TEST Engineering & Management

March - April 2020
ISSN: 0193-4120 Page No. 9250 - 9256

Proposal for a Sustainable Infrastructure Design (Ecolodge) in the Quichas Town, Perú

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Article Info
Volume 83
Page Number: 9250 - 9256
Publication Issue:
March - April 2020

Article History
Article Received*: 24 July 2019*
Revised*: 12 September 2019*
Accepted*: 15 February 2020*
Publication*: 09 April 2020*

Abstract

The Ecotourism is an alternative to social-economic development, especially in places where biodiversity is abundant, and that is why viable and sustainable alternatives must be generated for its realization. The application of a bioclimatic architecture is proposed to generate the least possible negative impact. Sustainable ecotourism principles and the use of biodegradable materials in the area that harmonize with nature will be taken into account to generate a good low impact ecotourism practice to promote the socio-economic, environmental and cultural development of the inhabitants. This proposal for a sustainable infrastructure design (ecolodge) is based on the collection of information from the people of Quichas. It uses the adobe in the construction and thermal insulation in the ceilings; it has a recreation area and uses renewable energy sources taking advantage of the climate of the area.

Keywords:*1. ecotourism, sustainable, 2. bioclimatic architecture, 3. biodegradable materials, 4. ecolodge, 5. renewable energy.*

INTRODUCTION

In this proposal, the constructions will have a design that applies natural ventilation and avoids the unnecessary consumption of energy, that is why the use of active or passive sources of solar energy, hydroelectric energy, and wind energy is considered, as well as the use of intelligent control of water and energy, avoiding or minimizing the use of air conditioning, but at the same time require permanent maintenance, tested for resistance and corrosion limits [1].

The project seeks to meet the needs of the inhabitants of the town through ecotourism infrastructure, where alternatives to boost cultural and economic [2] development are explored and will also be consistent with the landscape without altering the ecosystem balance.

The infrastructure will be based on a bioclimatic [3], a model that seeks to provide thermal comfort to potential customers. The town of Quichas has a climate corresponding to the Suni region [4], characterized by low cold-dry temperatures, where the average annual temperature is 11ºC. The minimum temperature is recorded between May to June, ranging from -1ºC to -16ºC. This area is characterized by the abundant seasonal rainfall that takes place between January to April, which reaches an average of 800 mm per year, covering altitudes from 3,500 to 4,000 meters above sea level [5].

According to the natural region given by the Peruvian geographer Javier Pulgar Vidal, this town is in the Suni region; at an altitude of 3,978 meters above sea level.

II. RESULTS OF THE RESEARCH

The town of Quichas "Fig. 1" is located in the province of Oyon in the department of Lima. The homes of the settlers are made of adobe walls, and they have a roof with calamine cover; they have gutters on their floors in the case of heavy rains, windows with wooden edges, and the roads are not

March - April 2020
ISSN: 0193-4120 Page No. 9250 - 9256

paved. They are found at a longitude of -76.7689 and latitude -10.5742 [6].

Figure 1.Project location in the town of Quichas. 2019

Potential tourist attractions: Colonial Church Our Lady of the Rosary, Guengue Chico Lagoon, Guengue Grande Lagoon, Guengue Grande Lagoon Waterfall, Snowy Condorseja

2.1 Flora and fauna

For this research work, as part of the analysis of the ecotourism potential of the town of Quichas and for the location of sustainable infrastructure, flora and fauna of the place were taken as one of the important components.

For this reason, information from other research works in the Oyon district was compiled “Tab. I” [7] and “Tab.II” [8], more specific information was taken from the Guengue lagoon, which is located in the town center of Quichas.

Table 1. Calculation of the effective wind power density, as indicated by the Danish Wind Industry Association of the District of Pillcomarca in May 2019

Vegetal group	Family		Genus		Species	
	N°	*%*	*N°*	*%*	*N°*	*%*
Magnoliopsida (Dicotyledoneae)	35	87.5	103	81.75	152	82.61
Liliopsida (Mono cotyledoneae)	5	12.5	23	18.25	32	17.39
Total	40	100	126	100	184	100

Aves			
Orden	***Familia***	***Especies***	***Nombre Común***
Falconiformes	*Accipitridae*	*Buteo melanoleucus*	Aguilucho
	Falconidae	*Falco sparveritus*	Halcón americano
	Apodidae	*Streptoprocne zonaris*	Vencejo grande
	Tirochilidae	*Metalura phoebe*	Picaflor negro
	Picidae	*Colaptes rupicota*	Carpintero serrano
	Hirundinnidae	*Camptostoma*	Golondrina
		Obsoletum	Santa Rosata
		Notiochelidon murina	Cucarachero
	Troglodytidae	*Notchtelidon*	Chiguanco
	Turdidae	*Cyanoleuca*	Gorrión americano
	Fringilidae	*Troflod**i**tas aedon*	Espigueros
	Cathartidae	*Coragyps atratus*	Gallinazo
Columbiformes	*Columbidae*	*Columbina cruziana*	Tortolita
		Zenaida asiatica	Cuculí

Anfibios			
Anura	*Buonidae*	*Bufo sp.*	Sapo
Mamifero			
Carnivora	*Mustelidae*	*Conepatus rex*	Zorrillo
Rodentia	*Canidae*	*Pseudolapez sechurae*	Zorro Costero
	Chincilidae	*Lagidium peruvianum*	Vizcacha
	Crecetidae	*Akodon sp*	Ratones
	Muridae	*Phyllotis sp*	Pericotes
Reptiles			
Squamata	*Viperidae*	*Bothrops pictus*	Sancaranca
	Iguanidae	*Tropidurus spp*	Lagartijas, iguanas
Animales Domésticos			
Artiodactyla	*Camelidae*	*Lama glama*	Llama
		Lama paco	Alpaca
		Ovis sp	Oveja
	Suidae	*Sus serofa domesticus*	Cerdo
Perisodactyla	*Equidad*	*Equus caballes*	Caballo
		Equus asinus	Asno

Table 2. Registered animal groups in the district of Oyón, Lima, Perú

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March - April 2020
ISSN: 0193-4120 Page No. 9250 - 9256

2.2 Implementation of clean technologies

2.2.1 Solar panels

For the implementation of photovoltaic panels, the data is based on an online tool called Global Solar Atlas, which provides an overview of the potential of solar energy. "Fig. 2" for a site or region, so a "Tab. III" with the characteristics of the area is shown of study of the town of Quichas, Oyon, specifically in the area of sustainable infrastructure.

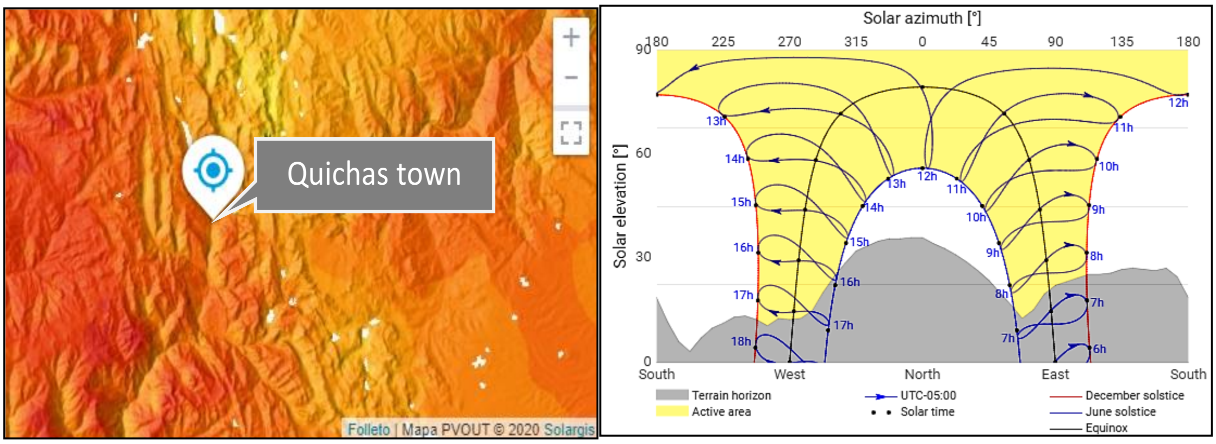

Figure 2.PVOUT map and Horizon and solar path, the populated center of Quichas, Lima, Peru 2020.

Table 3.Data from the study area, Quichas, Oyón, Lima, Perú, 2020.

Output specificphotovoltaicpower	Specific PVOUT	1667	kWh / kWp
Normal direct irradiation	DNI	1845	kWh / m^2
Global Horizontal irradiation	GHI	2002	kWh / m^2
Horizontal diffuse irradiation	DIF	709	kWh / m^2
Inclined global irradiation for the optimal angle	GTI opta	2057	kWh / m^2
Optimal inclination of photovoltaic modules	OPTA	16 / / 0 0	°
Air temperature	Temperature	7.1	°
Terrain elevation	ELE	4125	Meter

Table 4. PV system Source: Global Solar Atlas, 2020.

	**Pv system**	Small residential
	The azimuth of photovoltaic panels	Optimal (0º)
	The tilt of photovoltaic panels	Optimal (16°)
	Installed capacity	1 kWp

Regarding the calculation of the photovoltaic energy performance in the implementation area, it was based on the [9]; "Table IV" is shown below with this calculated data.

2.2.2 Biogas

Biogas is a gas production system with anaerobic digestion processes that present different forms of use, whether for heat or electricity generation, such as automotive fuel, natural gas [10], just as there are different sources in gas generation, such as the production of fecal matter and urine as a proportion of live weight, that is to say, that its productive potential is also influenced concerning the state of the animal, for this case, it is mentioned below in

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March - April 2020
ISSN: 0193-4120 Page No. 9250 - 9256

"Table V," the different sources of different excreta farm animals and humans. [11]

Table 5. Values and characteristics of manure

Animal class	% by live weight		% of digestion material		C/N relation	Biogas production (m3 of gas / 1kg Sol Org.)
	Manure	*Urine*	*Solids*	*Organic solids*		
Cattle	5.0	4.0	15 - 16	13	20	0.250
Pigs	2.0	3.0	16	12	13	0.350
Goats, sheep	3.0	1.5	30	20	30	0.200
Horses	5.0	4.0	25	15	20	0.250
Poultry, chickens	4.5	4.5	25	17	5 - 8	0.400
Humans	1.0	2.0	20	15	8	0.300

As shown in "Tab. V", the animals with the highest biogas production include cattle and pigs [11], which can be visualized in statistical graphs like "Fig. 3 "and" Fig. 4".

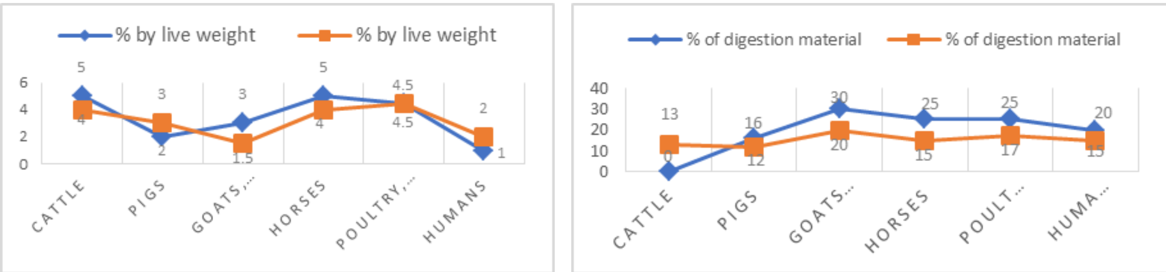

Figure 3.PVOUT map and Horizon and solar path, the populated center of Quichas, Lima, Peru 2020.

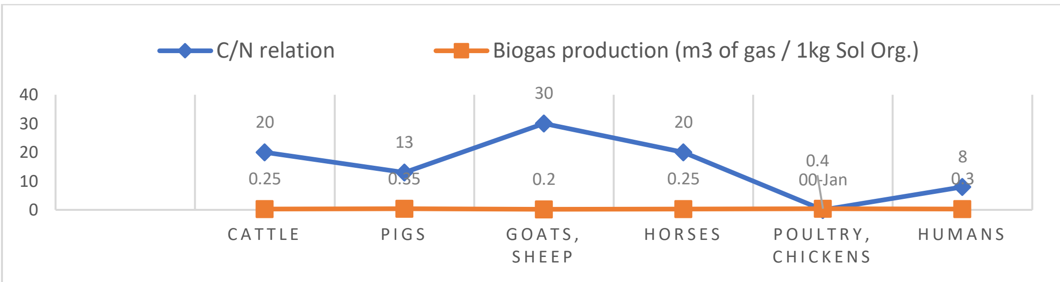

Figure 4.PVOUT map and Horizon and solar path, the populated center of Quichas, Lima, Peru 2020.

Due to the greater activity that occurs in the center of Quichas, the most feasible material as a source of biogas production is that of beef and pork, which the average concentration of some parameters of beef slurries such as dry matter (7.00%), BOD5 (15.000 mg/l), COD (60.000 mg/l), NTK (4.500 mg/l), Phosphorus (P2O5) (1.700 mg/l) and Potassium (K2O) (5.800 mg/l) [13].

Biogas needs a model for a family consisting of 5 people. [14]

Cook (5 hours)............0.30 * 5 ....1.50 m3/day

3 lamps (3 hours) ....0.15 * 3 * 3.........1.35 m3/day

1 medium refrigerator.......2.20 * 1 ....2.20 m3/day

Total 5.05 m3/day

Therefore, for the restaurant that is in the area of sustainable infrastructure

Cook (6 hours) ....0.30 * 6 ....1.80 m3/day

4 lamps (4 hours) ....0.15 * 4 * 4........2.40 m3/day

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2 medium refrigerators ....2.20 * 2 ....4.40 m3/day

Total 8.60 m3/day

2.2.3 Artificial wetlands

They usually consist of a monoculture or polyculture of macrophytes in shallow lagoons, which receive an affluent and the plants will fulfill the function of distributing oxygen to the root system where microorganisms live, absorbing nutrients that nitrogen and phosphorus have been more accurately pretreated, remove contaminants and filter solids with the fabric that forms the root system. [15]

For this research, the proposal for the implementation of artificial surface flow wetlands was considered because, according to [16], mentions that in terms of landscape, this system is highly recommended for its ability to house different species of fish, amphibians, birds, among others. “They can be constituted, in tourist places and in places of study of different disciplines by the complex biological interactions that are generated and established.”

After analyzing the most used plant species in the implementation of an artificial wetland and according to [17], “The plants of the Iridaceae family can withstand frost, which makes them suitable for the temperatures that occur in the area. They have a high consumption of water and are usually found in the wild in swamps or wetlands, especially the species are known as Yellow Lily Iris”.

III. PROPOSAL

“Fig. 5” is structured in three components, which are listed as follows, a. Restaurant, b. Accommodation, and c. The reception will not only focus on reducing the consumption of the building once built but also during the stage of obtaining the materials and their construction [18].

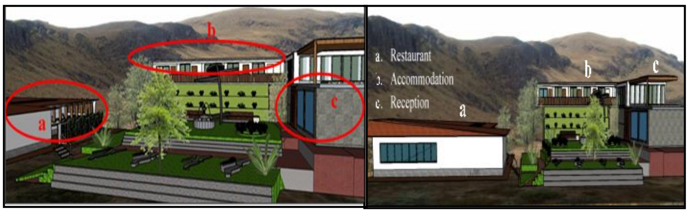

Figure 5.Ecolodge design proposal, the populated center of Quichas.

The “Fig. 6” shown below was taken with a plan view for a better appreciation of the position of the ecolodge components with their respective enumerations, a. Restaurant, b. Accommodation, and c. Reception and this reception area has solar panels for electrical self-supply, and marked with a red arrow.

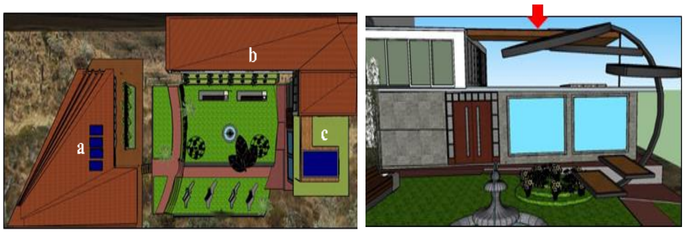

Figure 6.Plan view of the Project of populated center Quichas.

The restaurant “Fig. 7” has solar panels and a biodigester to process cattle excreta. The design of the restaurant consists of the use of wood for finishing and windows with vertical gardens.

Figure 7.Restaurant area, exterior view.

In "Fig. 8" on the left side the Inca Andean agricultural technique is visualized, that is to say, the agricultural terraces which use the Andean soils more efficiently.

TEST Engineering & Management

March - April 2020
ISSN: 0193-4120 Page No. 9250 - 9256

Figure 8.Recreation area with artificial wetlands.

In the "Fig. 9" shown below, he presents the use of a biodigester based on the excreta of cattle but also the pig for the restaurant supply, the use of artificial wetlands for the elimination of contaminants present in wastewater, being more respectful and integrated into the environment [19].

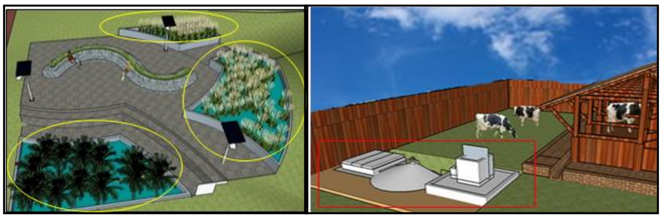

Figure 9. Use of artificial wetlands and the biodigester

IV. DISCUSSION

The study showed that the modality and design of the ecolodge related to the nature of the area, its construction, has the potential to be implemented, given the references to similar facilities found in the literature, since in the national context, it mentions that it is an opportunity to favorable business, due to macro and micro-environmental factors, among which stand out the offer of eco-technologies, growth trends in the high natural tourism sector, solid economic indicators of the sector, due to the low competition in this type of buildings and given the clear preference of foreign tourists for higher level establishments provide an optimal scenario for the project [20], others such as Pumarinri Amazon Lodge-Tarapoto in this case of a warm area, but which has the same purpose of generating benefits for the populations involved, as well as to nature, appreciating the biodiversity that is being designed and the materials following the bioclimatic and native criteria of the region that make the native architecture re reflected in the design, and this is combined with its environment. The same happens in the international context of the great positive impact generated by the implementation of an ecolodge such as KapawiEcolodge& Reserve - Ecuador, whose objective is to preserve the nature of the place intact.

V. CONCLUSIONS

The proposal of an infrastructure design (ecolodge) is undoubtedly one of the best options to improve the quality of life of the inhabitants of the town of Quichas, since this region will not only supply the economic sectors of livestock, agriculture, fish farming and mining, which threatens nature to a greater degree.

Thanks to the inclusion of ecotourism as an economic activity that boosts and increases socioeconomic development, entrepreneurship, and population empowerment.

The functionality of this Ecolodge will generate a minimum environmental impact because it will be sustainable, both in its construction and operations. It will generate an integration between the habitat and the community, where adequate comfort will be found for its guests and will be an important place for interpretation and enjoyment of nature.

This Ecolodge is a sustainable business that will comply with sustainable hospitality management because it will involve the management of the supply chain, waste, resources, biodiversity, and at the same time, generate work by hiring the inhabitants.

ACKNOWLEDGEMENTS

This paper has been possible to carry out as research due to the need to obtain and generate knowledge from different professionals. The authors wish to thank our university mentors for their support and guidance.

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March - April 2020
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