International Research Journal of Engineering, IT & Scientific Research
Available online at https://sloap.org/journals/index.php/irjeis/
Vol. 2 No. 9, September 2016, pages: 37~43
ISSN: 2454-2261
https://sloap.org/journals/index.php/irjeis/article/view/511

Sustainable Transformation of Energy Matrix

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Article history:

Received: 13 June 2016
Accepted: 30 July 2016
Published: 30 September 2016

Keywords:

energetic ordination;
geographic information system;
land management;
renewable energy sources;
sustainable development;

Abstract

Geographic Information System for Sustainable Energy Development (SIGDES). It is the system which contains geo-referenced data that leads to the knowledge about several potentials of renewable energy sources in the province of Manabí. The objective of providing this information is proposed in a system that promotes the educational research and projects for business development with a territorial vision of sustainability that can make possible the change of the energy matrix. The system allows the user to use the information contained in the database, focusing on the solution of energy problems in the community and leads to local sustainable development.

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1. Introduction

The Geographic Information Systems (GIS) have been revolutionizing territorial studies for the implementation of renewable energy sources (RES). It does not only apply to rural areas where it is so pervasive due to its different uses and combinations but also for urban areas where renewable resources are available and can be implemented in grid-connected systems next to the electrical load.

In the latter case, its implementation can be planned in the use of microgrids, smart grids, and the use of artificial intelligence to manage the system of generation, distribution, and dispatch of electrical energy for small or large users. Research activity at universities in the province of Manabí needs to address its investigational efforts to sustainable energy development through projects related to community engagement, university graduation thesis, postgraduate or master courses etc.

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For that, it is important to consider a database which can keep track of the problems in different territories, but unfortunately, there is no reliable information to lead researchers to the sustainable transformation of the electrical energy matrix.

The goal of this publication is to provide the basis for facilitating the management of the necessary information about the potential of renewable energy sources in order to encourage the scientific research activity at universities in the province of Manabí.

In the Manabí province, there was light in the city of Portoviejo in 1929, with the installation of an engine of 150 HP company SKF, although in previous years some wealthy area, owned power plants for their properties (Andrés E. Cabrera, *et al.,* 2014).

In more recent times, in 1998 and by Article 249 of the Constitution of the Republic of Ecuador, the state's responsibility for the provision of electric service is established, later in 2008 is approved by public referendum the current constitution policy of the country, where electrical performance as a public service, governed by the principles are endorsed: mandatory; generality; uniformity; responsibility; universality; continuity; quality; and environmental sustainability among others (Eduardo, 2015), in 2009 the National Electricity Corporation (CNEL) was formed, with full rights and obligations to operate the national electricity sector as electricity distribution company, associating a group of general management by territories (Electricidad and Estadística, 2012).

Until 2008 the national energy matrix was heated with a predominant dependence on oil use, with a very low contribution of renewable energy sources. At present, and after strenuous efforts, the energy system has become based on the use of renewable energy sources mainly hydro has led the dominant part with the construction and connection of large hydro plants connected to the national grid. Other renewable sources, as well as promoting distributed generation is almost symbolic, as in the case of solar photovoltaic and wind power (Instituto Geográfico Militar, 2013).

The major load centers in the Manabí province are located between 300 and 400 kilometers away from hydroelectric plants, economic resulting technically unfeasible power supply to the province from such great distances, which would increase the losses with very low efficiency and service quality. So the basis of electricity generation in the province is heated by burning oil.

For the territory is a need for the combined use of all energy sources that are available, especially solar, wind, and biomass, which combined with thermal generation and through solutions distributed generation, to ensure territorial energy scheme with the singular stamp of efficiency, saving resources and quality of service.

Under these conditions the solar photovoltaic and wind can play a leading role, especially in coastal provinces, which affects radiation consideration and some potential points of wind in tourist areas, which can be exploited by various technologies and models their connection, especially the systems connected to the grid in the model of distributed generation, connected to the load centers and consumption.

This study will focus on sustainable energy development through the use of native resources, preservation of natural resources, efficiency, savings, and environmental respect.

2. Materials and Methods

The technical methodology proposed in the Model of Territorial Energy Development was applied, using the GIS which can provide information on renewable potential at any point in Ecuadorian territory. Thereby it makes it possible that these places can be tracked anywhere in the national territory. By performing this, new technologies can also be introduced which take advantage of renewable energy sources in the sites with the suitable energy conditions. It is known that there is an atlas of solar radiation and wind speed of Ecuador, but this information is not available to students, teachers, and technicians who are the ones who make decisions. Alternatives of solar radiation and wind speed generated by NASA are proposed (José, A. and C.d. autores, 2004), in its Digital Model Version 1 where a land cover analysis was performed using references WGS84 / EGM96 (Gdem 2011) [6]. Ecuador mapping was used which was published on the website of free access to the Military Geographic Institute 2013 [7] in order to provide reference and information.

3. Results and Discussions

Nowadays, one of the aspects that must be evaluated is the study of energy potential behavior from local levels where GIS become useful. The country does not have information to study the potential of biomass for energy purposes, despite being small and biodiverse country, academic units such as universities can be grouped into projects that allow mapping the potential of biomass in the three regions of the country, introducing these different characteristics for example in figure 1, the four regions are shown to be studied.

In the coast region, there are different products of agricultural production that can be used for energy purposes; these can be studied to solve local problems in each region. The central and the Amazon region also have their peculiarities that can be valued. The region four is the insular (Galápagos), one of the regions that already have in its energy matrix different renewable sources such as the wind, the sun, and biomass, its future energy is to achieve sustainability.

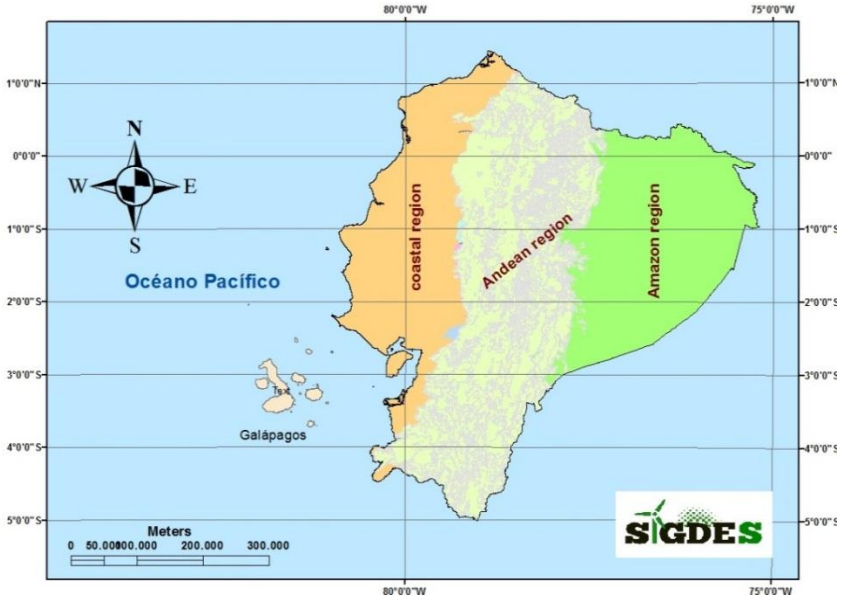

Figure 1. Ecoregions of Ecuador

With the use of GIS results of solar and wind potential was obtained. Studying them can result in the preliminary knowledge for the purpose of energy matrix diversification. Today research has been conducted in the province of Manabí to determine radiation levels affecting some cities.

In the case of Chone city which has worked for the analysis of economic feasibility studies mainly in remote regions of the distribution lines of the grid as shown in figure 2 the map of the city with the power line distribution and distance to population settlements and the number of villages by according to the distance from the network. These results allow us to present an innovative research contribution related to the feasibility study in Chone municipality of the Manabí province (NASA, 2010).

In the communities studied, the power company has fulfilled the needs of delivering electricity service by extending the network for benefit of the population. Achieving this has caused a social impact that has led to the appreciation of the people who recognize the effort made by the government. Even though the economic impact is not adequate and despite the effort, the population will not achieve the expected results in terms of quality of service.

In the field work, it has been shown that in the target areas electrical service with low quality is provided. It is caused by the instability of the parameters of voltage and frequency due to the very long distances of the electricity network from the central generation centers which also reported losses in the transmission of energy.

The foregoing difficulties have caused the need to improve the maintenance of power lines and to make investments in transformers to reduce technical problems which increase costs of delivered kWh. All this related to activities that can have a field of practical application in electric utility with a specific economic impact.

To achieve a change in the sustainable matrix and improve the difficulties encountered in the Chone municipality, it is proposed that studies of solar and in the territory would enable solutions. Primarily to sites where

the service is inappropriate and second to electrify isolated homes without basic energy services and that has solar power design allowing autonomous photovoltaic systems.

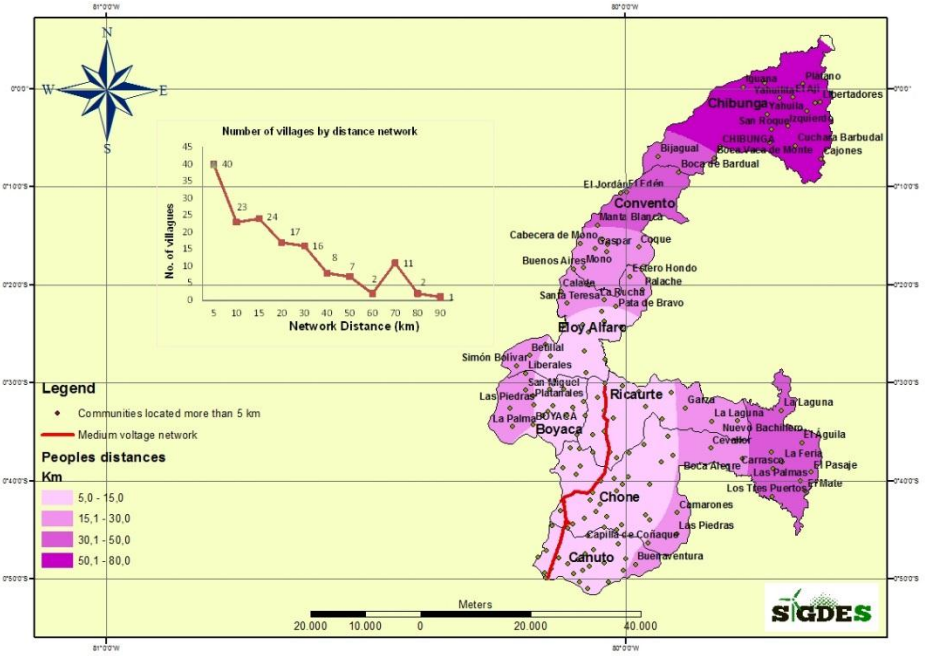

Figure 2. Location of population settlements by distance network

In figure 3, the solar potential maps, and wind in figure 4, the Chone municipality can be observed.

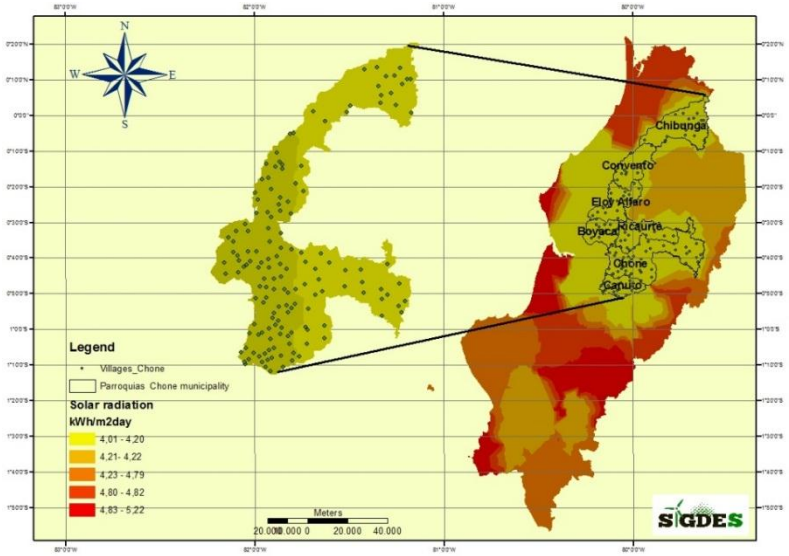

Figure 3. Map of solar potential

As you can see the solar potential varies between 4.04 and 4.88 kWh/m2day and the potential of wind can reach up to 3.55 m/seg (wind speeds that allow you to place small wind turbines that provide solutions to independent housing). This means that you can search for solutions with renewable energy sources in places where can be economically justified while seeking alternatives to improve the quality of service to the electricity grid by using microgrids. Taking it into account could direct to a dynamic simulation model, in order to forecast the supply and demand of energy that would have a micro-electric network composed of a house with own generation through

photovoltaic panels with the demand load for the house throughout the day. The forecast supply is determined by considering the physical and climatic parameters that determine the generation capacity.

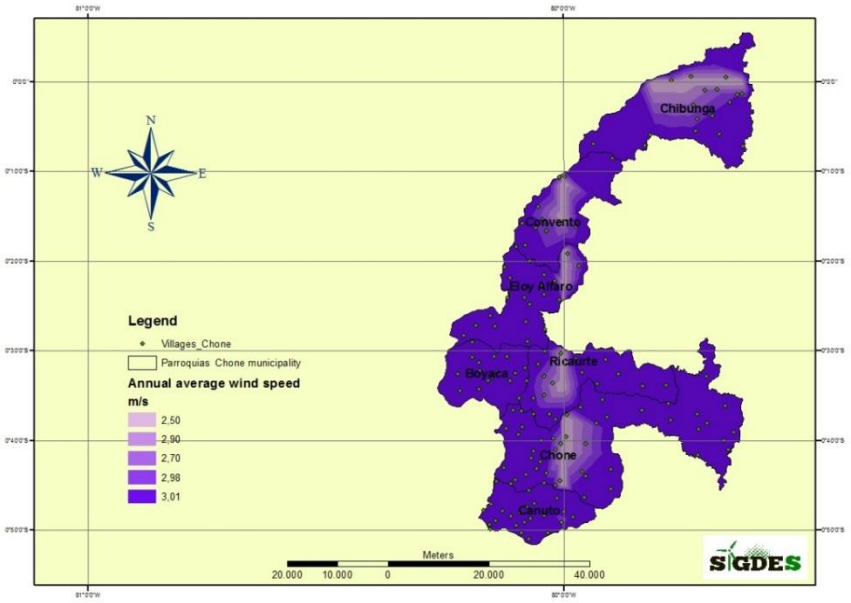

Figure 4. Maps of wind speeds

In the same way as in studies for the coastal zone it has been proposed by (Whitlock, 2000), used as a management tool system geographic information systems (GIS), which allows for the energy, economic and environmental feasibility of the application of photovoltaic technology in the technical format of microgrids for both isolated and for small plants connected to the grid systems and can be an important contribution to achieving a new energy matrix integrated and reliable resources from the technical point of view.

4. Conclusion

At this essay, work practical results were obtained with information managed by a GIS that can be generalized to the country by using the techniques of Information and Communications (TIC) of public use of the processed information.

Conflict of interest statement and funding sources

The author(s) declared that (s)he/they have no competing interest. The study was financed by the authors.

Statement of authorship

The author(s) have a responsibility for the conception and design of the study. The author(s) have approved the final article.

Acknowledgments

We thank the group of teacher's electric career of the Faculty of Mathematics, Physics, and Chemistry, University for their assistance in this investigation.

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