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Methodological Strategies for the Reconstruction and Sustainable Improvement of the Habitat of Localities in the State of Chiapas, Mexico

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Abstract

The dispersal of the population of the state of Chiapas with about 20 thousand small towns with less than 2,500 inhabitants and the orography of the territory, characterized by mountains, highlands, depressions, plains and coasts, are factors that limit the access of these localities to the basic services of water and sanitation, health, education, culture, recreation, communication, etc. Families living in small communities are essentially peasants and indigenous people with low economic incomes and, for this reason, have precarious, unsafe and unhealthy housing, without basic water and drainage services, among others. In the search for solutions to address this problem, the work team of the Academic Body Urban Development of the Autonomous University of Chiapas, has carried out research oriented towards the reconstruction and improvement of housing and its environment (habitat), in Nuevo San Juan Chamula, Zinacantán, Ocuilapa de Juárez, Chiapa de Corzo, El Encanto, among other communities, through the application of a methodological process that has allowed the analysis of problems and the elaboration of proposals safe, affordable, healthy and sustainable housing, considering the typology, culture of peoples and environmental conditions, based on the use of ecotechnologies and materials of the place, with low environmental impact.

Index terms— housing, security, sanitation, materials, typology, environment

1 Introduction

n Mexico, rural towns are characterized by small population groups, which are essentially peasants and indigenous people, who are associated with their natural environment. Communities are generally located in isolated territories and away from population centres with the greatest social and economic development. In rural areas, mostly, families are low-income and because of this condition they have long lived with deficiencies of all kinds. The houses they own are of poor quality, unsafe, built by them with materials obtained from nature such as wood, stone, earth, palm, carrizo, bamboo, etc.; some build their homes with lowcost industrialized materials, such as metal or cardboard sheets; others use waste materials: cardboard, plastic or metal sheets. In these places, unhealthiness prevails, in part, because water and drainage services are inadequate and, in some cases, do not exist, which limits personal hygiene; also, as a result of the mis management of solid and liquid waste generated inside the house and in the immediate environment, processes of decomposition of organic matter and pollution are generated, which attracts harmful fauna and proliferates the reproduction of vectors carrying different diseases, which is undoubtedly one of the main risk factors in the health of the inhabitants.

With regard to the degree of marginalization, which relates the deprivation of the inhabitants to The state of Chiapas registered in 2015 (INEGI), a total of 5,217,908 inhabitants and it was recognized that 49% of the

population is urban and 51% rural, with a total of 1,238,565 homes, of which 23.1% do not have a kitchen, 10.7% in floor of soil, 3.3% do not have sanitary furniture, 42.8% use firewood for food processing, 38.6% have poor garbage management and 2.3% are without electricity **??**INEGI, 2015). On the other hand, the National Council for the Evaluation of Social Development Policy **??**CONEVAL, 2015 and2018), indicates that in housing, 0.8% of ceilings and 4.6% of the walls are built with precarious materials, and in 13.5% cases live in overcrowding, 57.1% lack access to basic services and 23.6% have poor quality housing spaces; of the total population, 22.3% lack access to food, 83.6% to social security, 17.6% to health services, 29.2% have educational lag and 78.9% have incomes below the poverty line by income and 50.7% income below the extreme poverty line by income. The above images place Chiapas nationally in the last places in social lag.

In this context, the search for solutions that contribute to increase the quality of life and well-being of low-income families has been one of the main purposes of the Academic Body Urban Development (CADU), constituted by professors-researchers of the Faculty of Architecture of the Autonomous University of Chiapas (UNACH). The research carried out by the team, with the collaboration of students from the UNACH Faculty of Architecture and researchers from faculties and centers of other institutions, has been oriented towards the reconstruction and improvement of the habitat of rural and urban communities, mainly in the social sectors with low incomes.

At first, a site analysis is carried out, which allows the identification and interpretation of the problem of the house and its environment, as well as the characteristics of the place of study; a situational diagnosis is then developed which, at a second moment, is the basis for the elaboration and development of alternative housing proposals, safe, economic and healthy, sustainable with the environmental, socioeconomic and cultural conditions of the inhabitants, built with the use of materials of the region, environmentally friendly, and respecting the typology of the place, culture and customs of the inhabitants. In this work, the methodological strategies applied in the processes of the research carried out by the team in the state of Chiapas, in the localities are presented: Nuevo San Juan Chamula, Zinacantán, Ocuilapa de Juárez, Chiapa de Corzo and El Encanto.

2 II.

3 Methodological Process

The research activities carried out by the team (CADU-UNACH), they are often linked to teaching, according to the subjects taught in architecture, such as: "Natural Habitat Environment", "Research Methods and Techniques", "Material Laboratory Workshop", "Zero Impact Building Materials Workshop", "Urban Planning", "Urban Design Workshop", "Sustainable Architecture", "Topography". The purpose is to strengthen the teaching-learning processes, with the use of information obtained in a real context, for the realization of analyses, exercises or practices established in the analytical programs of the subjects; that is, reality is analyzed in the classroom and, with this, students are directly involved in the development of research activities, specifically in the survey and analysis of information, and subsequently in the elaboration of solution proposals.

The analysis of the reality of case studies begins with the identification and interpretation of the problem of housing and its environment (site diagnosis) and, based on the information obtained on site, the proposals for habitat reconstruction and improvement are developed. The process of obtaining and analyzing the information is carried out with the Model for the Assessment of rural housing conditions and the environment (MECVE) (Escamirosa, 2015), which allows to evaluate in a comprehensive way, the possible causes and risk factors to the health of the inhabitants of the rural environment, related to the conditions of the house they inhabit and their immediate environment. The analyses will consider the housing, the use and consumption of water and the management of organic and inorganic waste generated, in addition to the interactions that exist between these elements and the environmental conditions: biotics and abiotics of the housing environment.

The MECVE analyses 5 dimensions: a) Socioeconomic aspects, b) Physical-spatial (housing), c) Basic water services and disposition of excreta, d) Management of liquid, solid and gaseous waste, and, e) Environmental components (biotics and abiotics); These dimensions are also interrelated with: (f) Family Member Health and (g) Environmental Environment. The specific time at which the information is surveyed is identified as "zero time (t 0)". With the analysis of the situation in the case of study, the diagnosis of the house and its environment is integrated (see image 1).

The assessment of habitat problems and risk factors is based on the variables determined in the model, which allows to measure the negative effects on human health, based on the indicators and quality education, conditions of their housing and lack of property, according to the estimates made by the National Population Council, in 2010, the Entity occupied the first national place, with degrees of marginalization, Very high and high, at 67% of the total population (CONAPO, 2012); also, the recent estimates of the Human Development Index, which assesses the health conditions, education and incomes of the population, place the state of Chiapas in the last place throughout the country, below the states of Oaxaca and Guerrero (UNDP/UN, 2015).

On the other hand, it is well known that in the territory of Chiapas there is a vast variety of landscapes and diversity of species and ecosystems, the result of the different soils, climate and orography it possesses, the latter characterized by mountains, highlands, depressions, plains and coasts; Also, Chiapas is recognized as one of the most culturally rich entities in the country, the birthplace of indigenous ethnic groups such as tsotsiles, tseltales, zoques, lacandones, mames, tojolabales, among others, which have resulted in an extraordinary

variety and number of peoples, which according to INEGI there are more than 20 thousand localities, of which, 99% have fewer than 2,500 inhabitants, 85% less than 250 and of these, 74% have fewer than 100 inhabitants **??**INEGI, 2010); in this sense, the dispersion of the population of the Entity and the existing orography, are factors that limit access to localities to basic water and sanitation services, health, education, culture, recreation, communication, etc. ranges established according to the basic principles of sanitation and sustainability for habitat improvement; also, the model establishes the analysis tools (surveys, registration cards, etc.), necessary to carry out the information survey on site.

Image 1 shows that the model raises 3 phases operation and analysis: input, processes and output. In the "entry phase", the diagnosis of the site is obtained at "zero time (t 0)", and based on it, the conditions of the house and the environment are evaluated and the transformations to be made are recognized. In the second phase, processes, corresponds to the "habitat reconstruction phase", where the control and monitoring of the transformations that have been executed is considered, from a re-evaluation of the 5 dimensions in atime other than "t 0 ", so this moment is defined as "time one (t 1)". These evaluations are carried out according to the indicators and quality ranges, and are carried out as many times as necessary in different times: "t 1 ", "t 2 ", "t 3 "..."t n ", until achieving the established quality of a "healthy rural housing", which corresponds to the last phase of the model, called "exit phase". At this final stage, families are guaranteed to live in a healthy, safe and sustainable environment over time; however, further assessments confirming that this condition is maintained will be required.

MECVE is a tool that guides the realization of healthy rural housing (RSV), which aims to keep its inhabitants in a healthy environment over time, without pathogenic germs and thereby avoid possible communicable diseases; in addition, it helps to reduce risk factors to the detriment of human health, so RSV will help family social development, addressing the biological, social and psychological needs of people by minimizing tensions with the internal environment of housing and the immediate environment to it.

4 Source: Escamirosa, 2015 Image 1: Condition assessment model rural housing and the environment (MECVE) a) Site diagnosis

The site is studied in 2 stages: Stage 1. Initial work. It refers to work to be carried out, which consists of obtaining and analyzing the largest amount of information from the study area, available from official sources, government units, research work of the site, etc., related to the 5 dimensions posed with the MECVE; also, we proceed to design those instruments of analysis, which does not consider the model and are necessary to identify and interpret the additional information required for the elaboration of the intervention proposals, such as: the characterization of the elements of the urban image, typology and materials used of the place, as well as guided interviews aimed at

5 Initiation of habitat reconstruction and improvement

Habitat improvement assessment and control "zero time (t 0)" "time n (t n)"

In times: "t 1 ", "t 2 ", "t 3 "...

In times: "t 1 ", "t 2 ", "t 3 "... notable people or key informants, representatives of the inhabitants of the place, among others. All instruments shall collect information exhaustively from the primary source on site, since the accuracy and variety of the records obtained avoids more than one field work exercise, which corresponds to stage 2 of the site study, thereby streamlining the available resources for that purpose. Stage 2. Fieldwork: It consists of approaching reality, where observation becomes a fundamental exercise; on the one hand, to interpret the problem focuses on housing and its environment, and, on the other hand, on the process of identifying the natural resources of the site, including the materials of the place, technically safe for construction, and the experience of traditional techniques of the inhabitants of the locality, which are important and opportunity elements in the definition and solution of the intervention proposals. At this stage of site analysis, students involved in research need to be trained to properly interpret the analysis tools and perform the required data and information records, with sufficient clarity and precision; they should also be trained to behave with respect and formality towards people during the interview process.

6 b) Variables, indicators and quality ranges of the dimensions planted in the MECVE

The analysis focuses on "the house", it is part that it constitutes the space that comprises the architectural object and its relations with its immediate environment "the context", where it is located. This relationship -housing and immediate environmentdefines the nature of the object and integrates it as a unit of assembly, and both, form the essential cell of the inhabited territory that provides identity with respect to the social group to which it belongs, which for our case refers to the rural environment.

The variables considered in each dimension of the MECVE model (image2) are as follows: The model is proposed as an open system that, in terms of the sciences of biology and social sciences, dimensions and variables

are subject to external conditions to maintain a certain level of functioning. In the process of analyzing housing and the immediate environment, for the determination of possible causes or risk factors to human health, it is directly related to habitat conditions in general. According to Quesada (1978), the system refers to a set of interrelated elements and the whole as such has a number of properties that are not individualized in any of the elements of the model, the consideration of the system is justified as unity and not as a simple sum of elements that make up it; therefore, the approach proposed of the MECVE model is integral, holistic that corresponds to the conduct of a case analysis with the joint study of all the elements.

The parameters and quality ranges of the variables are established with a health and sustainability approach, which facilitates the identification and evaluation of current conditions (zero time "t 0 "),of rural housing and its immediate environment; they also allow to measure, on a scale, the quality levels according to the condition in which it is located: R1: excellent (green color), R2: sufficient (yellow), R3: partially (orange), R4: not met (red) and R5: critical (intense red); and it is determined that the desirable quality ranges for healthy rural housing (RSV), are R1 and R2 (see image 3).

7 Socio-economic aspects:

Number of inhabitants per home, schooling, economic activity, income, consumer goods, land tenure and housing.

8 Physical-spatial (housing):

Location, materials used and construction process, spatial distribution, ventilation, interior lighting and safety

9 Environmental components (biotic and abiotic

10 c) Intervention proposals

Possible solutions to the identified problems are analyzed by the team, based on the diagnosis of the site obtained. The proposals for habitat reconstruction and improvement; on the one hand, they focus on the development of structurally safe, economical and healthy homes, with water and drainage services, functional spaces and suitable to environmental conditions, which preserve the typology, with ecotechnologies and use of local building materials, alternative and environmentally friendly, with the purpose of preserving the biodiversity of species and ecosystems; and, on the other hand, proposals are carried out for habitat improvement in general such as community equipment: recreational, cultural public spaces, education, etc., consistent with the characteristics of the locality, in accordance with the environmental environment and the socio-economic conditions of the inhabitants.

Intervention proposals are submitted to users of the information; that is, to the inhabitants, notable people and representatives of the locality, with the aim of knowing their opinions or comments, which will be analyzed and taken care of, since they are important to R1: is excellently met (Very Good) R2: is sufficiently met (Well) R3: partially complied with (Regular) R4: not true (Bad) R5: critical condition (Bad) Quality ranges R1: is excellently met (Very Good) R2: is sufficiently met (Well) Expected quality ranges for RSV (Healthy Rural Housing)

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achieve the relevance and appropriation of the proposals put forward by the inhabitants.

III.

11 Results

The team, integrated into the Academic Body Urban Development (CADU), with the participation of architecture students, have developed research work in various locations in the state of Chiapas, especially in the communities of low-income families, with the purpose of analyzing housing problems and their environment, and, from this, developing proposals for a solution. Below are some of the studies conducted. Larrainzar, who were placed by the government in this new territory, in usufruct for people, due to various conflicts that the inhabitants had with other groups of indigenous people due to the tenure of the land. Some indigenous people found conditions similar to their places of origin; however, 30 of them were returned. From 1969 to 2000, the population increased to 500 inhabitants, today there are more than 850.

12 Image 5: Proposed alternative housing with local materials

Agriculture is the main economic activity, they grow coffee, corn and beans. In study, 3 main problems were identified: Access road (2.2 km of road in poor condition), health service (clinic, with only a medical assistant and midwife) and agricultural productionmarketing (lack of transport). Of the houses: 34.6% in floor of soil, 64.4% do not have sanitary furniture, more than 30% do not have sanitary furniture or body grooming area, etc. (see image 4). The source of water supply is a spring, the water is not drinkable and is supplied by surface hoses, they have no sanitary drainage network or public cleaning service, among others (see image 4).

The proposed house (see image 5), was developed based on existing materials and environmental conditions: 1) The wooden walls of the original house, if the quality of the material allows, thus recycling the existing wood;

Also, the walls are supported on a low wall built of stone: 40 cm wide, 50 cm high and 40 cm deep (foundation), to prevent deterioration by moisture, 2) The structure of the walls and roof, will be made of wood and the roof of sheetzinc placed on a thermal layer, to conserve or isolate the heat , 3) A bathroom with tank to store water, for the purpose of dignifying the body grooming of women, 4) A dry latrine of 2 chambers. The research carried out in the ejido Ocuilapa de Juárez, municipality Ocozocoautla, was funded by Fomix- **??**ONACYT (2006 **??**ONACYT (-2008)) and UNACH. The objectives set were: to carry out the diagnosis of housing and to develop prototypes appropriate to the characteristics and social conditions of the community. Analyses identified that 13% of homes are in precarious condition (see image 7), 80% with masonry walls built with concrete block parts with 2 holes, confined vertically with steel only at the intersections of walls and in the perimeter a dala; However, 77% of the condition of the structure of the houses is poor (R4), there are cracks in the spaces of doors and windows. Problems are attributed to the use of sand with 22% clay, technical deficiency in construction, etc.

13 Image 8: Records of the condition of floors, walls and roof of homes

In Image 8, the table shows the records obtained in the Ocuilapa community, specifically in the dimension: "Physical-spatial", in the "zero time" (site diagnostics) that identifies the materials used and the structural condition in which the walls and roofs are located. It is observed in homes that, 27% with floor, and, based on the quality ranges, corresponds to "R5" (Very bad); also, of the total homes with concrete block masonry, 77% record a structural condition on the "R4" (Mala) walls, which warns of insecurity. Regarding the ceiling, 10% have cover of cardboard sheet or waste material, 2% palm and 67% sheet-zinc; of these, 40% of the structure has various "R4" problems; In addition, the sheet covers have no insulators, which generates unfavorable thermal variation inside: cold and heat.

Image 9: Alternative housing for Ocuilapa Image 9 shows the meeting with farmers from Ocuiapa, where architecture students presented prototype models, to listen to family feedback and make decisions in the configuration of homes. The construction plans of the homes that were built by 5 families were then developed, with the technical assistance of the team. The proposed walls with concrete blocks with 3 holes were reinforced with steel inside; vertical and horizontal senses, based on technical standards. The sand of the place that has 22% clay was used, due to the usual use of this material, as well as its availability and low cost. The technical information was integrated into a self-construction manual that was delivered to the ejidal representative (Escamirosa, et al, 2017). With the MACVE model, it is also possible to obtain the individual analysis of the house and its surroundings. The image shows some records in the "zero time (t 0)", of Joaquin's family home (see image 12). The walls, ceiling and structural, were in critical condition, "R5" (Very bad).

Identified the elements to be transformed (image10), Joaquin's family built their home in 10 months, which included training, advising and supervising the work, which ended in "time one (t 1)". The research project financed the materials used: cement, reinforcing steel, etc. The labor, for the extraction of stone and sand from the place and the construction, was in charge of the family.

14 Image 12: Housing before and after the intervention

The home of Joaquín Hernández, his wife Norbel Jiménez and their two children, during construction received no financial support, as it was a commitment raised from the beginning. Image 12 shows the housing conditions before and after the intervention: "zero time (t 0)" and "time one (t 1)", respectively. The house has 2 bedrooms, living room, dining room, on 36 m 2 of surface, plus an ecological stove, dry latrine with 2 chambers and bathroom with water storage tank. Also, the seismic-resistant capacity of housing built with concrete block walls with 3 holes was assessed and resulted from "low vulnerability", indicating that the walls have good resistance in cases of seismic action (Escamirosa, et al, 2017 and2018).

In the town of Chiapa de Corzo, the research project was carried out: "Proposal for structural strengthening for the consolidation of traditional housing...", funded by PROMEP-SEP (2013-2015) and the objective was to contribute to the conservation of traditional adobe homes and increase structural security. The proposal was to reinforce the walls with a concrete membrane of 2 cm and steel mesh (electrowelded mesh 6x6/10x10). In Image 13, you can see the houses and their initial conditions (zero time), the construction process and the completion (time one). The work carried out did not require specialized labor, only one masonry officer and one pawn per dwelling (Ecamirosa, et al, 2014 and 2019) were employed. The sism-resistant capacity of the houses of Ocuilapa de Juárez and Chiapa de Corzo, was examined with measurements of accelerographer, analysis and structural modeling with finite elements, and it was determined that the structure was adequate. This fact was corroborated by physically inspecting the dwellings, after the earthquake that occurred off the coast of Chiapas, on September 7, 2017, which had a magnitude of 8.2 on the Richter scale and caused damage and collapsed homes in different locations in Chiapas state. In the structural analyses carried out, the team of researchers of the Academic Corps Natural Risks and Geotechnology (CARNG)of the Autonomous University of Guerrero (UAG) collaborated.

The sism-resistant capacity of the houses of Ocuilapa de Juárez and Chiapa de Corzo, was examined with measurements of accelerographer, analysis and structural modeling with finite elements, and it was determined that the structure was adequate. This was corroborated by noting that the houses physically did not record damage, after the earthquake that occurred off the coast of Chiapas, on September 7, 2017, which had a

magnitude of 8.2 on the Richter scale and caused damage and landslides in different locations in Chiapas state. In the structural analyses carried out, the team of researchers from the Academic Corps of Natural Risks and Geotechnology (CARNG) of the Autonomous University of Guerrero (UAG) collaborated. Intervention proposals were also developed for habitat improvement in general, according to the site. The team proposed 5 housing prototypes, as well as public spaces necessary for the community, among which are: Health Unit, Sports Court and Children's Games, Center of Art and Culture, among others. Image 14 shows the process of obtaining information from the site, with the participation of students; also, the presentation of alternative housing to low-income families, to know their comments and opinions of the proposals.

The alternative housing was developed for lowincome families, without losing the essence of the local typology, habits of the inhabitants and materials used in the construction. The proposals are economical, with water and sanitation services, natural ventilation and thermal cover with sheet on insulating layer built with bamboo or cane of the place, which supports a mixture of soil and fiber of the coconut shell, to reduce the heat inside the houses. An important aspect of the proposal was the safety of the structure, as El Encanto is located Year 2021 Volume Xx XI Issue II Version I Global Journal of Researches in Engineering ( ) E 2.5 km from the Pacific Ocean and in the region of greatest teluric activity that exists in the country, so, the houses will have to withstand the strong winds and hurricanes that occur, as well as the seismic action.

IV.

15 Conclusions

In the search for solutions for the reconstruction and improvement of housing and its environment (habitat) of low-income families living in rural communities in the state of Chiapas, the team has implemented a methodological strategy, based on the implementation of the rural housing condition assessment model, as a tool to assess initial conditions, monitor and control habitat transformations. The model has the possibility of being implemented in a community, which will guide the development of strategies and actions for collective housing improvement, but also, the instrument is used in the particular analysis of housing, at the beginning of "zerotime" reality assessments and the conduct of follow-up and intervention control assessments at various times ("time 1, 2, 3,... n"), and thus assesses the continuity of healthy and sustainable rural housing status over time.

The work presented, carried out in localities in the state of Chiapas, shows the importance of identifying and interpreting habitat problems in a holistic way and developing proposals for a solution in the same direction, which, according to the availability of economic resources, interventions can be progressive but aimed at meeting and ensuring the safety, health, well-being and quality of life of the inhabitants, especially for the benefit of low-income families living with high levels of social lag, poverty and vulnerability. And finally, with these works we try to consummate one of the aspirations of the Autonomous University of Chiapas, link their work with social reality, through teaching and research. [1]

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Figure 1: Image 4 :

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Figure 2: Image 6 :

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Figure 3: Image 10 :

Figure 4:

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Figure 5: Image 14 :

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systematized and the study case diagnosed. After the two stages, the results obtained are

1. Socio-economic aspects: Number of inhabitants per home, schooling, economic activity, income, consumer goods, land tenure and housing. 2. Physical-spatial (housing): Location, materials used and construction process, spatial distribution, ventilation, interior lighting and safety.

3. Basic water services and disposal of excreta.
Regarding water: Supply, quality of supply service,

4. Waste management. Liquid waste (RL): Used water,
body and hand grooming, washing of waste and
clothing, food production (nixtamal or other) and
urine; Organic and inorganic solid waste (RS): Characterization, composition, health quality of RS
management in the environment, final arrangement;
Gas residues (RG): Food-production (PA), health
control of gas emissions (smoke), physical quality of
furniture in the PA, average time spent in the PA and
burning matter in the environment.
5. Environmental components (biotic and abiotic).
Abiotic components: Geographical location, soil
type, bodies of water, climate, geology; Biotic components: Flora (vegetation) and fauna
(domestic animals). . Respect for the interrelationship of the previous 5 dimensions, with the health of the inhabitants and the environmental environment, are
as follows:
6. Health of family members. Common diseases: Acute respiratory infections (IRAs), acute diarrhoeal diseases (EDAs), other diseases and health services available to the inhabitants. 7. Environmental environment: Health quality of soil, quality of natural resources and health quality of water bodies.

Variables	Sub variables	Indicator
Version I	Floor	Basic water services and disposal of excreta. Regarding water: Supply, quality of supply service, q
	Roof	Type of roof

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