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Proposal of Rural Housing and Habitat Improvement of the Town El Encanto, in Tapachula, Chiapas, Mexico

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Abstract

In the state of Chiapas, Mexico, there are numerous rural communities located in isolated territories and away from important population centers. Families, in essence, have indigenous roots and low economic incomes and, because of this condition, their homes are precarious, unsafe and unhealthy, with many limitations to access basic water and sanitation services, as well as basic health services, recreation, education, communication, etc. This study analyzed the housing and habitat problem of the El Encanto community, located on the coast of Tapachula, Chiapas. As a result, structurally safe, economical and healthy housing proposals were developed, with water and sanitation services, functional spaces with sociocultural characteristics, typology and appropriate to environmental conditions, with the use of ecotechnologies and building materials of the place for the conservation of the environment and biodiversity, in addition, proposals for community equipment for habitat improvement were developed.

Keywords: rural housing, security, habitat, sanitation, sustainability

1. Introduction

In Mexico, the state of Chiapas is characterized by its vast diversity of ecosystems, the result of its geographical location, soil types, climate, etc., too, is recognized as one of the most culturally rich entities in the country, cradle of original villages such as tsotsiles, tseltales, zoques, lacandones, mames, tojolabales, among others, which have resulted in an extraordinary variety of villages that are located throughout the territory of Chiapas, configured by mountains, highlands, depressions, plains and coast. In this regard, there are more than 20 thousand localities, of which 99% have fewer than 2,500 inhabitants and of those 85% have less than 250

and 74% less than 100 inhabitants [1]. In this sense, the dispersion of the population of the entity and the existing orography, are factors that limit the access of localities to the basic services of water and sanitation, health, education, culture, recreation, communication, among other aspects.

The study of the house and the habitat that is presented, corresponds to the town of El Encanto of the municipality of Tapachula in the state of Chiapas, Mexico. Population data indicate that the town has 1,726 inhabitants, of which 51.8% are men and 48.2% women, there are 446 dwellings that, according to their conditions, lack of property and deprivation of the inhabitants to education, the indicators of marginalization and social lag place the locality with the degree of marginalization "Very High" and the degree of social lag "Medium" [2], also, the recent estimates of the Human Development Index, which evaluates the health conditions, education and income of the population, places Chiapas in the last place throughout the country [3, 4].

El Encanto is a town that does not have basic water and domestic sanitation services, public lighting is deficient, its streets have no folder and lacks recreational spaces for family coexistence. Today, it is observed that the families of El Encanto are peasants, fishermen and low-income employees, living at constant risk to health, as a result of the pollution of the water they consume and the environment in general, due to the poor disposal of liquid and solid waste generated. Most of the houses are unsafe and unhealthy, built by the inhabitants with inadequate materials and technical processes, with high vulnerability in relation to the site where they are located, corresponding to the coast of Chiapas with the Pacific Ocean and in the region of greatest teluric activity existing throughout the country, so they are exposed to strong winds, hurricanes and seismic action. On the other hand, El Encanto is located in an area of estuaries and lagoon system with high ecological diversity, especially with extensive mangrove ecosystems, which are being affected by the domestic and economic activities of the inhabitants of the town and other nearby human settlements, since there are processes of environmental pollution and degradation of the original conditions in existing ecosystems, due to the inadequate management of the waste generated.

The analyses of the town of El Encanto were carried out with the application of the Model of evaluation of the conditions of rural housing and the environment [5], which, at first, focuses on the analysis of the current situation of the site, with information obtained through surveys, registration cards, etc., in order to identify and interpret the problems of housing and its immediate environment. The elements analyzed are the socio-economic situation of low-income families, the characteristics and conditions of the housing, as well as the water and sanitation services, the management of the waste generated, the health risks, the structural security of the house, the typological characteristics of the community, the materials of the place suitable for the construction of new houses Etc. In a second moment, the transformation process begins, which in this case, consists of the elaboration of prototypes of safe, economic and healthy housing, for the benefit of low-income families and in accordance with the environmental, socioeconomic and cultural conditions of the inhabitants. The typology, the application of ecotechnologies and the use of local materials with low environmental impact were considered in the prototypes. Proposals for habitat improvement in general were also developed in accordance with the physical and socio-cultural characteristics of the site. In general, the intervention proposals are aimed at improving the quality of life and well-being of people, as well as preserving the ecological design of the area. With this, it is intended to contribute to the development of the inhabitants of El Encanto and to the conservation of the environmental conditions of that region.

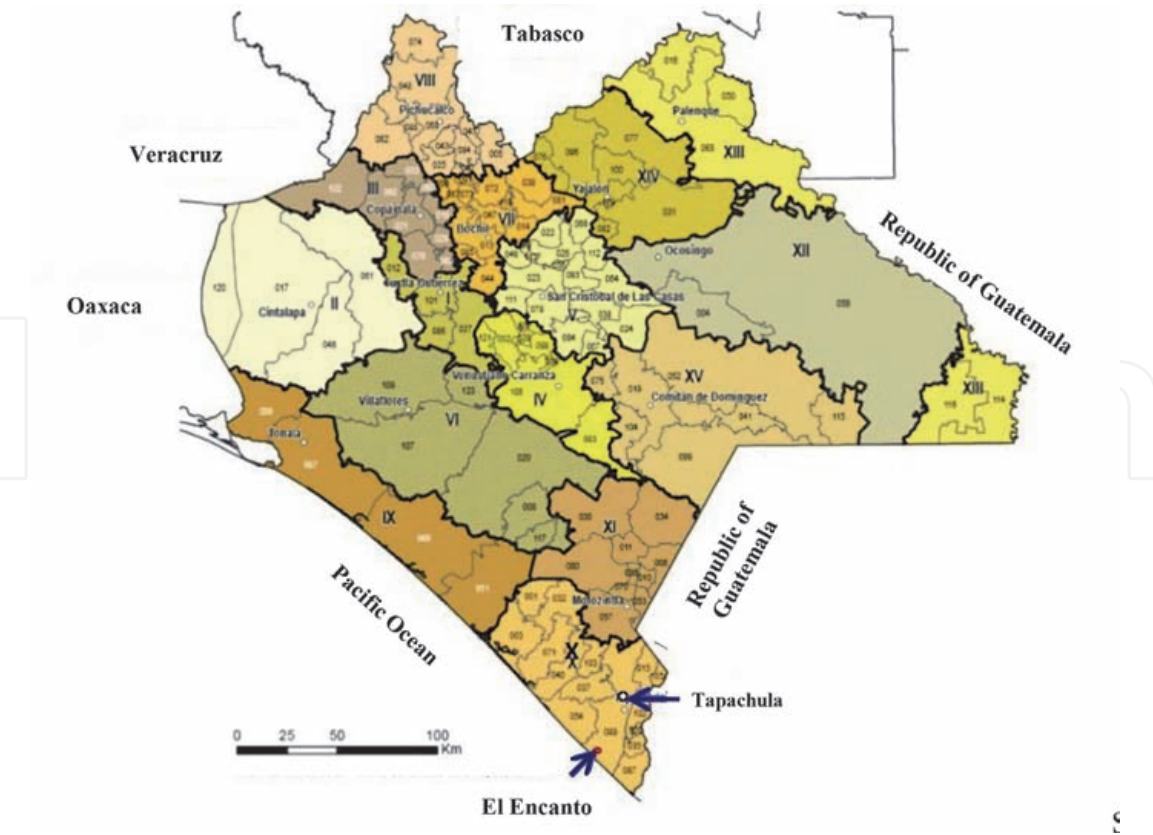


Figure 1.
Location of the “El Encanto”, Tapachula, Chiapas. Source: NISG [1].

2. Geographical location of the town El Encanto

El Encanto is part of the municipality of Tapachula de Córdova and Ordoñez, Chiapas, Mexico. It is located 392 km from the city of Tuxtla Gutiérrez, capital of Chiapas, by the road section Tuxtla Gutiérrez-Arriaga and then the stretch Arriaga, Tonalá, Pijijiapán until you reach the city of Tapachula. El Encanto is located 26.5 km from Tapachula by road to Puerto Madero and 2.9 km before reaching the town of Puerto Madero (see **Figure 1**).

3. Background

In January 2019, through one of the members of the team, Dr. Angel René Estrada, communication was established with Ms. Elena Matías Molina, representative of the El Encanto community, with the aim of expressing the interest of the team of academics and students of the Faculty of Architecture, Autonomous Universidad of Chiapas, to carry out research work and develop intervention proposals aimed at improving housing, sanitation, recreational spaces, for the benefit of the inhabitants. On that visit, the first approaches were made to the town, where the lack of basic water and sanitation services, the lack of public recreational and family coexistence spaces, streets without folder, and with little lighting were observed. Most of the homes are inhabited by low-income families and were built by them with the resources available and traditionally with organic materials such as cane, wood, palm, etc., others with conventional materials with cement-sand blocks or solid brick produced on site by the inhabitants, ceilings with galvanized sheet; also, precarious housings built with waste material, such as cardboard, sheets, etc. were identified. In general, it was observed that families live in unsafe and

unhealthy conditions, there is contamination of bodies of water due to poor disposal of wastewater, presence of excrement of domestic animals (dogs, hens, etc.) and poor disposition of the excreta of the inhabitants.

With the acceptance of the community, the team of collaborators of the Academic Body Urban Development of the Faculty of Architecture of the Autonomous University of Chiapas and the Academic Body Natural Risks and Geotechnology of the Academic Engineering Unit, Autonomous Universidad of Guerrero, created the research project: *Proposal to improve the habitat of the colony El Encanto of city Puerto Madero, Tapachula, Chiapas*. In August 2019, the project was approved and funded by the Institute of Science, Technology and Innovation of the Government of Chiapas and the Faculty of Architecture, which was carried out in the period: September 2, 2019 to January 31, 2020 [6].

4. Analysis of homes and their environment (habitat)

In the analysis of the conditions of the households of families, with low economic income, the Model of Assessment of the Conditions of Rural Housing and the Environment was applied [5], which includes surveys, registration cards and photographic report. The model proposes that initially the analysis of the current situation (zero time- “t₀”) should be carried out, *which consists in obtaining the information on site and determining the conditions of the dwellings and their housing environment*. The analyses include the socio-economic aspects of low-income families, the characteristics, conditions and basic services of housing, the management of the waste generated and the conditions of the natural environment, also, at this stage, the health risks, structural safety of housing, the typological characteristics of the community, the flora and fauna, the materials of the place with the possibility of being used in the construction of new homes are recognized.

On **Figure 2**, you can see that the town is located on the side of the Tapachula-Puerto Madero road. The study area is the town of El Encanto and the analysis unit is the houses. The analysis of the conditions of the houses and their surroundings was carried out from a random and representative sample of the homes of the community. In this regard, data were taken from the Population and Housing Count 2010, which, in the case of El Encanto, has a population of 1,726 inhabitants, 446 dwellings and an average of 3,86 inhabitants per dwelling [1].

The conditions and statistical arrangements taken for the sample size were as follows: a) The homes considered in the sample are those inhabited by low-income families, who receive less than \$102.68 national currency per day (5 dollars) or between \$102.68 and \$205.36 national currency per day (between 5 and 10 dollars), and b) The sample size was obtained with the following mathematical model [8].

$$n = \frac{n_0}{1 + \frac{n_0}{N}} \quad n_0 = P(1-P) \left[\frac{z(1-\frac{\alpha}{2})}{e} \right]^2 \quad (1)$$

Where:

z = Degree of reliability (95%, cumulative normal distribution value is 1.96).

N = Population size (446 dwellings).

Q = Probability of success (98%, as a family is considered to generate organic and inorganic waste and makes use of water to meet their biological needs).

q = Probability of failure (2%, since: q + P x 100%).

e = Experimental error allowed (may vary between 0.03 and 0.07; in this case it was taken 0.05).

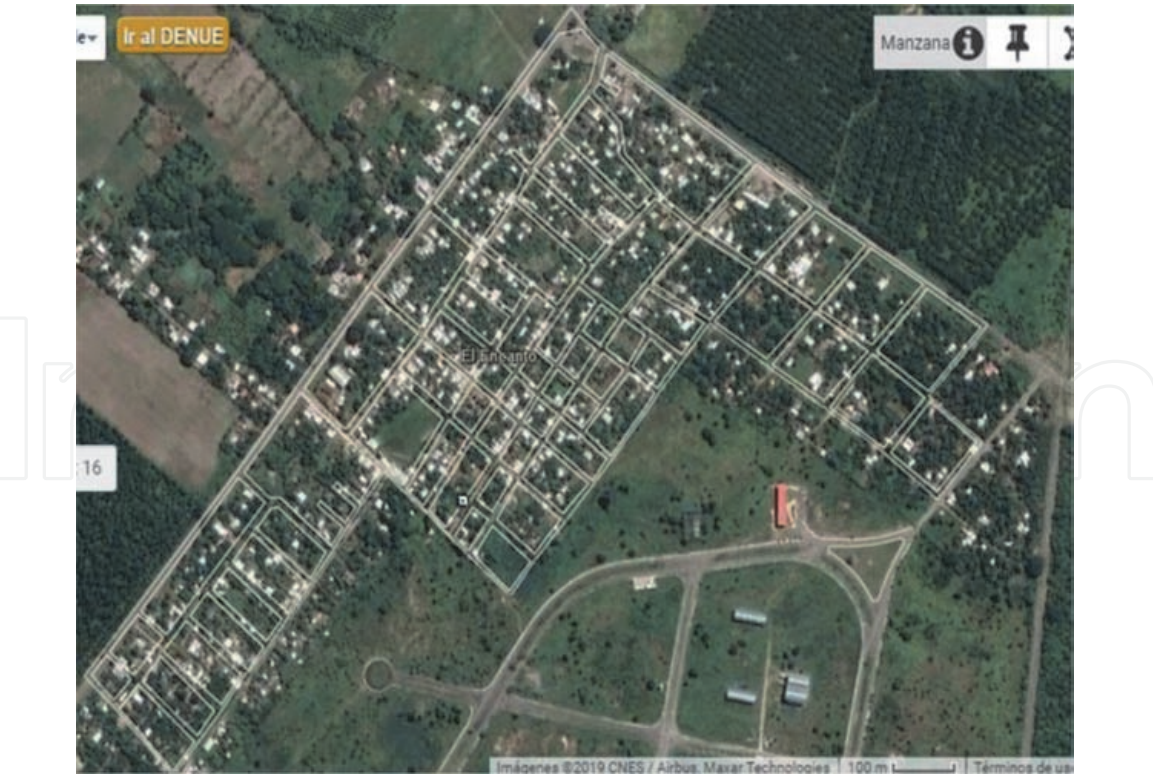


Figure 2.
El Encanto, Tapachula, Chiapas. Source: NISG [1, 7].

PR = Percent rejection (considered 10%).
n = Calculated sample size (28 dwellings, plus 10% rejection, therefore, the minimum sample is 31 dwellings. In this case 62 surveys were applied, which is equivalent to double calculated).
Fieldwork was carried out on 11 and 12 October 2019, as set out in the research project. At this stage, the participation of architecture students was held, to support in the activities of obtaining and analyzing information, and with this, the teaching is strengthened, based on the information obtained in the field, in a real context that will be useful in the application of exercises established in the bachelor's degree, in the subjects: Workshop of Construction Materials Zero Impact and Sustainable



Figure 3.
Student training.

Architecture. Subsequently, students also participate in the development of alternative housing proposals and public spaces. Before starting fieldwork, students were trained for the proper interpretation and recording of the required information, in accordance with site analysis tools, too, they were instructed to behave and address people with respect (see **Figures 3–6**).



Figure 4.
Group of students and teachers.



Figure 5.
On-site work team with locals.



Figure 6.
Students in interviews (surveys).

5. Results obtained

In the process of validation and systematization of the information obtained in the home surveys applied in El Encanto, 56 were validated that are well above 31 required, based on the model used, therefore the reliability of the information obtained was successful. The analysis of the surveys allowed to identify and interpret the situation of the houses and their immediate housing environment. Below are the results of the information obtained on site:

5.1 Socioeconomic records

Of the total homes surveyed, 76.8% responded that the head of the family is originally from Chiapas, 10.7% come from another state and 7.1% are foreigners. Regarding the time of residence, 37.5% mentioned that they have always lived in El Encanto, 41.10% have more than 10 years, 12.5% between 5 and 10 years and only 7.2% less than 5 years. This indicates that 78.6% of the inhabitants have 10 or more years of retaining residence in El Encanto, so the population is consolidated on the site.

The number of inhabitants per dwelling, 3.6% register a person, 16.1% 2 people, 26.8% 3 people, 16.1% 4 people, 14.3% 5 people, 8.9% 6 people, 3.6% 8 people, 1.8% 9 and 1.8% 15 people; 12.5% are enabled by 2 families, 1.8% by 3 and 1.8% by 4. The religion they profess, 39.3% are Catholic, 10.7% Jehovah's Witnesses, 37.6% other Christian religion and 12.5% are atheists. The marital relationship, 39.3% are married, 32.1% in free union, 10.7% divorced, 10.7% widowed and 3.6% single.

There are 55.38% women and 44.62% men. The ages of the inhabitants: 28.72% are under the age of 15, 23.08% from 15 to 29 years old, 26.67% from 30 to 49 years old, 11.28% from 50 to 59 years old and 16.26% register 60 years or older. According to the ages, there is a population decrease of 20 to 29 years, representing 12.82%, possibly due to the change of residence to other places for work reasons. Of the total number of over-14 s, 20.87% are illiterate and, of the inhabitants with studies, more than 30% have primary, 35% secondary, 18.5% high school and 2.9% have professional studies.

With regard to work activities, aged 14 years or older, 80% of people work and, of this, 30% receive less than a minimum wage (MW), 60% between 1 to 2 MW and 10% more than one MW. On average they have income of 1.43 MW, which, in monetary terms, in 2019 was equivalent to \$102.68 national currency per day [9], which is equivalent to approximately 5 dollars. On the other hand, most work in activities in the primary sector: fishermen, barkers, day laborers, etc., with the following working conditions; 32.91% temporary, 22.78% per contract, 39.24% definitive and 5.06% are working on their own. For the purposes of the project, the production and marketing of cooked clay partitions by some inhabitants is highlighted. In relation to income with the monthly expenses made by families, they minimally manage to meet their basic food needs and with extreme limitations address the other aspects such as clothing, housing, health, transportation, etc. Access to consumer goods, linked to people's lifestyles, it is an important aspect that encourages and protects health habits; however, the acquisition of consumer goods is conditioned on the economic capacity of families, in this sense, the results show that 62.5% of homes have refrigerators, 58.9% have blenders, 33.9% have washing machine, 53.6% television and 37.5% radio transistor.

Another important aspect was the legal possession of the property where they live, since the possession of the land offers certainty, security and reduces the tension of the inhabitants with respect to the housing heritage. In this sense, 89.3% own homes, 5.4% lend and 1.8% rent.

5.2 Housing conditions (physical-spatial)

Data record that, housing is inhabited 4.06 people, average. This figure suggests that housing proposals will consider at least 2 bedrooms with the right space to accommodate 2 people per bedroom. Also, the adequacy for a future increase in the number of inhabitants will have to be considered, as 30.4% of the dwellings are inhabited by more than 5 people, which suggests a possible future spatial growth of housing. In relation to the surface, the land is flat with soil type at the site: 71.4% the houses are found on clay, 23.2% on sand and 5.4% on rocky material. The housing floor, 32.1% in floor of soil, shows precarious condition of habitat, 46.4% has concrete, 17.9% polished concrete and 1.8% have mosaic coating (see **Figures 7 and 8**).

In the various types of roofs of the homes analyzed, more than 50% use galvanized sheet, 35.7% use local palm and 3.6% sheet of cardboard considered as precariousness. It is important to note the use of galvanized sheet, due to the low cost of acquisition and maintenance, however, do not have any additional elements that decrease the implications of this material, related to the high temperatures generated in the heat season, which make uninhabitable the spaces built with this type of roof (see **Figures 9–12**).



Figure 7.
Walls and roofs in housing.



Figure 8.
Wooden walls and palm-sheet cover.



Figure 9.
Concrete block walls.



Figure 10.
Galvanized sheet roof.



Figure 11.
Housing; foil walls and palm roof.

Figure 13 shows the existing conditions inside the dwellings. Spatial fragility, overcrowding, disorder, precariousness, etc., which disturbs people’s well-being are observed. Also, it was observed that only 48.3% of the dwellings have some structural confinement, essentially the construction with bricks or blocks of cement-sand, however, only 26.8% of the dwellings have adequate confinement vertical and horizontal, in the rest of the houses the structural confinement is insufficient and inadequate, which represents a situation of risk and vulnerability structural.



Figure 12.
Housing; cane walls and palm roof.



Figure 13.
Housing interiors; stay, bedroom, kitchen-eat.

Regarding the conditions of the structure, 48.2% of the houses have problems: 21.4% register cracks in walls, 7.2% in doors and windows. The causes are diverse: incorrect construction procedures, lack of structural reinforcement, etc., in addition, there is damage to the wooden structure used in the ceilings, 35.7% of the roof have deterioration and structural damage: 19.6% with rotting woods and 10.7% with fractured woods.

5.3 Immediate environment conditions

El Encanto is located in a region of high ecological diversity, in this sense, 89.3% of the houses have fruit trees planted in the surrounding areas with their property; However, only 60.7% of families are careful to maintain vegetation and control organic waste generated in the yard (see **Figures 14** and **15**).

The waste generated, liquids, solid or gaseous, product of daily domestic activities, only 55.4% of the inhabitants have some control, however, 51.8% present health risks to the health at the poor disposal of the water used in body grooming,



Figure 14.
Abundant vegetation on the property.



Figure 15.
Cleaning the property and burning waste.

washing of waste and clothing, in addition, it was identified that 3.6% burns organic solid waste: branches and leaves of trees of the property.

Of the total dwellings, 69.60% register having animals for consumption or trade: 57.1% have poultry and 12.5% they have goats. That aggravates the situation of mismanagement of organic waste, basically the droppings of animals generated, which directly harm the health of people. Others have pets; 60.7% have dogs and 17.9% cats (see **Figures 16 and 17**).



Figure 16.
Liquid waste accumulated on the site.



Figure 17.
Bird corral for self-consumption and sale.

The town has no sanitary sewerage network, 85.8% have makeshift sheds with toilet furniture and use water for the eviction of excreta, which is transported to and deposited in a poorly constructed septic tank that contaminates the body of underground water, 17.9% use common latrines, 1.8% defecate outdoors and, the rest, did not specify (see **Figures 18 and 19**).

The materials used in the construction of toilet sheds and latrines are very varied, 26.8% have concrete signature, 3.6% polished concrete, 10.7% use blocks, 5.4% waste material and 12.5% nothing. The walls and ceilings are precarious as seen in the figures. In terms of quality of service, all do not meet minimum sanitary conditions: 92.8% have no lid or seat, odors are perceived, discharges of excreta pollute groundwater level (depth of 3 to 4 m) due to filtration, latrine shed conditions or toilets are improvised, poor quality and unsafe (see **Figure 18**).

For body grooming, most have improvised and fragile sheds, as shown in **Figures 16 and 19**. The waste water, deposited in the yard, accumulates and that causes an unhealthy environment with bad odor, attracts the harmful fauna that puts at risk the health of the inhabitants.

Water is obtained by the inhabitants, to meet basic needs, through artesian wells, some have square protection, but the generality is circular (see **Figure 20**). The material used for protection is bricks of cooked clay settled with lime mortar or cement-sand. The water, the inhabitants store in plastic container; however, there are houses, the least, that have tanks built with bricks masonry, as shown in **Figures 21 and 22**.



Figure 18.
Toilet and septic tank.



Figure 19.
Bathroom area.



Figure 20.
Types of artisan wells for water extraction.

In relation to cooking food, all homes use handcrafted stoves, which consume significant amounts of firewood. The characteristics of the stoves are very diverse, as shown in **Figures 23 and 24**, observing energy inefficiency, high consumption of firewood, exposure and contact of the inhabitants to smoke emissions (CO, CO₂, others), which affect the health, well-being and quality of life of people.

5.4 Urban structure (urban services)

Although El Encanto has full electricity coverage, only 76.8% of the homes surveyed are connected to the electricity grid. Only 26.8% of homes have street lighting. Previously, it is established that the town has no water or sanitary drainage, however, at the time of field work, the construction of the well, treatment, storage and distribution of drinking water, covering the total area of the town, had been completed. Today (2021), the inhabitants do not yet receive drinking water,



Figure 21.
Water storage in plastic container.



Figure 22.
Storage tank features.

due to an administrative and operating problem by the municipality of Tapachula, Chiapas.

5.5 Health services

There is no basic health unit in the locality to care for illnesses or receive first aid from doctors, a consequence of any ailment or injury caused by a work or domestic accident. In this regard, the information obtained in the surveys indicates that, 73.2% of the inhabitants of the dwellings have health service, through the “People’s Insurance”, which this year (2020) became the Institute of Health for Welfare. On



Figure 23.
Food processing stove.



Figure 24.
Type of stove precariously built.

the other hand, 8.9% have IMSS, 5.4% ISSSTE and 10.7% without the right to a public service. Common diseases suffered by the inhabitants: 51.8% flu, 14.3% diarrhea, 10.7% cough, 5.4% dengue, 3.6% parasite and 3.6% hypertension.

Health institutions where residents receive medical care for illness, despite the fact that most have public health services, 41.1% of users say they go with private doctors and others; 28.6% to the SSA, 7.1% to IMSS, 1.8% to ISSSTE. The sites to which they travel for medical care, 60.7% head to Puerto Madero, to 2.9 km, and 35.7% to the city of Tapachula at 26.5 km.

5.6 Road and transport

The streets of the town are reticular with anchovies of 7.0 m and bounded by some fences and trees planted by the inhabitants who define its properties. The

streets have no cladding, except for a small section in the main access of El Encanto. This problem causes the soil to soften in the rainy season and prevent people and vehicles from circulating (see **Figures 25** and **26**).

5.7 Solid waste collection

The solid waste collection service is done through a collection vehicle of the town hall of Tapachula, which makes a route of 26.5 km from Tapachula plus 6 km where the municipal dump is located, near the town of Viva Mexico, which means that routes of 65 km are made. The service is only performed on Wednesdays of each week, due to the low amount of waste and high operating costs, in addition, the service is limited to the streets of the main and central access, so, the inhabitants move their waste to the collection points. For this reason, it causes the inhabitants to continue the practices of burning garbage.



Figure 25.
Street without coating.



Figure 26.
Fences of property borders.

5.8 Community equipment or public spaces

During the field work, the facilities of the only public spaces that exist in the town were also inspected, which correspond to the Preprimaria and Primary schools (see **Figures 27** and **28**), which is located one side of the Tapachula - Puerto Madero road and in the main access street to the town.

In pre-primary and primary schools, it is noted that all classroom buildings where classes are taught require urgent basic maintenance: cleaning and painting in general, installation of new luminaires and electrical installations, construction of toilets for children, construction of new classrooms, kitchen construction for the production of school breakfasts, in addition, there is an opinion on civil protection, which prohibit the use of one of the classrooms of the pre-primary school, due to the severe damage that the structure has, a consequence of the sism that occurred on September 7, 2019, and since then has not been repaired, so the old kitchen for the preparation of children’s school breakfasts was adapted as a classroom.



Figure 27.
El Encanto pre-primary school.



Figure 28.
El Encanto primary school.

5.9 Problems identified by the inhabitants

The inhabitants surveyed are asked what are the problems of the services that the locality has? 44.6% manifest the lack of security, 39% the accumulation of garbage (solid waste), because the collection takes place only on Wednesdays and 7.1% that there are problems in transport, since the medium used is the tricycle adapted with a motorcycle and when transiting on the road is unsafe.

When asking the inhabitants what are the problems of public spaces? 55.4% believe that the absence of a health unit to receive emergency medical services, 28.6% believe that it is missing in high school, since children move to Puerto Madero, 2.9 km from El Encanto, by a path located next to the road, representing a constant risk and 7.1% say that a local market is missing.

In relation to the question of what are the problems that have been done in the service infrastructure? 25% of the inhabitants pointed out that the problem is paving, since currently the streets, with the exception of a small section of the main access, have no cladding, are only plotted at ground level, and, in rainy times, the soil softens and are impassable. With an almost similar percentage, 23.2% say that the main problem is the absence of the drinking water supply network, which is already solved with home intakes located on the premises, however, to date they do not yet receive drinking water service. On the other hand, 17.9% of the inhabitants pointed out that the absence of health drainage is a health problem to be addressed, 612.5% say that street lighting is the main problem to be addressed, as it is related to the safety of people, and 10.7% who do not have electricity means a problem for them.

Finally, he wondered what other problems were considered important in the town? 55.4% have employment problems, and 5.4% of them have economic problems, 16.1% are manifested in land or property tenure and 1.8% report food problems.

5.10 Construction materials identified at the site

The materials identified in the locality and in the region for use in the construction of both the homes and the proposed community spaces, are as follows: sand to make cement-sand mortar to glue solid bricks of cooked clay and other masonry structures, river stone used in the concrete of cyclopean processing in foundation,



Figure 29.
Cooked clay bricks.



Figure 30.
Type of handcraft oven used on site.

concrete with crushed river stone, coconut palm stem wood used in roof structures, cane (bamboo) used in walls and roof structures, etc.

The bricks are made by locals with local clay, cooked in handcrafted ovens (see **Figures 29** and **30**). A sample of solid clay bricks parts was analyzed in the Materials Laboratory of the Faculty of Architecture and obtained an average compressive resistance of 9.31 MPa (93.10 kg/cm²), which complies with the Complementary Technical Standards [10], however, the furnaces will be improved for greater heat efficiency, lower consumption of firewood and adequate control of emissions during production.

6. Proposals for a solution: alternative housing and community equipment

The realization of the diagnosis of the habitat of El Encanto and the results obtained were fundamental to the elaboration of the proposals of alternative housing and community equipment. The characteristics of the houses, their identity values, materials, habitability, form, function, structure and construction systems, structural quality, sanitation in general and environmental components, were essential for the design of the prototypes. From the above, the traditional elements, the functional spaces of the house are defined: bedrooms, stay, kitchen, sanitary service, etc., in addition to the construction of the elements with the use of local materials and others with low environmental impact, the application of ecotechnologies according to the traditions of the inhabitants, the type and environmental conditions. The housing proposals were created with the idea that the inhabitants have the possibility of self-construction, with the technical assistance of a facilitator (an academic, technician or student of engineering or architecture). Also, to make them structurally safe, economical and healthy and for the benefit of low-income families. Similarly, the characteristics of the community equipment proposals were prepared in accordance with the socio-economic conditions and environmental of the site. In this sense and based on the diagnosis, proposals for community equipment for health, art and culture services, recreational, were designed, in addition to the improvement of trails of El Encanto, essentially in the sections of interconnection with public spaces.

6.1 Considerations for the development of alternative housing and its surroundings

In the process of drawing up the proposals, the different aspects and conditions identified in the homes and environment are contemplated. The criteria and guidelines adopted for the design and construction proposals for community housing and equipment are then related.

A. Alternative housing proposal (physical space):

- a. Respect for traditional identity, culture and activities.
- b. Use of local materials, low environmental impact and characterizing the site, harmony with the context.
- c. Creation of open spaces for estufas, corridors and hammocks.
- d. Balance of door and window with solid walls, also unify heights.
- e. Housing access hierarchy.
- f. Facades of houses with a focus on neo-vernacular architecture, with garden in front that offers transparency and shade for the circulation of passers-by.
- g. Use of colors that match the context and make the locality an identity.
- h. The principles of housing hygiene and access to an adequate housing environment, according to the World Health Organization [11] and the Sustainable Development Goals of the United Nations Development Programme [3, 4] will be addressed.

In the area of housing (construction):

- a. Maximum construction area 36 m², includes: stay and 2 bedrooms.
- b. Two-water cover with galvanized sheet with thermal insulator, preferably organic.
- c. Use ecotechnologies for eco-friendly stove construction with greater heat efficiency, reduced firewood consumption and gas emission control.
- d. Electric network with lower power consumption luminaires.
- e. Construction of a 60 cm high platform for the housing floor, with the aim of reducing the risks and vulnerability caused by heavy rains or hurricanes.¹
- f. Consideration of the housing growth area (from 2 to 3 bedrooms).

In the area adjacent to housing, the yard (construction):

¹ During the heavy rains that occurred on October 4, 2005, by Hurricane Stan, which caused river overflows and bridge collapses off the coast of Chiapas, Mexico, the inhabitants of El Encanto comment that the water was drained in the form of a 50 cm sheet over the surface and swept everything, until it reached the Pacific Ocean, in Puerto Madero, Chiapas.

- a. Body grooming área.
- b. Area of washing clothes and kitchen utensils.
- c. Water storage tank.
- d. Dry latrine of one or two chambers at the boundaries of the property.
- e. Consideration of the area for the rearing of animals (hens) and control of animal excreta.
- f. Control of wastewater generated by domestic activities: washing clothes, body grooming, etc., a starting of wetland construction.

Materials used in construction:

- a. Use of site materials. Inorganic materials: stone, sand, clay, etc. Organic materials: coconut palm stem, cane, coconut shell, etc.
- b. Use of solid bricks of cooked clay produced by inhabitants of El Encanto, with oven modified for mayor heat efficiency and lower consumption of firewood.

B. Proposal for Community equipment and streets improvement.

- a. The socio-economic characteristics of the site, existing environmental conditions, use of site materials, application of ecotechnologies, etc. overflows shall be considered.
- b. It is proposed to set up a health unit for urgent medical care.
- c. For recreation and family coexistence, it is proposed to develop a unity of art and culture, a multi-purpose sports court in the open space for the practice of: fast football, volleyball, basketball and inclusion of children's games.
- d. Hierarchy of streets for a better distribution of the town, it is proposed to create a public streets circuit with coating, which interconnects the community equipment proposed, improves the circulation in rainy season of both pedestrians and used vehicles.
- e. Urban furniture is required: Chairs, trash cans, lighting, etc., as well as the implementation of an efficient garbage collection system.
- f. In existing, pre-primary and primary educational facilities, a maintenance and construction programme for health services and school canteens should be implemented.

6.2 Proposal-making process

The housing proposals and public spaces were developed with the participation of students of the Faculty of Architecture, with the advice and direction of the academics of the working group (see **Figures 31** and **32**).



Figure 31.
Academic advice to students.



Figure 32.
Review of housing proposals.

6.3 Alternative housing 1

5 alternative homes of 36 m² of construction are proposed, which includes 2 bedrooms (3x3m each), living areas, dining room and kitchen (see **Figures 33–38**). Foundation: stone and concrete masonry of 15 MPa (150 kg/cm²) and section: width 50 cm, depth 50 cm and floor height 60 cm. Walls: solid clay brick masonry, section: 7x14x28cm, made *in situ*, reinforced with vertical and horizontal concrete elements of 15 Mpa (150 kg/cm²), reinforced with steel. Vertical elements are placed at the intersections of walls and on the sides of doors or windows, with section: 15x15cm; the horizontal elements or dalas, with section: 15x25cm, are placed at the height of 2.00 m of doors and windows and on the crest of 3.40 m height. All reinforced concrete elements shall have: 4 rods of 3/8", además de 1/4" stirrups @15 cm. Ceiling: coconut palm stem structure that supports thermal insulation made with organic layer of otate rod, soil mixture with coconut shell and Covered with galvanized sheet. In the patio will be located: bathroom, water storage tank, laundry room of kitchen utensils and hands, in addition, the dry latrine

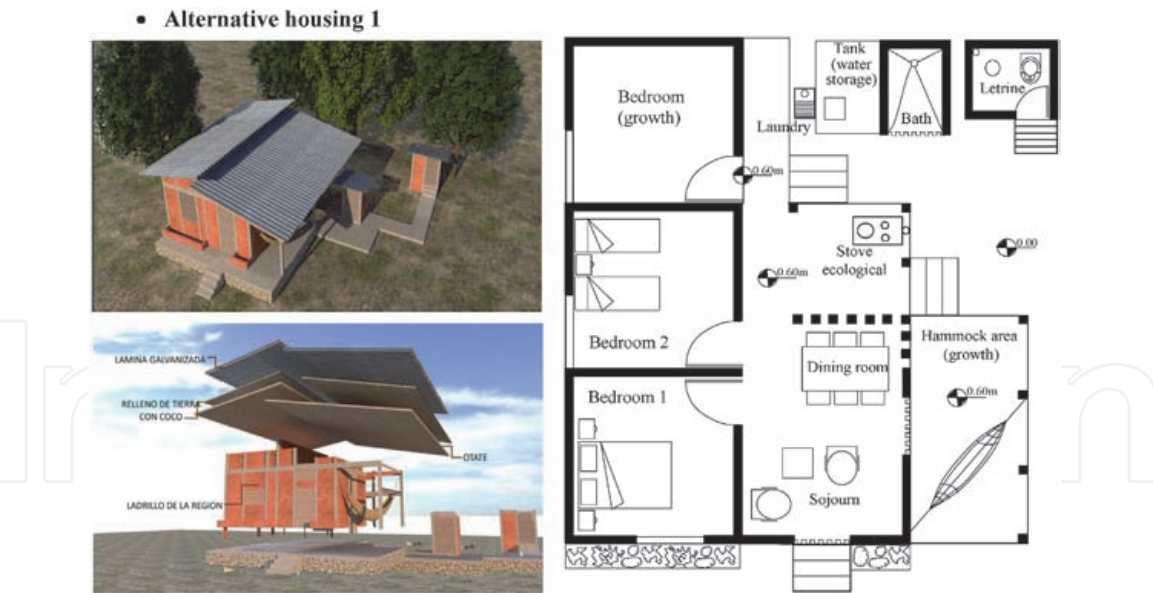


Figure 33.
Alternative housing 1, architectural plant.



Figure 34.
Facade alternative housing 2.



Figure 35.
Facade alternative housing 3.



Figure 36.
Facade alternative housing 4.



Figure 37.
Facade alternative housing 5.

(double chamber), with height of 90 cm from the floor for maintenance. In addition, future growth is considered: a fourth bedroom and the rest area (hamacas).

6.4 Community public spaces

In the streets proposal for the interconnection of public spaces, is proposed a height of 0.60 m above the ground. The coating with river stone joined with mortar and walkers with blocks.

The public spaces service proposed are: Health Unit, Center for Art and Culture, Multi-Purpose Sports Court and Children’s Games (see **Figures 39–44**). **Figure 40** shows the location of real estate and the improvement of the road of interconnection of real estate.

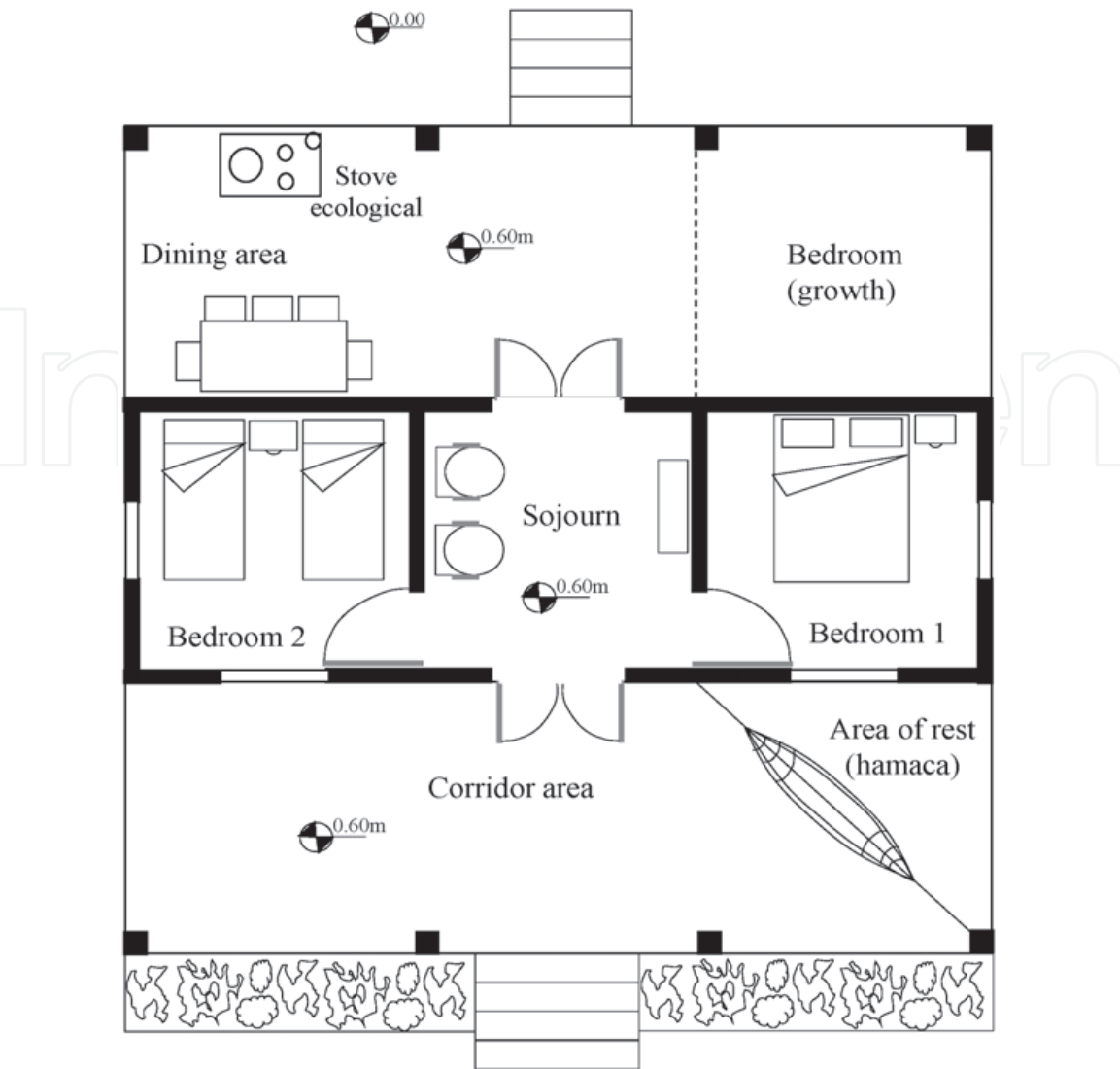


Figure 38.
Alternative housing 4, architectural plant.

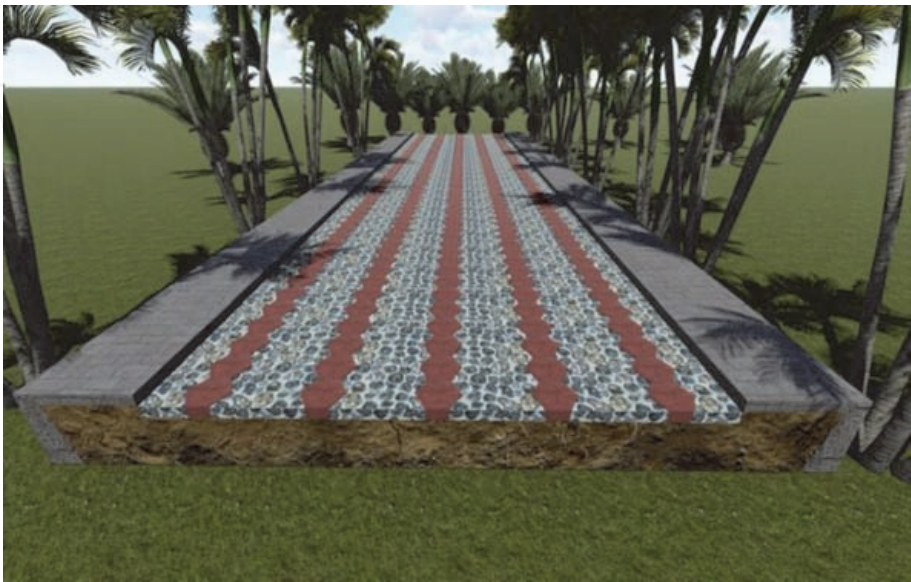


Figure 39.
Improving the streets.



Figure 40.
Location of community public spaces.



Figure 41.
Health unit.

6.5 Process of conciling proposals with the community

On 5 December 2019, a working meeting was organized in El Encanto to present housing proposals and community equipment. Ms. Elena Matías Medina, the town’s representative, and locals participated. The characteristics of the proposals are detailed with graphic information posters and models of the houses prepared by students and academics of architecture: Health Unit, Center of Art and Culture, Multi-purpose sports court and Children’s Games. The objective of the meeting was to know the opinion of the inhabitants and to specify the characteristics of the roofs, sanitation, etc. (see **Figures 45 and 46**).



Figure 42.
Center for art and culture.



Figure 43.
Multi-purpose sports court.



Figure 44.
Children's games.



Figure 45.
Proposals submitted to the inhabitants.



Figure 46.
Analysis of houses models.

7. Conclusions

The houses and community equipment presented for the village of El Encanto, Tapachula, Chiapas, were elaborated based on the environmental conditions and socioeconomic aspects of the inhabitants. It respected the typology, the domestic customs, the use of building materials of the place, tales such as: sand, river stone, coconut palm stem wood, cane, clay for the elaboration on the site of cooked bricks. In addition, the use of ecotechnologies, ecological stoves, water and sanitation services, covered with galvanized sheet and organic thermal insulation, etc. was implemented. The site's analyses and results, obtained by the team, are essential to the design of the proposals: structurally safe, economical and healthy.

The project, in its various stages, constituted a pedagogical exercise framed in a vision of architecture as an academic discipline, committed to improving the living conditions of the low-income population and environmental conservation. In this sense, the design of the house and habitat is the product of the interaction between academics and the inhabitants of the town. The design of the house and habitat is the product of the interaction between the academics and the inhabitants of the

town. In this case, the main conditions have been the economic and social precariousness of the inhabitants of El Encanto and the physical environment, such as the zero slope of the terrain, the situation of vulnerability to the events of nature such as rains, cyclones and tsunamis; are challenges for architecture professionals. In this work, the teaching of architecture is included with practical exercises in real situations, aimed at improving the quality of life and well-being of poor families.

Undoubtedly, social participation at all stages of the project brings not only empirical knowledge, but also helps to ensure the social appropriation of the products contributed by the project, such as an valuing the knowledge and changes generated by them. Faced with a situation such as the current one, the use of local materials and the experience of the inhabitants in the production of cooked clay bricks, constitutes a low environmental impact solution for the construction of new housing.

With regard to urban facilities, since they have to comply with official standards, in the case of schools or health centres, the experience of the inhabitants in participating collectively in the design of their homes provide a good starting point to consolidate a community organization that allows them to successfully manage before the relevant authorities, the resources for such equipment.

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