It can be individual or collective. Educational action research is a strategy for the development of teachers and researchers in order to use their research to improve their teaching and the learning of their students (TRIPP, 2005).

The QGIS is a cross-platform, free and open source desktop GIS application written in C++ and Python used by a wide variety of users on Windows, MacOS, and Linux systems (MEYER; RIECHERT, 2019). The easy access to the QGIS for a vast number of users including engineers, geographers and topographers makes its choice relevant. In addition, there are several free manuals and instructions for use in the internet to allow a good use to platform to researches.

Qualitative analysis was performed using data already treated. The raster files were obtained by SOLARGIS (2019) and Cardoso (2007). The resolution offered made it possible to carry out the evaluation without having to perform operations on the images. For this reason, the work is easy to replicate, focusing on the teaching experience to be provided. QGIS was used for visualization and map layout creation. The spatial reference used in the map is EPSG: 3857 (WGS 84/Pseudo-Mercator). In addition, to locate the Sahara desert, the Shape of the country boundaries and the Shape of the Köppen-Geiger Climate Classification of 1936 (KÖPPEN; GEIGER, 1936; HYLKE E. BECK, 2018) provided by Cardoso (2007) and its visualization was made using the free software QGIS as shown in Figure 3.

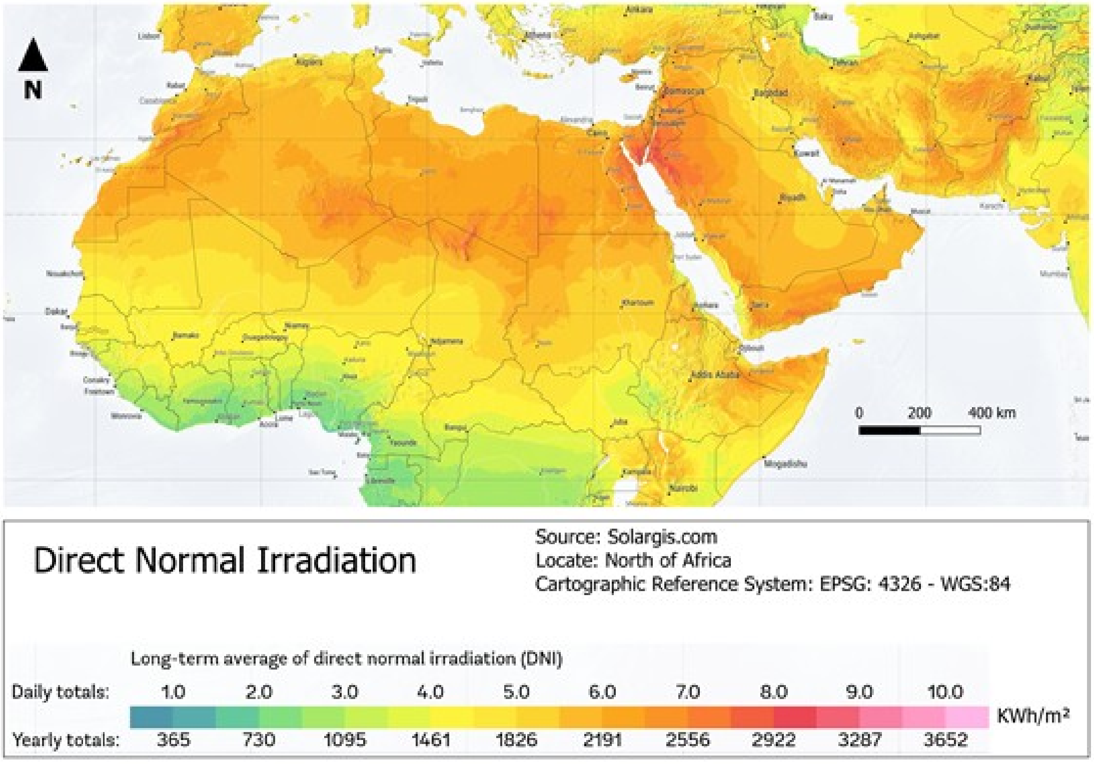
Figure 3: Köppen-Geiger Climate Classification.



Source: Elaborated by the authors

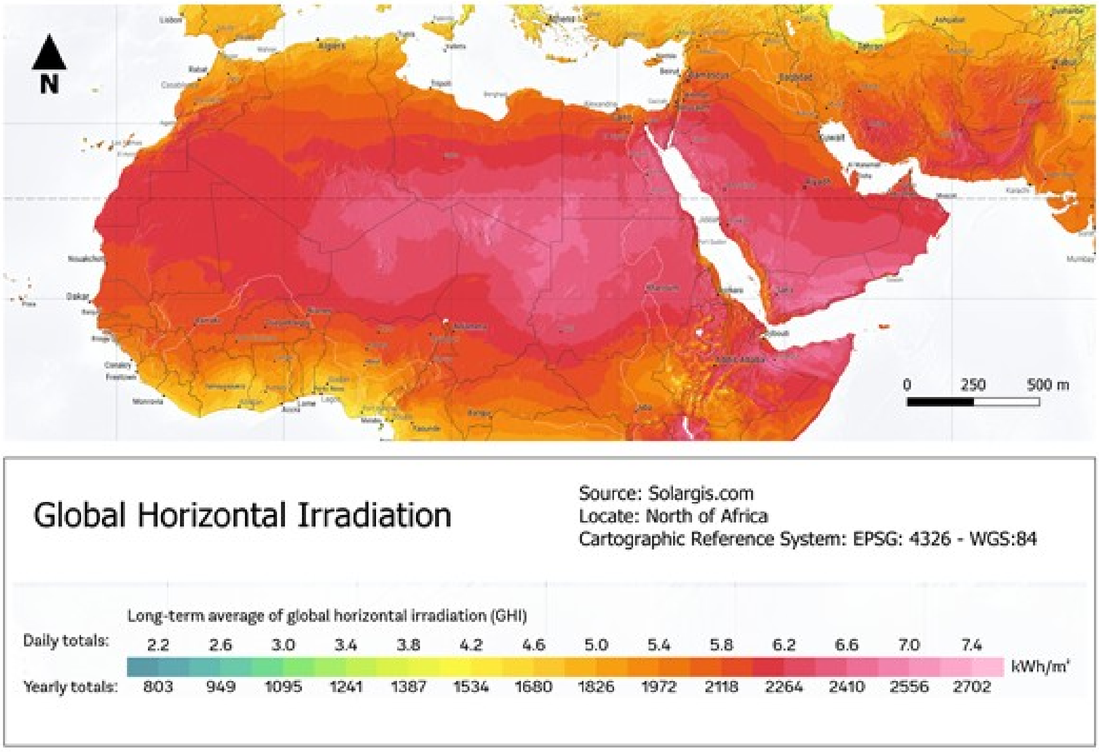
The analysis of the region was done in a qualitative way. For the analysis of the best region for the implementation of a solar farm, three shapes obtained on the site were used SOLARGIS (2019). These shapes were visualized and presented below in an illustration developed in the QGIS software. The Figure 4 illustrates the intensity of solar radiation by direct radiation. The Figure 5 illustrates the intensity of solar radiation that strikes horizontally. The Figure 6 illustrates the electrical potential measured by solar radiation.

Figure 4: Direct Normal Irradiation.



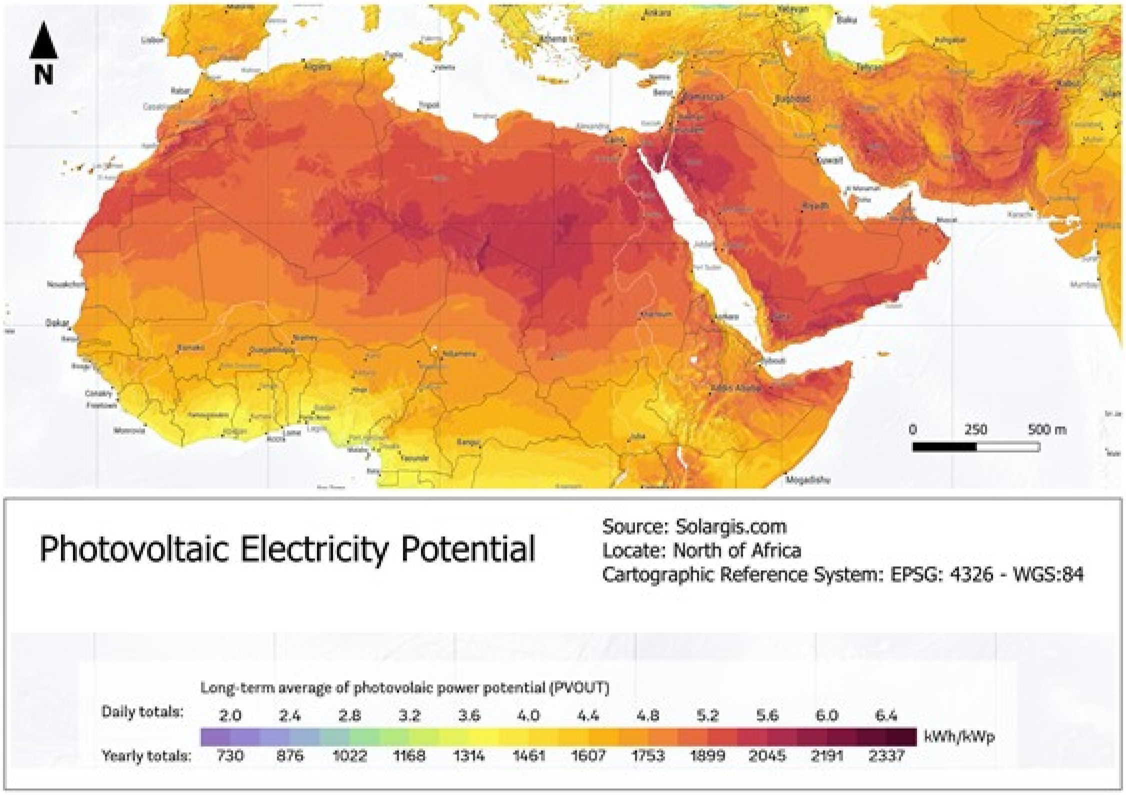
Source: Elaborated by the authors

Figure 5: Global Horizontal Irradiation.



Source: Elaborated by the authors

Figure 6: Photovoltaic Electricity Potential.

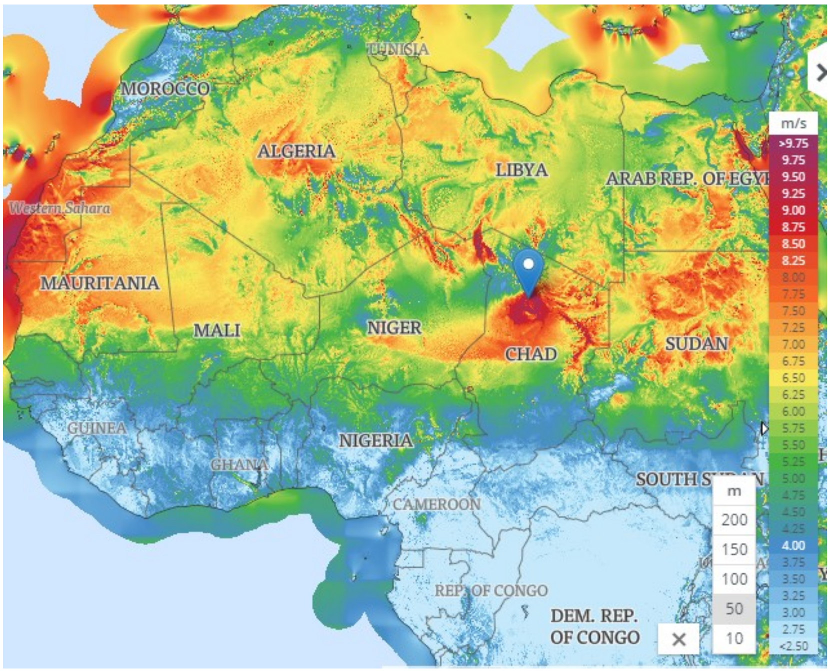


Source: Elaborated by the authors

For a qualitative analysis of the best location for the installation of a wind farm, the website was consulted Global Wind Atlas (2019), where is possible observe the wind speed in any part of the globe at predetermined heights. In this paper, the wind speed in the heights of 50 meters and 100 meters was compared through a qualitative visual inspection.

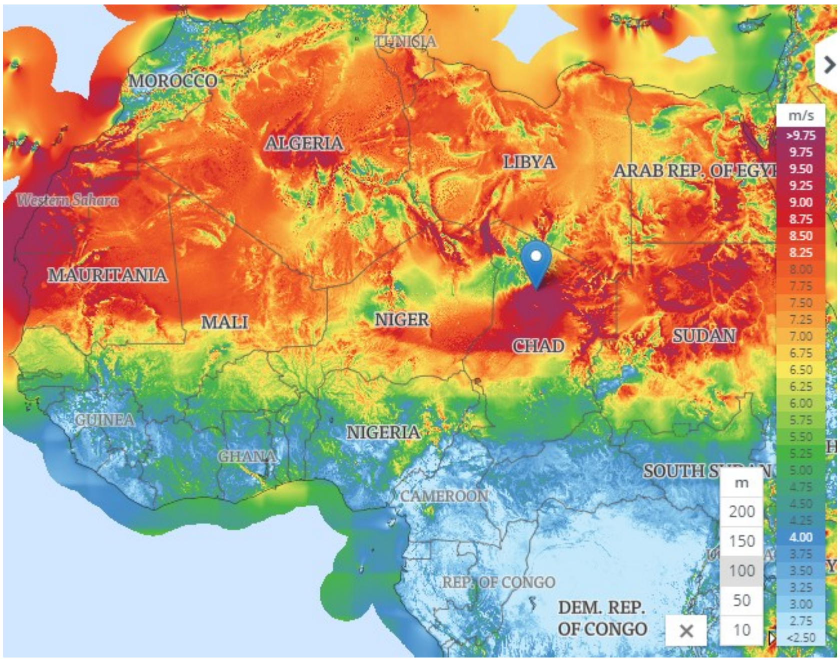
According to VASEL-BE-HAGH and ARCHER (2017), a wind farm with turbine height of 57 meters and 100 meters combined generates greater energy than a farm with turbine height of 80 meters isolated. The heights of 50 and 100 meters were illustrated on the map as they are usual heights for wind turbines. In Figures 7 and 8 it is represented the map obtained on the website Global Wind Atlas (2019) for heights of 50 meters and 100 meters respectively.

Figure 7: Incidence of winds at 50 meters. Signaling made by the authors.



Fonte: Global Wind Atlas (2019)

Figure 8: Incidence of winds at 100 meters. Signaling made by the authors.



Fonte: Global Wind Atlas (2019)

RESULTS

The QGIS program brought a positive experience for learning how to manipulate maps. It has an easy-to-use interface and several features for using other coupled programs, although no extensions are used in this paper. The program QGIS proved to be suitable for a qualitative research because the images are of high quality and wide variety of colors available. In addition, the image quality is maintained when exported.

Figure 4 and 5 illustrate that the region with the greatest potential for irradiation in the normal direction and horizontal radiation, respectively, is the boundary between the countries of Algeria, Niger, Libya, Chad, Sudan and Arab Republic of Egypt (Egypt). In addition, Figure 6 illustrates that the region with the highest photovoltaic electrical potential is found mainly on the boundary between Libya, Chad, Sudan and Egypt. Considering the intersection of figures, it can see that Libya, Chad, Sudan and Egypt are regions with great potential for the implementation of a solar farm.

Figures 7 and 8 illustrate that Sudan and Algeria have good wind potential, with Chad being an outstanding region for presenting an extensive region with good intensity of wind speed. Mauritania and other coastal regions can present an impediment to the construction of a wind farm because of they are generally more densely populated. In this case, Chad has the best location for setting up a wind farm.

FINAL CONSIDERATIONS

In a qualitative way, it analyzed the intensity of solar radiation by vertical radiation, the intensity of solar radiation that falls horizontally and the electrical potential measured by solar radiation. It is stated that the best place for implanting a solar farm would be on the borders between countries Sudan, Chad, Libya and Egypt.

In addition, it analyzed the wind speeds at 50 meters high and 100 meters high. In a qualitative way, it is considered that the best region for setting up a wind farm would be in the country Chad, a region signaled by the authors in Figures 7 and 8. From this case study, it was possible to discern which region has the greatest vocation for the implementation of a wind and solar farm. The geographical perception of the desert can be better understood through maps with administrative divisions of the territory and climate.

This study showed that it is possible to use QGIS for analysis through the qualitative method, because, it uses illustrative resources, with very visual characterizations of countries and geographical regions, allowing a better visualization of the analyzed criteria for decision making.

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