How to Cite:
Pérez, A. V., Ramos, J. L. M., Gámez, M. R., Giler, B. I. C., Villavicencio, C. I. P., & Mendoza, M. E. C. (2021). Use of the local energy resource in the El Carmen canton of the Manabí province. *Linguistics and Culture Review*, *5*(S4), 645-656. https://doi.org/10.21744/lingcure.v5nS4.1700

Use of the Local Energy Resource in the El Carmen Canton of the Manabí Province

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Abstract---The supply of energy to the entire Ecuadorian population constitutes a great challenge for the country, especially in rural areas where it is more difficult and expensive to extend the lines of the electricity system and where, despite efforts, the required quality of service is not achieved. presenting a negative impact on meeting the needs and socioeconomic development of rural regions. The objective of the research is to study the hydraulic potential of the De Oro River, for which 12 communities were visualized that are close to the riverbed and where technologies capable of taking advantage of the small existing potential in terms of improving quality could be used. electricity service, save natural resources and contribute to the reduction of CO2 emissions into the atmosphere. Data series are presented in tables that allow to analyze the result of the study of the hydraulic potential in 12 river sites and its possible link in terms of benefiting the social element that resides near these points, the field study was implemented as a methodology. The result was a map with the study of the hydraulic potential that can be used to generate

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Manuscript submitted: 18 June 2021, Manuscript revised: 09 Sept 2021, Accepted for publication: 27 Oct 2021

electricity, thereby improving the quality of the service received, saving resources and helping to avoid CO2 emissions into the atmosphere.

***Keywords*---**demand, local development, poor energy quality, water potential.

Introduction

In ancient times, men used as energy: their own muscles, and from domesticated animals, firewood, wind and water. Man had no other source of energy than his own muscles to hunt, fish, crush food grains, move loads and other necessary tasks. The human being goes through the production of his own food in the farmer man stage, the average energy consumption of the human being helped in his work by the domesticated cattle and the heat happened to be of greater use than in the previous hunter and gatherer phase, that is, about twelve thousand kilocalories per day (Morales Damian, 2010).

The first major energy systems in history were developed in the 4th and 3rd centuries BC. In areas irrigated by the Tigris, Euphrates, and Nile rivers, the first crop irrigation systems were built. This stage of human development was flourishing in inventions and innovations, due to the same need to advance in their what to do, instruments such as the machine for lifting weights based on the principle of the lever were developed (Muoz, 2017). The energy development of society has been a giant step forward in the leaps in human progress. It is evident that without energy the accelerated development of the productive forces and the creation of the material base that allows man to abandon the first forms of life and undertake new routes in the progress of humanity would not have been possible.

Between 1860 and 1930 takes place with the second industrial revolution, the introduction of electrical systems, aviation, and the steel industry. In this stage, the mineral coal gives way to the preferential use of oil. Already during the first years of the 20th century, this fossil fuel had become the preferred source of energy. From the first moments of its creation, the Ecuadorian energy matrix is the daughter of a centralized development model, oil, devouring natural resources and with a high dose of pollution environmental (Muoz, 2017). Until 2012, the national energy matrix depended for more than 90% on oil consumption and despite this, an adequate quality of electricity service towas not achieved users (Castro, 2011).

Despite the fact that currently more than 70% of the energy generated in Ecuador is of hydraulic origin, in the province of Manabí the basic generation source is thermal, with a high cost of the kWh generated and with high indices of COemissions2 into the atmosphere. However, in the territory of the province there are several rivers, among which is the De Oro River that can provide small potentials of hydro energy that could be used in the generation of electricity, despite knowing the importance of rural development for achieve good living (Mendieta et al., 2017). Until now, it is not known that studies have been carried out on the calculation of the hydraulic energy potential in the De Oro River, so it is very difficult to estimate its potential in terms of generating energy and thus contribute to the improvement of the living conditions of the residents who reside on its margins and who in many cases present difficulties in the quality of electricity service (Rinartha et al., 2018; Entele, 2020).

Hydraulic energy is cheaper than the average price of thermal energy, in addition to the environmental benefit that the implementation of these projects entails because it is clean energy (Posso, 2002), these criteria still prevail (Bravo, 2015). In the De Oro River there are small hydraulic potentials that can be used in the generation of electricity; however, they have not been sufficiently studied, despite the fact that there are ways to make an integrated analysis of local energy sources (Rodríguez et al., 2015). The development of a part of the rural areas in the province of Manabí, where the De Oro River flows, has been marginal from the energy point of view in recent decades like many other regions of Latin America (IBANEZ MARTIN et al., 2020), which has impacted on the progress of agricultural areas and on the very quality of life of the inhabitants, mostly from poor strata. At present, more than 5% of the population does not have electricity services, mainly in rural areas that are distant from generation centers.

The existing needs in rural areas in many cases can be solved by carrying out studies of the autochthonous resource, in this sense the need to embrace an energy development model that adopts as a paradigm the concepts associated with local development and the adequate use of endogenous resources should be promoted (Rodríguez et al., 2021). In the province of Manabí there are several permanent rivers, including the De Oro River, which, although it does not have a large flow, could be studied to define the potential Hydraulic available for electricity generation at certain sites. Hydropower generators constitute an alternative to solving the problem of energy supply mainly in isolated regions, in addition to technically reinforcing the country's electricity system. This is why with the implementation of projects based on peak power plants (up to 5 kW of power), a technical and economic contribution is produced that benefits the areas of influence and contributes to meeting the demand for electricity, in addition to contribute technically to the National Interconnected System.

Manabí reacheshm36,270, a value that corresponds to 545.1 mm of average annual runoff sheet, where the De Oro River has the maximum annual runoff volume, equivalent to 1 313 hm3, with 20.9% of the total demarcation (Ashok et al., 2021; Suratao et al., 2021). The De Oro River is considered one of the main sources of water in the province of Manabí. The project constitutes an important study that can promote a community intervention in the energy order, to improve the living conditions of the inhabitants of rural areas, emphasizing the development of the Productive Matrix and Strategic Sectors in the National Plan for the good living which literally states: “In parallel to the execution of large hydroelectric projects, in 2030 the electricity supply will be complemented with the implementation of small energy generation projects with renewable sources such as: photovoltaic, wind, biomass and hydroelectricity in areas close to consumers and with participatory management schemes of Decentralized Autonomous Governments, community organizations and the private sector (Kieft, 1987; Kiesling, 2021). Projects that allow the use of renewable energy sources promote local development, since microenterprises can be activated by generating employment, the use of natural resources is optimized, electricity generation is diversified and technical losses in the transmission of electricity are reduced. electricity (Marsden & Smith, 2005; Blankenship et al., 2019).

Materials and Methods

Field research was used, as it corresponds to a type of design that is based on information obtained directly from reality, allowing close contact with normal conditions, a flow measurement was made at the previously selected points of the Río De Oro, which made it possible to obtain reliable information regarding the realization of the river's capacity at the indicated points and to be able to determine the potential for power generation; In addition, the descriptive research method was used, since it was possible to obtain information about the determination of the small hydraulic potentials in the river and their possible use to generate electricity based on meeting the demand in isolated communities or in the connection mode to the grid, to improve the quality of the electricity service in areas far from the generation centers, increase efficiency and contribute to the preservation of the environment. With the explanatory method, it was possible to establish a conceptual study on the various electricity generation technologies by taking advantage of small hydraulic potentials, using the basic gauging technique, which is based on the method of speed per known area, which is one of the simpler ways to study the hydraulic potential of the river; In addition, interviews were conducted with experts and residents of the community (Richter & Pollitt, 2018; Minav et al., 2013).

Analysis and Discussion of the Results

Rural communities that are isolated from the electricity grid have difficulties in receiving energy with good quality (Rodríguez et al., 2018), despite the fact that in many of them there are renewable energy resources that are not exploited, in many cases due to ignorance of these being able to take advantage of the autochthonous resource.

River capacity

For the capacity, the method was used where the speed of the surface water flowing through the river is measured, taking the time it takes for a floating object to get from one point to another in a uniform section, complying with the following procedure : the section of the stream is measured, the area of the section then an object is thrown that floats upstream from the first control point and as the body passes through said point, the time taken for the trip to the point is started downstream control (Arcentales et al., 2017; Widharma et al., 2017). The speed result is adjusted by a factor of 0.8 to 0.9, for example, If the place where the gauging is to be carried out is 5 m wide and 10 m long and the river is 0.5 m deep, the data will be used to calculate the total area where the speed will be taken with the object of which was thrown into the river.

The calculation of the area of the riverbed is carried out using the equation 1.

$$A * p = Lr \qquad (1)$$

Where:
A → width of the river
p → depth
Lr → bed of the river

Then the calculation of the speed of travel of the object is carried out released into the river current, for which equation 2 is used.

$$D * t = Vr \qquad (2)$$

Where:
D → travel distance (m)
t → time (seconds)
Vr → travel speed (m / s)

The last operation performed is the flow calculation and is obtained by applying equation 3.

$$Cr = Lr * Vr \qquad (3)$$

Where:
Cr → river flow (m^3/ sec)

According to the analyzes made of the river's capacity, it indicates that 3.6 m^3/ sec pass. With this information, calculations of the energy to be generated with the river water can be made (Ahn et al., 2020; Pinto et al., 2014). The map in figure 1 shows the area where the research was carried out, as can be seen there are several communities in the river's area of influence.

Figure 1. Map of Rio De Oro water influence areas of El Carmen canton

For the study, a population was selected that was surveyed to know the criteria of the inhabitants in relation to the behavior of the electric service, obtaining what was observed in figure 2.

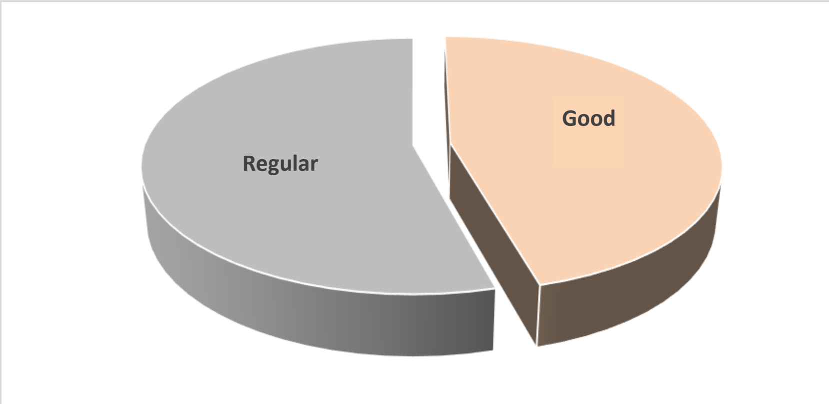

Figure 2. Quality of the electrical service

As shown, the majority of those surveyed considered that the electrical service was regular, in many cases at night hours and very frequent in the winter periods when the electrical system collapses, and it is difficult to carry out maintenance. The river flow was measured in 23 points near the communities, the results are shown in figure 3. The data obtained in the investigation allow to affirm that in most cases there is enough flow to be used in the generation of energy, especially in twelve of the points studied.

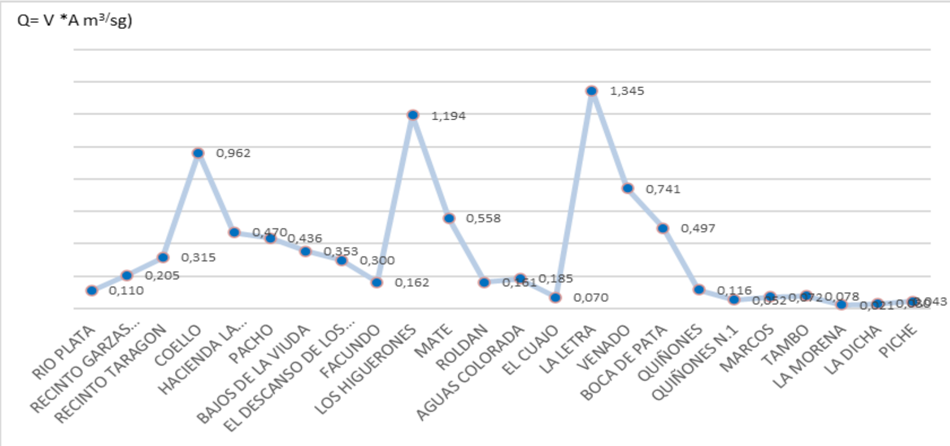

Figure 3. Graphic behavior of the flow measured in the 24 points studied

The energy use of the flow measured can lead to oil savings, the reduction of CO_2 emissions into the atmosphere, as well as the improvement of electricity service, especially in the sites where the electric service is presenting quality problems. Figure 4 shows the graphical behavior related to the flow measurement in the 13 points studied that present a regular situation in the quality of the electricity service.

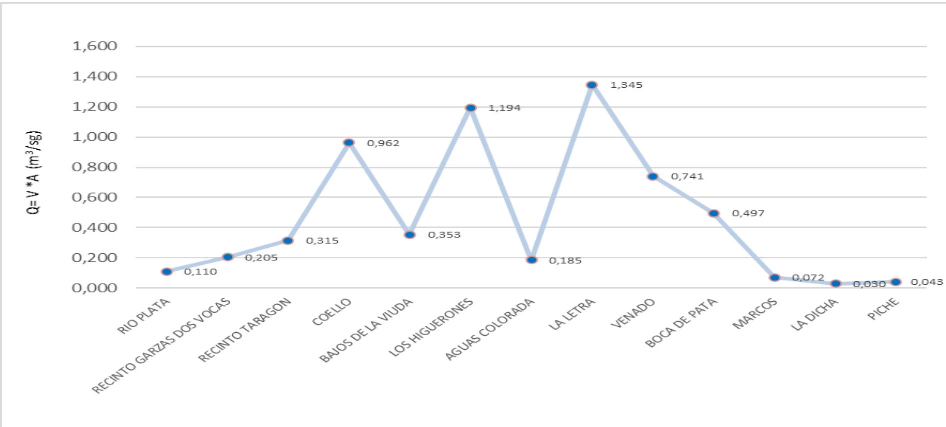

Figure 4. Flow behavior in the 13 points that present difficulties

As can be seen in many of them, small systems of mini hydroelectric or Pico hydroelectric plants can be used to generate energy and improve electricity service. Figure 5 shows a graph of the distance from the population centers to the site where the water potential has been identified.

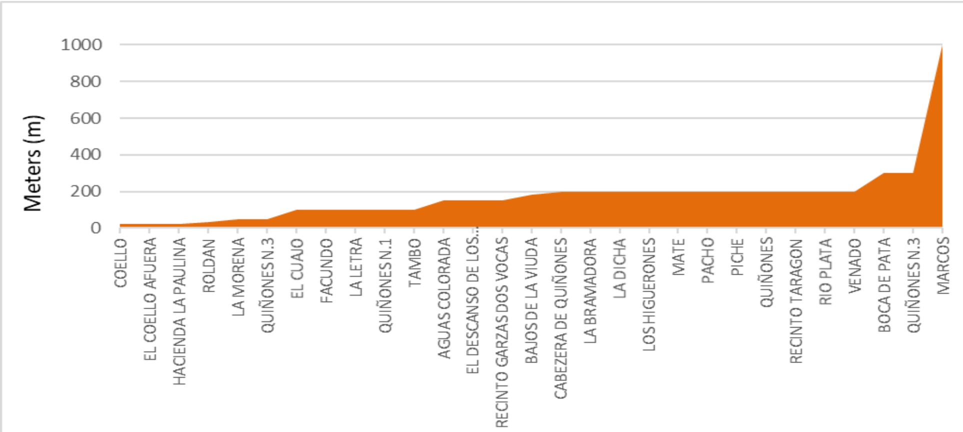

Figure 5. Distance between the population centers and the studied water potential

It can be seen that in most cases the population centers do not exceed 200 meters of distance to the site where the water potential exists, which shows that its use can be viable in terms of improving the quality of the electricity service, saving resources and promote the reduction of CO_2 emissions into the atmosphere. Figure 6 shows the graph of the number of houses in the studied sites.

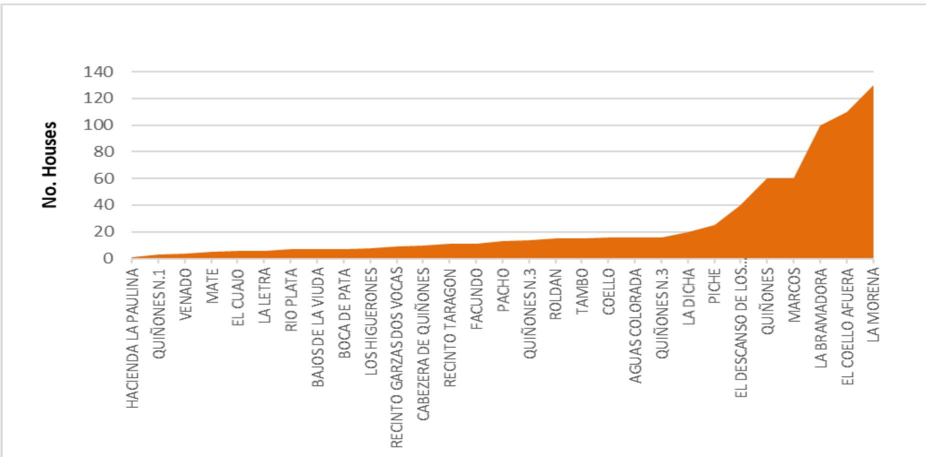

Figure 6. Number of houses in the studied sites

In the results of the research, in most of the studied sites the largest number of houses is in 20 and it has been observed that the population concentration in these is not greater than 100 citizens.

Figure 7 shows a graph of the demand for electricity in the studied sites.

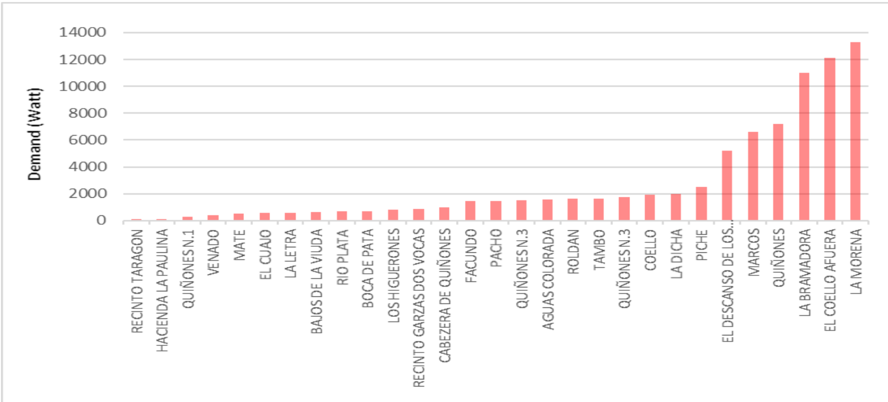

Figure 7. Electricity demand

With the study of electricity demand, it can be seen that in most of the sites studied there is between 1 and 2 kW of demand, which allows installing small pico turbines or small systems of microturbines with which It is possible to solve the problem of the quality of the electricity service, at the same time that it is possible to take advantage of the local energy potential, promoting the saving of resources and the reduction of CO_2 emissions into the atmosphere. Figure 8 shows the map of the flow map of the points studied in the river (A) and the statistical map (B), specifying the flow measured at each point and other data of interest that were generated as a result of the work.

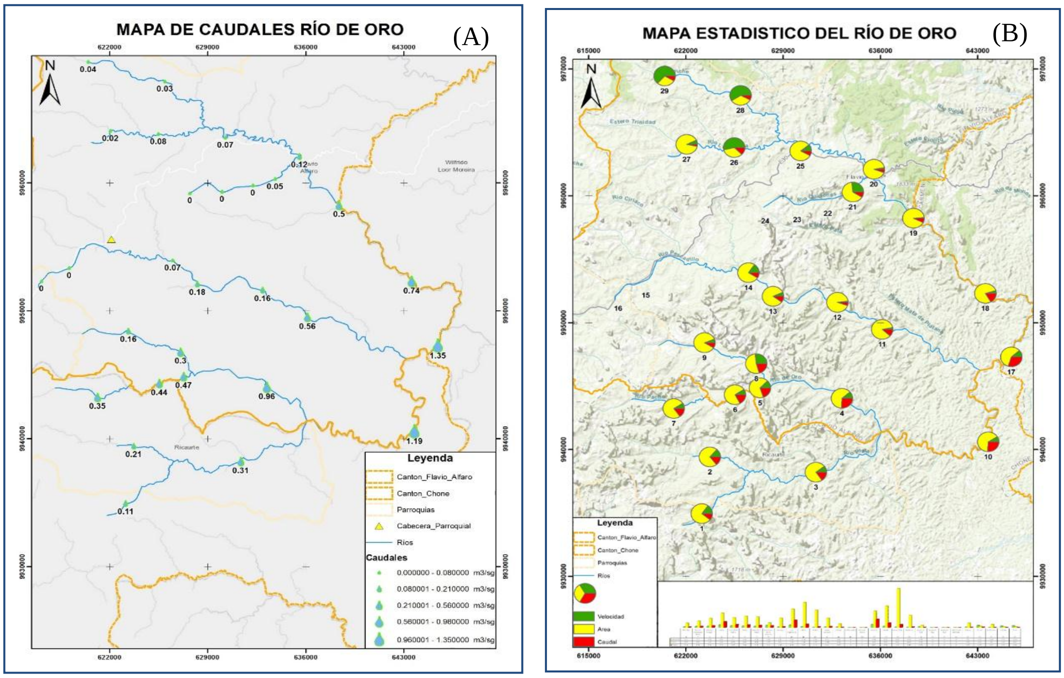

Figure 8. Flow map of the measured points (A) and statistical map in (B)

As can be seen in almost all the measured sites, there is a water potential that can be by using small generation systems and improving the quality of energy in the territories studied in the Río de Oro (Rajapaksha et al., 2016; Azazzi, 2020).

Conclusion

After analyzing the socioeconomic situation of the communities considered for the research, it was determined that they depend entirely on agricultural activity and that they have electricity, but in more than 50% of the cases the energy is not arriving with the required technical quality parameters, a situation that becomes more conflictive during the winter months with the rains, where there are frequent interruptions of electricity service. Once the corresponding gauges were carried out in each of the points, it was possible to determine the flow for the simulation of the hydraulic jumps and the use of these flows to improve the quality of the electricity service, contribute to the reduction of COemissions2 to the atmosphere, according to the needs of each of the selected communities.

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