Infrastructure of the Aquaculture Reserve and Ecotourism in Castrovirreyna in the department of Huancavelica, Peru - 2022

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Abstract

The objective of this research is to propose an infrastructure for an aquaculture and ecotourism reserve; because the ecological zones are not used correctly, which are built with polluting materials and excessive costs where the population has low income. The methodology applied is an eco-friendly design that blends in with the environment, using bioclimatic design strategies (topographic strategies, solar orientation, materiality and reuse) supported by digital tools such as (AutoCAD, SketchUP). As a result, an aquaculture reserve was obtained with 4 important sectors differentiated by levels, which promotes ecotourism; social area with 45%, environmental awareness area covers 20%, private area with 17% and the industrial area with 18% of the project. It has natural lighting capture through 62 polycrystalline solar panels which generates 18,600w supplying the entire reserve and reuse of rubber in concrete mix, reducing greenhouse gases by up to 50%. In conclusion, the proposal allows to improve the economic conditions of the place due to the increase in the tourist flow, likewise it revalues the lake which generates visual comfort for the visitors, enhancing the landscape of the place.

Keywords: Green building solution, Recycled rubber, Infrastructure, Aquaculture reserve, Tourism.

I. INTRODUCTION

Peru is one of the countries with the greatest climatic vulnerability that affects ecosystems, including animal husbandry in the Andes [1], including Huancavelica, one of the main regions with vulnerability due to natural causes [2] as well as that a low suitability of the soil for trout aquaculture of 4.26%, 23.03% and 69.73% of the territory is "very suitable", "moderately suitable" and "marginally suitable", respectively, for the development of aquaculture. [3] By not taking into account the quality of the trout habitat due to its proximity to mining centers, lead particles with 0.0690mg/l are found, exceeding the LMP compared to Supreme Decree No. 015-2015, which is 0.05mg/l. [4] widespread exposure causes adverse impact on human life and the aquatic ecosystem [5] is the index for trout habitat contamination [6] followed by increases in temperature and decreases in ecosystem productivity [7] influencing the development of the competitiveness of the department with position 24 at the national level [8] because its economic income is based on its primary activity with a per capita income of S /. 131.29 per month [9] with a deficient investment for the construction of aquaculture reserves in the lagoons [10] Despite the variety of productive areas and suitable soils, they are not used to the maximum [11] much less the existence of technologies for the quality of the industry [12] taking into account that the few existing reserves are made of polluting materials and the water was not taken into account [13] added to the contamination by rubber residues that harm the health of the population [14].

The rubber industries cause not so good impact in the environmental sector compared to the impact in the economic sector. [15] Rubber and concrete are the producers of greenhouse gases and CO2 emissions, so their reuse represents a great decrease in environmental load [16] where the experimentation of concrete with crushed rubber had the lowest emission and greater resistance of 45 MPa [17] in this way these materials can have an important impact in the reduction of gas emissions up to 50% [18] in turn would reduce the cost in large constructions [19].

Currently in Peru there is no reserve infrastructure that implements the reuse of rubber, there being a growing need to use these materials as a replacement for conventional aggregates to concrete, due to environmental and economic considerations [20]; For this reason, an ecological and tourist aquaculture reserve is proposed in Castrovirreyna in the department of Huancavelica.

II. METHODOLOGY

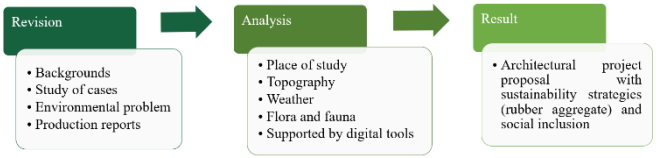

Figure 1. Study phases.

IEECP'23, July 11-12, 2023, 3rd European Conference

III. ANALYSIS SITE

A. Study Delimitation

The geographical location of Huancavelica is located between the western chain and the central highlands of the country, nestled in the high mountains, between the Lima, Ica, Ayacucho and Junín regions. It is located at about 3 500m.s.n.m. related to the type of soil for the development of the different activities [21].

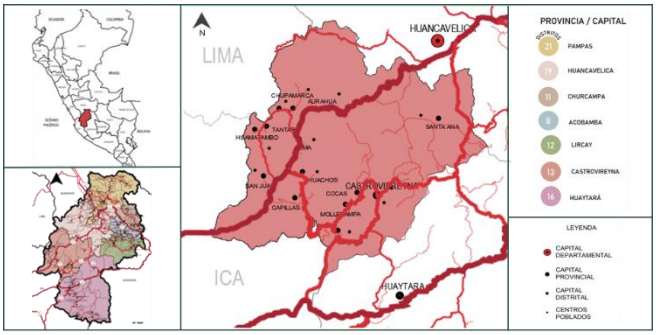

Figure 2. Location map.

B. Climatology

The department has a cold and rainy climate:

1) Solar Radiation

The month with the most sun is November with an average of 10.7 hours of sunshine, less sun in April with 6.9 hours; the months with the highest UV index are September and November, and the rest of the months with the lowest index.

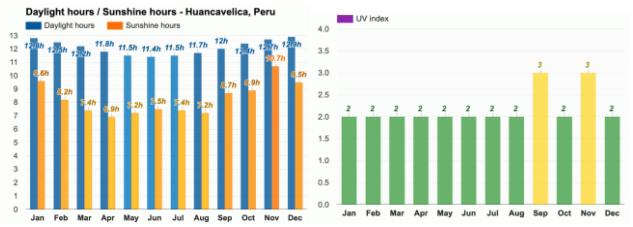

Figure 3. Daylight and average UV radiation.

2) Precipitation

Huancavelica is a very humid place, which is why the soil is very good for cultivation. Rainfall greater than 500 mm (l/m2) [22].

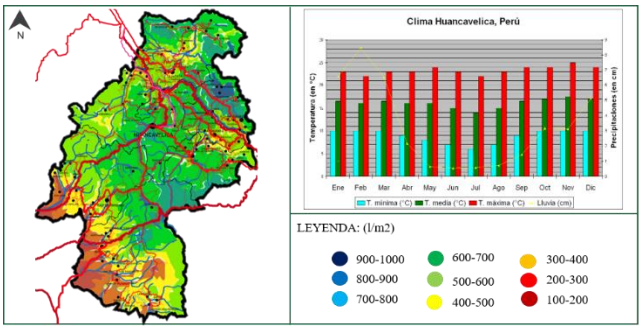

Figure 4. Precipitation map.

3) Humidity

The month with the highest relative humidity is February (84%) and the lowest are July and August (70%) [23].

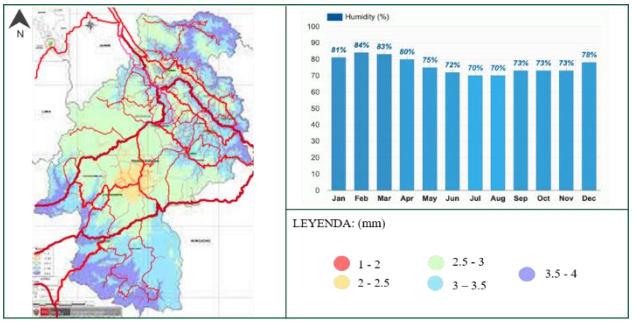

Figure 5. Solar Radiation Graph

4) Winds

The prevailing winds come from the West - Southwest, with a range of 15 to 20 km/h [24].

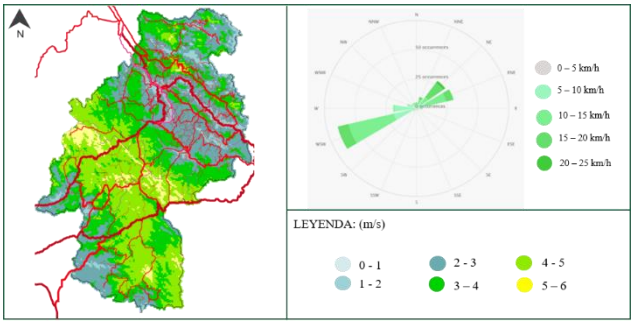

Figure 6. wind map.

5) Temperature

It is cold - temperate, moderately rainy and with moderate thermal amplitude. The annual mean maximum temperature is 15.4 °C and a minimum of 2.8 °C [25].

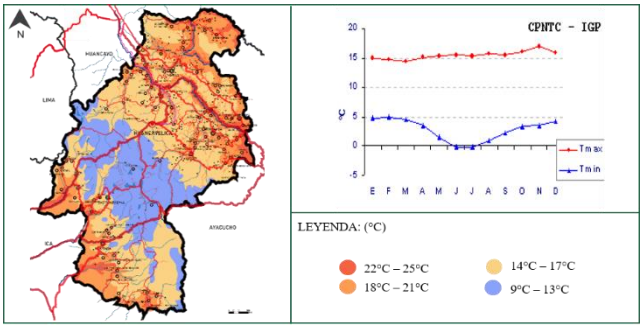

Figure 7. Temperature map.

6) Psychometric abacus

The department has 5 climatic zones that must be taken into account for the design: desert zone, temperate continental, cold continental, very cold continental and high tropical jungle. It coincides with the lower parts of the valleys of ravines, with a temperature of 10 – 25°C, its humidity is low, the solar radiation is direct, and the winds vary, depending on the hours of the day and the seasons [26] [27].

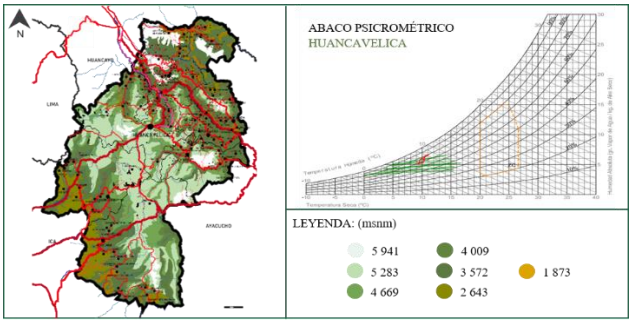

Figure 8. Huancavelica abacus.

C. Flora and fauna

Huancavelica has a diversity of flora thanks to its types of soils and microclimates that favor its development, the highest concentration occurs in the low jungle ecoregion. It allows economic income in the agricultural sector for the production of native potatoes and alfalfa and in the tourism sector for its orchid forests located in the province of Tayacaja (Pampas) in the populated centers [28].

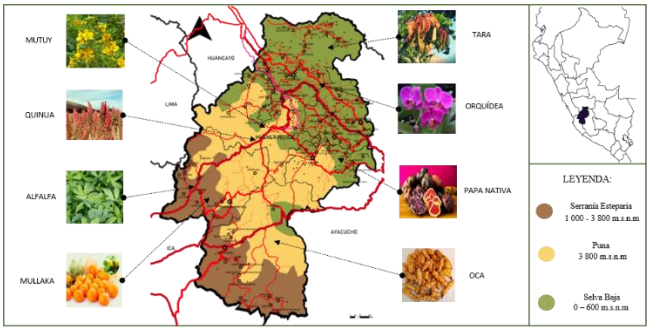

Figure 9. Flora map.

The province of Castrovirreyna produces large quantities of alfalfa that are distributed to the communities that are in charge of raising camelids, in this way the province of Castrovirreyna generates economic income and the peasant communities maintain the breeding [27].

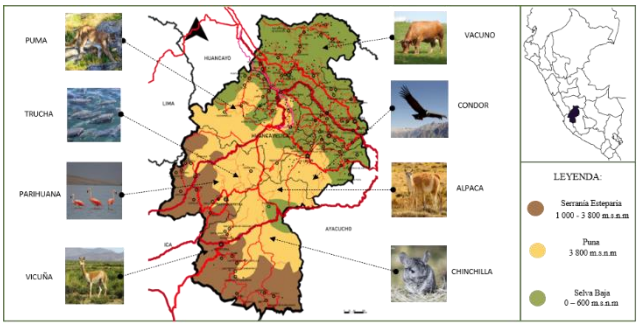

Figure 10. Fauna map.

IV. DESIGN STRATEGIES

A. Project location

The development of the project is located in the district of Castrovirreyna, in the set of lagoons that is located in the northeast area of the district, favoring aquaculture activity in the rearing and stocking of rainbow trout.

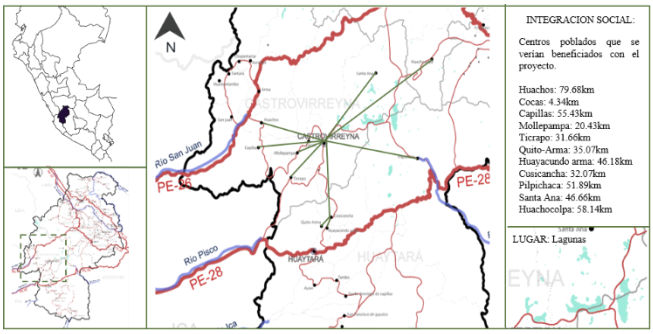

Figure 11. Place of Proposal.

B. Topography

The type of soil and the height were taken into account for the development of the project, with a reinforcement in the foundation, relief and unevenness.

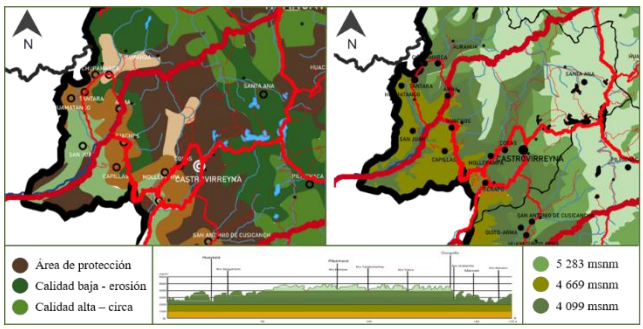

Figure 12. Compatibilization and relief.

C. Orientation

A Northeast - Southwest orientation, to take advantage of natural lighting most of the day, take into account the direction of the winds for natural ventilation. The project integrates with the environment and takes advantage of the direction of the lake.

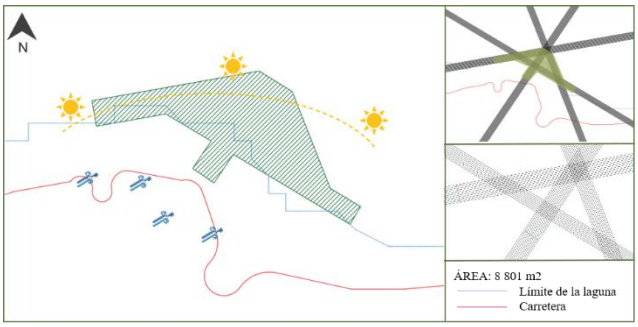

Figure 13. Orientation of sun and winds.

Figure 14. Ground axes.

D. Materiality

The aquaculture reserve took into account the climate and the economic level of Huancavelica for the selection of the material. As the first component, concrete with recycled rubber particles was implemented in the structure; By having greater seismic resistance characteristics, it reduces cracking by 17.5% and has better behavior against water.

Figure 15. Concrete with recycled rubber particles.

As a second component, wood resistant to water and humidity was implemented for the coating and finishes of the project. Among them we have Olmo wood with an approximate density of 650 kg/m3 at 12% humidity and Cedro with a density of 0.5 g/cm3 at 12% humidity suitable for the Castrovirreyna climate [29].

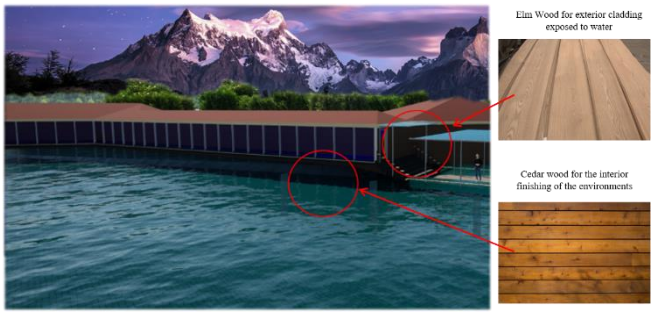

Figure 16. Elm wood structure and cedar cladding.

E. Production

After Puno and Junín, Huancavelica is in the third place with the largest trout producer. This proposal seeks to expand the quantity and quality of rainbow trout, for export to foreign countries such as the United States.

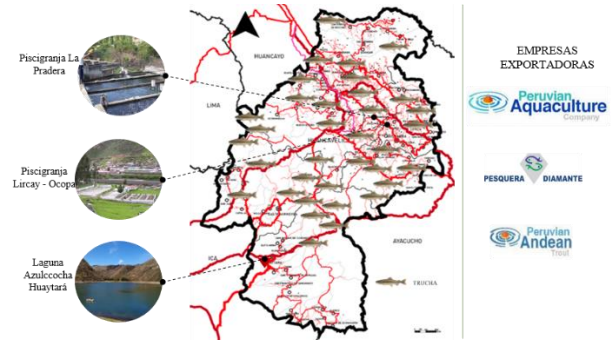

Figure 17. Aquaculture cluster of the department of Huancavelica.

Table 1. Countries where it is exported.

	EE. UU	JAPAN	RUSSIA	THAILAND
Trout fillets	48%	44%	44%	44%
Whole trout	-	19%	19%	19%

V. RESULTS

A. Volumetric proposal

A project was proposed that blends in with the environment, includes the exterior with the interior and that meets the objectives of the research; The proposal is located on the shore of Lake Orcococha to take advantage of the direction of the water currents for raising rainbow trout, in turn a fishing space was proposed that invites tourism and the preservation of the species; It has production control and packaging to export the product.

Figure 18. Volumetric proposal.

B. Environments

The reserve is divided into 4 sectors; Sector 1 Social (45%): Main entrance – Food Court – Fishing Area, Sector 2 Environmental Sensitivity (20%): Museum – Training Area, Sector 3 Private (17%): Trout Farming – Laboratories – Incubation – Food Production, Sector 4 Industry (18%): Trout Cleaning – Embedding – Distribution.

Figure 19. Relationship of environments.

For the design of the entrance, partitions were used, inviting the entrance and connecting the interior with the exterior, framed with two large statues of trout and golden letters.

Figure 20. Main entrance.

Figure 21. Interior view of the food court.

C. Ecotourism

It has a route for the public through 3 sectors covering 83% of the total built area: passing through the social-cultural and industrial sector, which are located at different levels taking advantage of the wide views of the landscape. The social-cultural sector consists of a large passage on two levels, the first platform fulfills the function of environmental awareness and fishing area; The second, lower platform is submerged in the lake up to -0.72m with glass walls taking advantage of its transparency.

Figure 22. First platform.

Figure 23. Second platform.

The industrial sector consists of 6 ponds for their rearing separated by age with a passage in the middle connecting two spaces of the reserve.

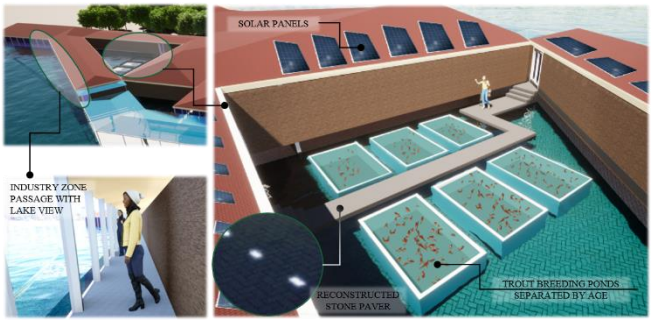

Figure 24. Trout breeding.

D. Sustainable Energy

It is supplied by means of 64 solar panels that are distributed according to the needs of each space with a power of 18,600W, in the exterior passages an ecological cobblestone was implemented that is recharged during the day providing light at night, in addition to large partitions that provide natural light and cross ventilation.

Table 2. Quantity of panels in the project according to need.

	LUMINAIRES (W)	PANELS (quantity)	TOTAL PANELS
Environmental awareness	182 W	1	62
Food court	487 W	2	
Museum	78 W	1	
Service area	11 023 W	37	
Industrial zone	6 143 W	21	

Figure 25. Panel view.

VI. DISCUSSION

In the Aquaculture - King's Cross London project, the objective was a hatchery and fish market, a sushi bar and a recreation area with pedestrian and vehicular access that connects the two river lakes; As a methodology I use the topography, the direction of the river, collection technology; As a result, a project was obtained that takes advantage of the land, incorporating a water treatment system with restoration technology, managing to reduce large percentages of effluents from the land, likewise it is characterized by waterfalls and continuous terraces. The fish is processed and packaged in the same place for immediate consumption or purchase. Visitors can experience the entire business process through bridges. The project was nominated for the bronze medals from the president of Riba, one of the most prestigious international architecture awards [30].

The Sustainable Fisheries and Aquaculture Development - Environmental and Social Analysis has among its objectives the study and reproduction of fish of the native species of the Paraná

River. As a result, a fish farming station was built with several culture infrastructures such as microalgae production modules, a live food production module and a fattening module. The surrounding population and of different ethnic groups will be improved, through workshops and training [31].

The Aquaculture Reserve Infrastructure and Ecotourism project in Castrovirreyna in the department of Huancavelica aims to propose a sustainable architectural design that contributes to the care of the species, promotes tourism and influences the socioeconomic sector of Castrovirreyna [32]. As a methodology, the location, design criteria and materials that are sustainable and of minimum costs were taken into account. Taking into account the references, as a result an eco-friendly infrastructure was obtained that revalues the lake with spaces at different levels for the increase in tourist flow; a materiality of concrete with recycled rubber particles for the structure and wood with characteristics that are resistant to water and humidity.

VII. CONCLUSIONS

The architectural proposal improves the use of species with a sustainable infrastructure that meets 7 ODS objectives: As the main objective, No. 11 - Sustainable cities and communities, since the project has a sustainable infrastructure that covers the socio-economic; N°01 – End of Poverty, since the infrastructure could become a prototype for the aquaculture reserves of the rest of the department of Huancavelica; N°03 – Health and Well-being, since it has spaces for recreation and culture; N°08 – Decent work and economic growth, based on their location with the radius of influence they have with the surrounding populated centers, providing opportunities for families for a better economic income; N°09 – Industry, Innovation and Infrastructure, has technological innovations in its materiality and trout production spaces; N°13 – Action for the climate, reduces greenhouse gases in its construction and in its useful life; N°15 – Life of the Terrestrial Ecosystem, promotes the care and good management of the species (rainbow trout); The project complies with a location that takes care of the environment.

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