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Analysis of Housing Settlement Patterns on the Banks of the Chilca River

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Para optar el Título Profesional de Arquitecto

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Analysis of Housing Settlement Patterns on the Banks of the Chilca River

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Abstract According to the Peruvian Chamber of Construction, 80% of the houses are informal constructions built with cheap materials and located in risk areas such as riverbanks, endangering the physical integrity of their occupants due to the constant erosion of the material subject to possible damage over time. This work develops the analysis of the settlement patterns of dwellings on the banks of the Chilca River. For the work, 265 houses were analyzed by the method of visual observation based on a card, and the sample was reduced to 234 houses due to the lack of access at some points, including 120 houses from Real Avenue to Jose Olaya Avenue, 58 houses from Jose Olaya Avenue to Inclan Street, and 56 houses from Inclan Street to the intersection of ocopilla, which was obtained in the field by the authors. Finally, 3 characteristic patterns were observed in the GBP (49.14%), PV (33.77%) and HRP (17.09%) dwellings, with the GBP-2 typology representing 25.64% of the dwellings, while the RP-1 represented 24.36%. The settlement patterns have a distribution in the territory that is associated by blocks. For example, in sectors 1 and 3, there is a greater presence of RP, while in sector 2 HRP predominates, and the presence of GBP is distributed in the 3 sectors analyzed.

Keywords Urban Development, River Edges, Natural Risk, Visual Inspection, Housing Patterns, Housing Settlement

1. Introduction

According to the Peruvian Chamber of Construction, 80% of homes in Peru are informal constructions based on non-load-bearing elements, in accordance with the building regulations [1]. Being a country focused on self-construction through the use of cheap materials for its execution [2-3], this varies according to the geographical area since 54% of households with informal income are located in urban areas, while 49% in a rural area coming from the highlands [4]. The process of occupation in the territory is informal due to the growing need for housing for the family home, which gives rise to complexities and challenges for urban planning and territorial management [5]. The access and construction of housing in a given area is established under normative conditions of the national building regulations in Peru which is related to family and individualistic needs that are related to power and inequality that lead to environments where precariousness and lack of basic services predominate, such as housing settlements on river banks due to low economic resources [6]. Despite the prohibitions of Law No. 29869, which prohibits occupations in ravines, riverbanks, marginal strips and risk zones where there is a special protection regime that indicates that these are uninhabitable sites because their construction is not permitted. There are still houses in riverbanks because it is a management and civil defense problem that municipalities are responsible for ensuring compliance [7].

Despite current regulations, there are informal settlements in different parts of Peru, which are generally characterized by a large number of residents and poorly developed physical dwellings such as low-quality, densely populated dwellings that do not follow planning regulations and construction prohibitions in risk areas such as riverbanks [8-9]. It is the household residents who face these problems, who risk their physical integrity as well as that of their family members as they are exposed to natural disasters, leading to a lack of adequate life security [10-11].

The occupants of these lands on riverbanks do not have an adequate quality of life, due to the absence of basic services for human beings such as water supply, electricity, being predominantly self-construction with local materials such as earth and clay bricks, However, over time, due to soil erosion on the river banks, the buildings show settlements which cause the walls to begin to crack and therefore lose mechanical capacities that could lead to the collapse of the built structure [12-13].

This work was carried out in order to evaluate 234 houses settled on the banks of the Chilca River which runs from east to west 13885 km flowing into the Mantaro River, for which it was divided into 3 study areas, being sector 1 the Royal Avenue to Jose Olaya Avenue where 120 houses were analyzed presenting that they maintain a distance of 10 meters with respect to the edges of the shore. Sector 2 is located from Jose Olaya Avenue to Inclan Street where 58 houses were analyzed, presenting a reduced space between the house and the banks of the river. Sector 3 is located on Inclan Street to the intersection of Ocopilla where 56 houses were analyzed and had little access, which were analysed through the visual survey analysis where 3 characteristic patterns were obtained in the dwellings analysed in the city of Chilca of GBP (49.14%), PV (33.77%) and HRP (17.09%), in which it is highlighted that in sectors 1 and 3 there is a greater presence of RP, while in sector 2 HRP predominates, and the presence of GBP is distributed in the 3 sectors analysed.

2. Materials and Methods

Based on the background mentioned in the introduction, there are houses built on the banks of the Chilca River in the study area that have different configurations in the three sectors analyzed by the visual observation method.

2.1. Location of the Study Area

The city of Huancayo is located in the central highlands of Peru, with a population of 545,615 inhabitants [14], and is located at an average altitude of 3,200 m.a.s.l. in the central sector of the Mantaro Valley. Huancayo is considered the natural epicenter for administrative, cultural, commercial and financial services in the Junín region. The area has elements that favor agricultural, agro-industrial, and tourism development, highlighting its archeological and scenic value. The province of Huancayo has 28 districts in which our case study focuses on the district of Chilca, which is bordered to the north by the districts of Huancayo, to the east by Sapallanga and to the south by Huancán and to the west by the province of Chupaca and has an area of 8.3 square kilometers and a surface area of 28.04 square kilometers [15]. These characteristics classify the city of Huancayo as an intermediate Andean city.

In addition, the city has the presence of the Chilca River, which runs from east to west, approximately 13,885 km from the farthest point to its mouth on the Mantaro River.

The study area is shown in Figure 1 and Figure 2; the altitude varies gradually depending on the distance to the river. In general, there are no steep or steep slopes that could represent a danger to the stability of nearby houses, but there are specific areas where it represents a risk. Regarding the river that crosses the study area, it was found that its flow is relatively low during most of the year, suggesting that it is a rainfed river. However, during the rainy season, the flow can increase significantly, even overflowing in some stretches. The study area was divided into 3 sectors: sector 1 was from Avenida Real to Avenida José Olaya, in which a greater distance was observed was observed from the location of the house but at the same time with houses close to the boundary of the house and the river, with a total of 120 houses. In the second sector, from Avenida José Olaya to Calle Inclán, 58 houses were observed with a reduced space between the house and the river. In the third sector, from Calle Inclán to the intersection of Avenida Ocopilla and Calle Los Incas, there were fewer houses and little access, with a total of 56 houses. There were fewer houses and little access, with a total of 56 houses. The data collection was carried out in January in 3 days of work in the morning and afternoon, and 234 houses were analyzed.

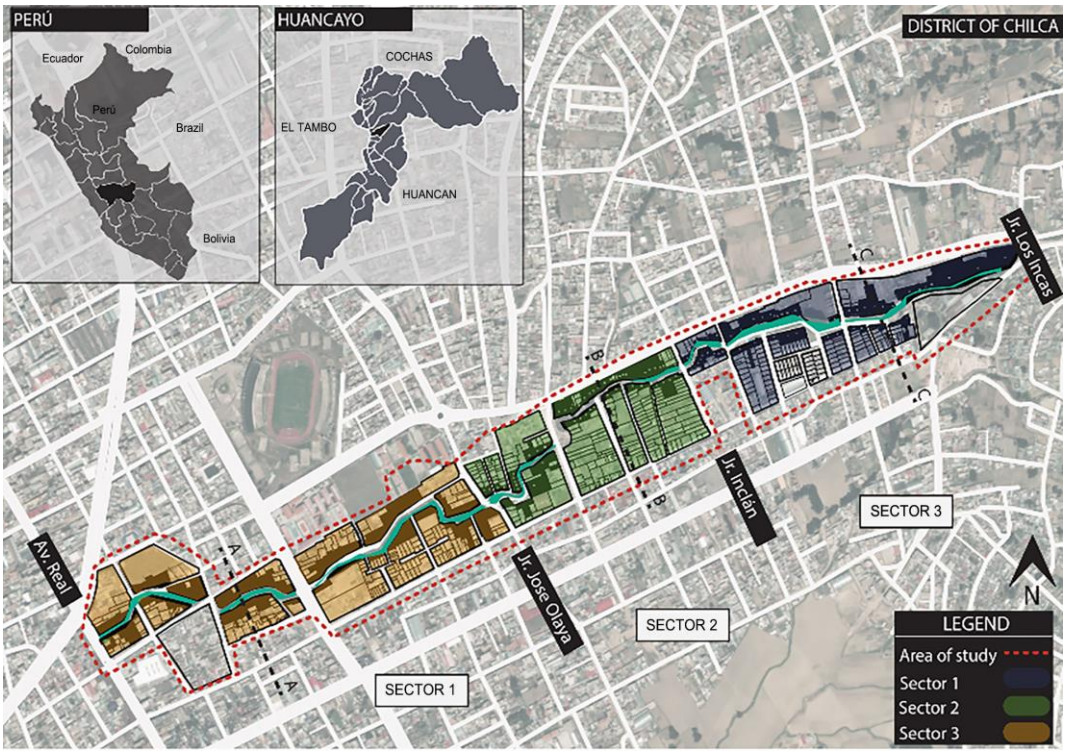

Figure 1. Study sectors of houses near the banks of the river

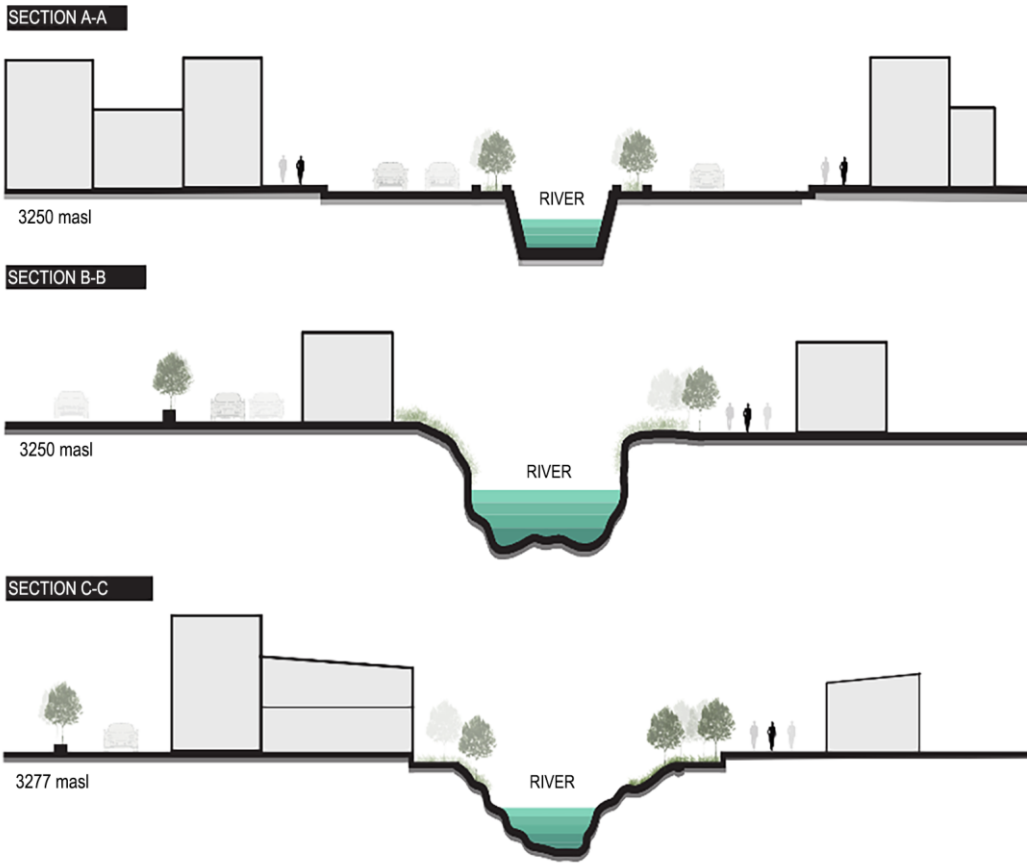

Figure 2. Study sectors of houses near the banks of the river

2.2. Visual Observation Method

A structured visual survey was used for the analysis, applying the observation sheet instrument (see Figure 3). From a total set of 265 dwellings subjected to analysis, a data cleaning process was carried out resulting in a total of 234 dwellings. A data cleaning process was carried out resulting in a total of 234 dwellings analyzed. Subsequently, relevant information was processed using a geographic information system and management software and a data management and analysis software and to generate data map visualizations. Three elements of analysis were determined: the river, the block and the lot. In order to identify characteristic settlement patterns such as: (i) zoning, which refers to land use or predominant activity; (ii) age, which influences the quality of the construction, its resistance capacity and durability over time; (iii) distance from the river, to determine the degree of exposure to river floods and the probability of flooding; (iv) materiality, to evaluate resistance in the river context; (v) number of floors; (vi) state of conservation; (vii) existing barriers between the house and the river, such as concrete walls or vegetation and, finally, (viii) type of façade that relates to the river. These characteristics have made it possible to define the different patterns existing among the dwellings analyzed and how they have been settled according to the differential characteristics of each area.

3. Results

After analyzing the 265 dwellings, only 234 dwellings were taken into account, from which the years of construction of the house analyzed were obtained, as well as the settlement pattern with respect to the distance of the dwellings from the edges, for which they were grouped by the following characteristics: Green Barrier Pattern, Via Pattern, Housing Rio Pattern, Housing Rion Pattern, which are in function of green areas, road, free distance between the river bank and the house, in some cases these have certain distance with respect to the bank, pedestrian walkways, backyards, which determined for the grouping.

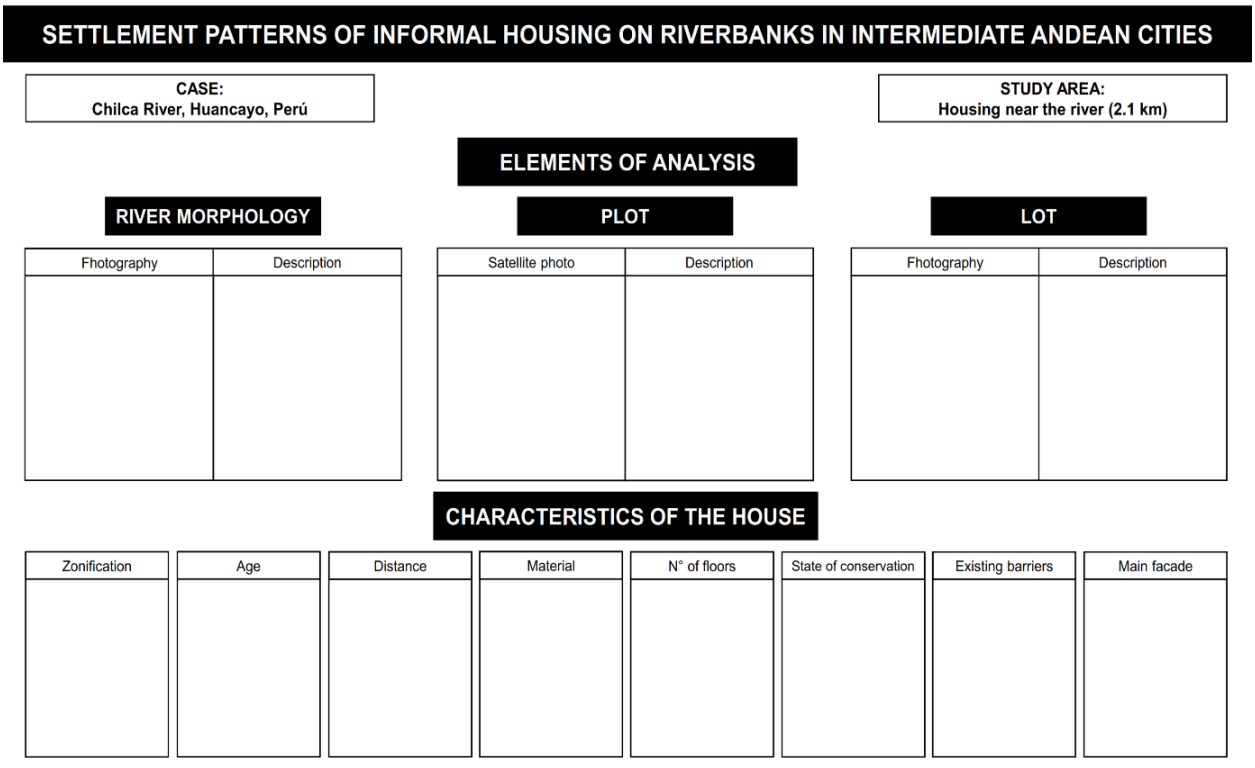

Figure 3. Observation sheet

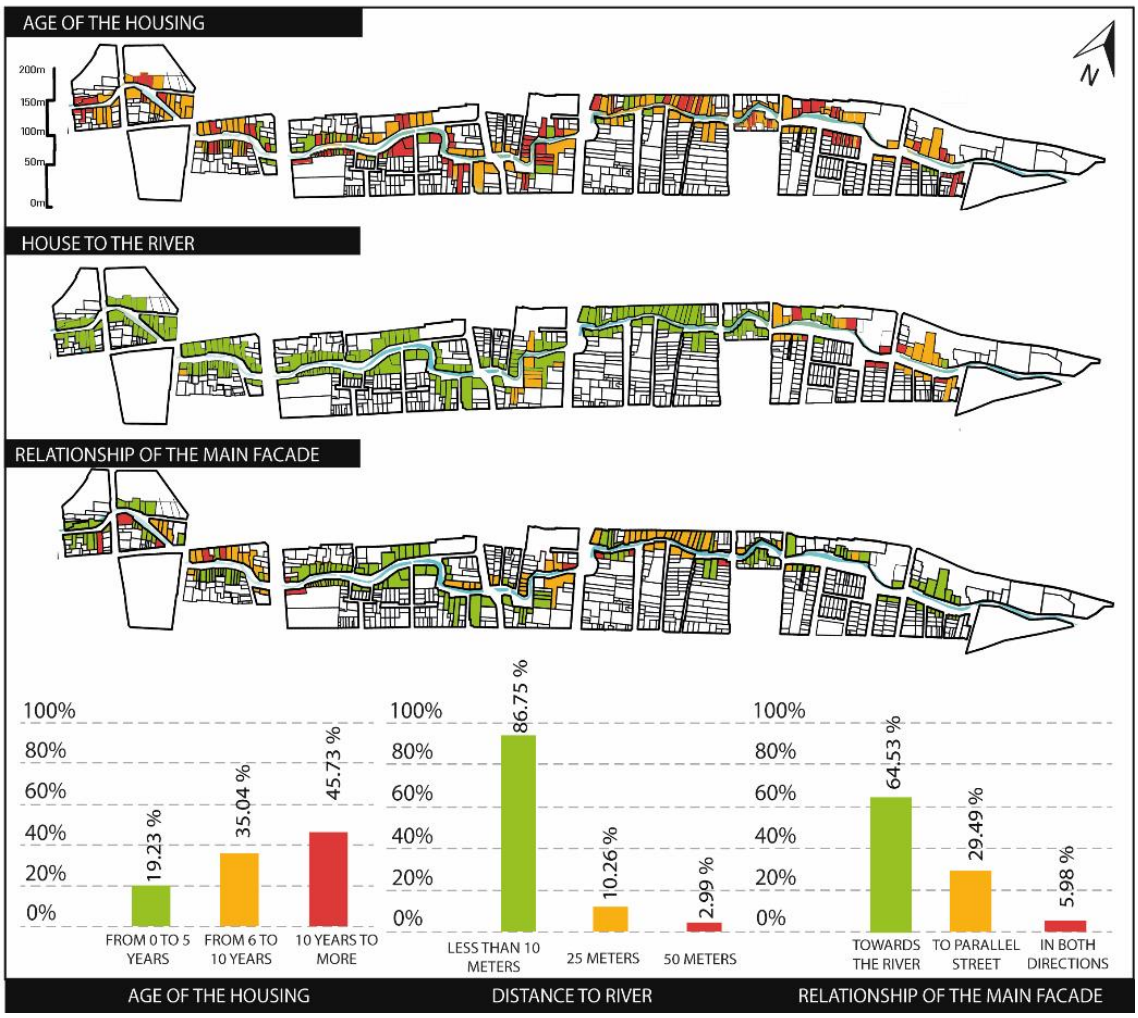

Figure 4. Characteristic of the houses settled on the banks of the Chilca River

3.1. Characteristics of the Dwellings

For the analysis of the case study, the relevant characteristics of the houses were determined: age, distance of the house from the riverbed and the relationship of the facade with the river. Thus, Figure 4 shows the percentage of houses older than 10 years is 45.73%, while 35.04% of the houses are between 6 and 10 years old. Likewise, 19.23% of the dwellings are no more than 5 years old since their construction. It is also evident that 86.75% of the dwellings were built at a distance of less than 10 meters from the river boundary and are located mainly in sectors 1 and 2, while 10.26% are less than 25 meters away and 2.99% are less than 50 meters away. The results indicate that 64.53% of the houses with frontage on the river, 29.49% of the houses with main frontage on a road parallel to the river and only 5.98% of the houses have frontage in both directions.

3.2. Location of Dwellings along the River Banks

By means of the visual analysis carried out in the 3 sectors along the Chilca River, we grouped by characteristics related to the green areas and the distances that existed between the housing and the banks of the Chilca River, the most representative ones being the Green Barrier Pattern, Via Pattern, Housing Rio Pattern and Housing Rion Pattern, as shown in Figure 5.

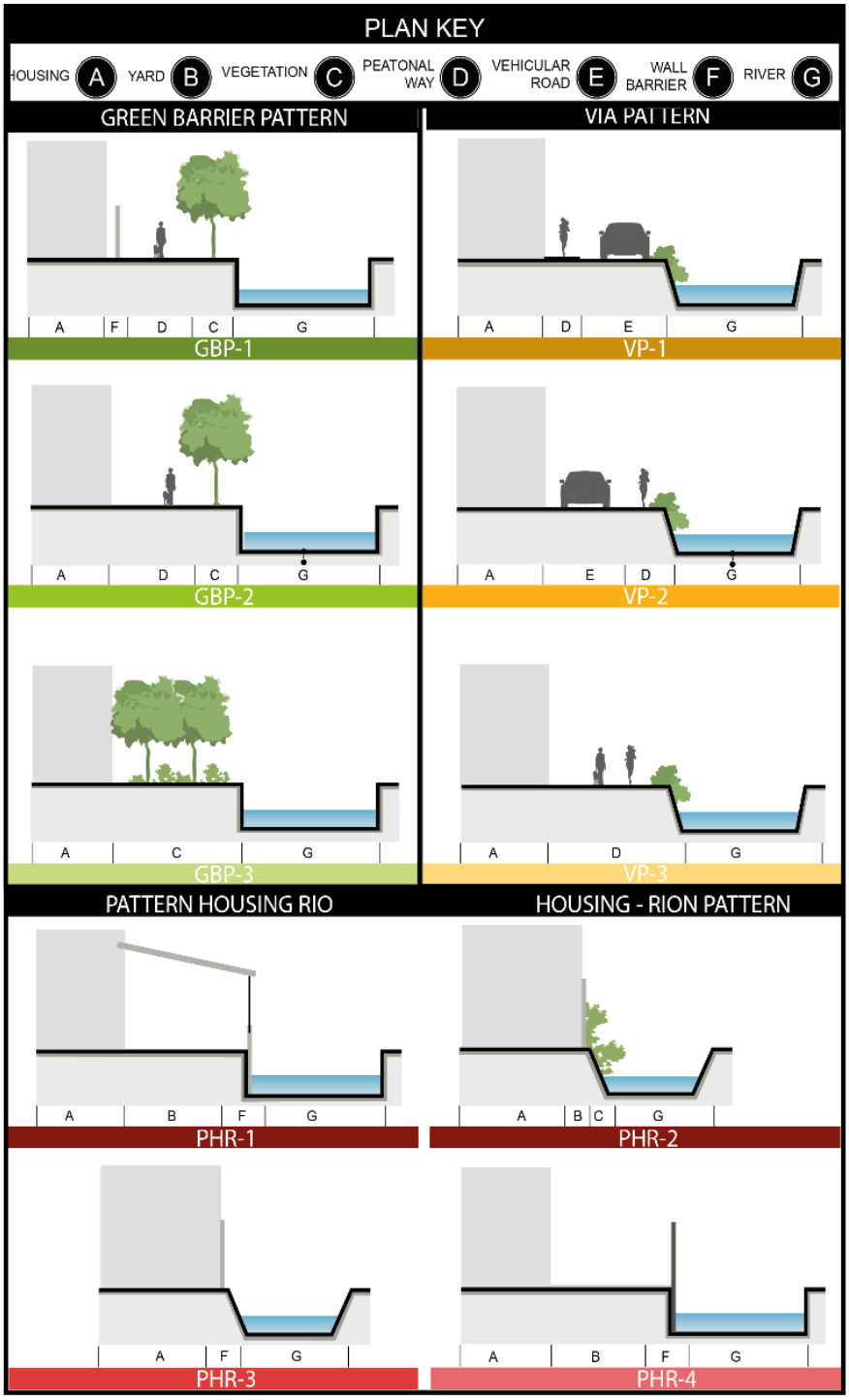

Figure 5. Configurations of the houses built on the banks of the Chilca River

3.3. Green Barrier Pattern (GBP)

The GBP is characterized by the presence of a vegetation barrier at different heights, planned or unplanned, on the riverbanks. This pattern presents three typologies, shown in Figure 6. The first GBP-1; the house presents a masonry wall as a barrier and property boundary and a planned vegetation barrier between the main façade of the house and the public space with the function of providing protection and privacy to the house as well as visually integrating the house with the natural and river environment. On the other hand, the presence of an intermediate pedestrian access suggests an intention to integrate the house with the river, allowing a more direct connection with it. The second typology, GBP-2, is characterized by the presence of unplanned vegetation and

the absence of a masonry wall. This suggests a greater integration of the dwelling with the river, as it allows a more direct visual and spatial connection with the river. However, the absence of a masonry wall may mean greater exposure of the dwelling to flood risk. And the third GBP -3, is characterized by the presence of a blind wall barrier without access to the river, and a vegetation barrier both planned and unplanned, in this case, the presence of the blind wall barrier suggests less integration with the river, and the vegetation barrier beyond its extra protective function can be interpreted as a design tool to visually separate the dwelling from the natural environment.

3.4. Road Pattern (RP)

The RP is defined as the typology in which the location of the dwelling contemplates the presence of a roadway, which can be vehicular or pedestrian and is intended for the dynamics of displacements. Thus, 3 typologies are also recognized: RP-1 has both pedestrian and vehicular access, the pedestrian road being close to the dwelling. The RP-2 type also has both roads, but the pedestrian road is continuous up to the river's edge. On the other hand, the RP-3 type has only a pedestrian path, accompanied by natural vegetation (Figure 7).

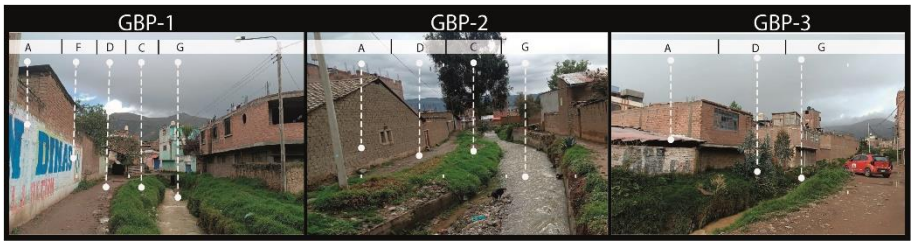

Figure 6. Informal dwellings with GBP patterns

Figure 7. Informal dwellings with RP patterns

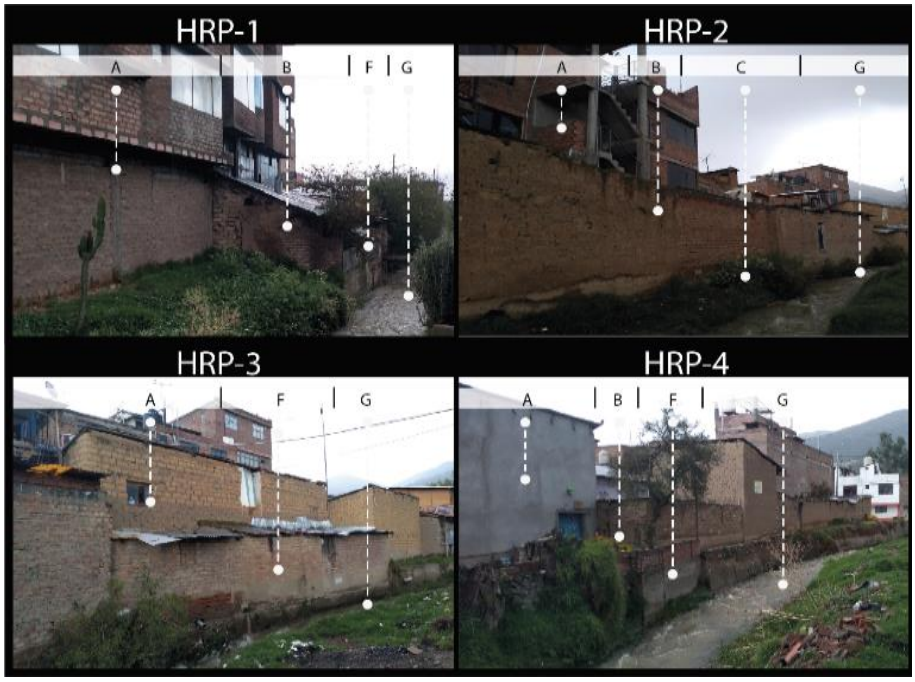

Figure 8. Informal dwellings with HRP patterns

3.5. Housing River Pattern (HRP)

In the HRP, (see Figure 8) the proximity between them stands out, with practically no distances, which implies an intrusion into the natural course of the river. The distinctive feature of this pattern is that the main facades of the dwellings are oriented towards a road parallel to the river, while the rear facade is in relation to it. Four typologies are recognized: The HRP -1 type, part of the dwelling is related to the river and consists of a covered backyard, sheltered by a combined barrier of reinforced concrete masonry (in direct contact with the river) and metal materials (superimposed on the concrete wall). This space is used as a storage area. In the second type HRP -2, the dwelling is separated from the river by a barrier of natural vegetation (without direct access). In the third type HRP -3, the dwelling is in direct contact with the river, being protected only by a concrete wall barrier with a minimum height. Finally, in the HRP -4 type, the relationship between the house and the river is established through a backyard. This space is protected by a concrete wall barrier with a 0.5 m high sill.

3.6. Critical Analysis of Housing Patterns

Figure 9 shows the analysis of the 3 types of patterns according to the following percentages: GBP (49.14%), PV (33.77%) and HRP (17.09%). Then, within each pattern, one typology stands out, for example, the GBP-2 typology represents 25.64% of the dwellings and RP-1 24.36%. In addition, it is important to note that the settlement patterns have a distribution in the territory that is associated by blocks. For example, in sectors 1 and 3 there is a greater presence of RP, while in sector 2 HRP predominates, and the presence of GBP is distributed in the 3 sectors analyzed.

4. Discussion

The expansion of urban areas towards the edges of the river has blurred the boundaries between private property and public property, such as the river's marginal strip. This represents important challenges in terms of flood risk management, river ecosystem conservation and soil conservation. In this sense, it is crucial to adopt an integrated approach that combines water resources management with urban planning, actively involving the surrounding neighborhoods and sectors in decision making and promoting citizen awareness to achieve sustainable urban development that protects water resources and river ecosystems.

In addition, the geographic and physical characteristics of the territory, in this case the river banks, influence human settlement patterns, being the spatial and temporal scale. In line with these statements, the research evidences that the location and proximity of the river to the dwelling are significantly influenced by the morphology of the tributary. Specifically, it is observed that the width and depth of the river, as well as the slope of the adjacent terrain, are relevant variables affecting the settlement pattern at the river's edges. These results are consistent with previous studies that highlight the importance of the characteristics of the physical environment in the spatial distribution of housing in riverside areas. To this can be added new urban problems and issues that relate to the growth of housing on riverbanks, as different natural spaces that are affected by the anthropic dynamics of human beings.

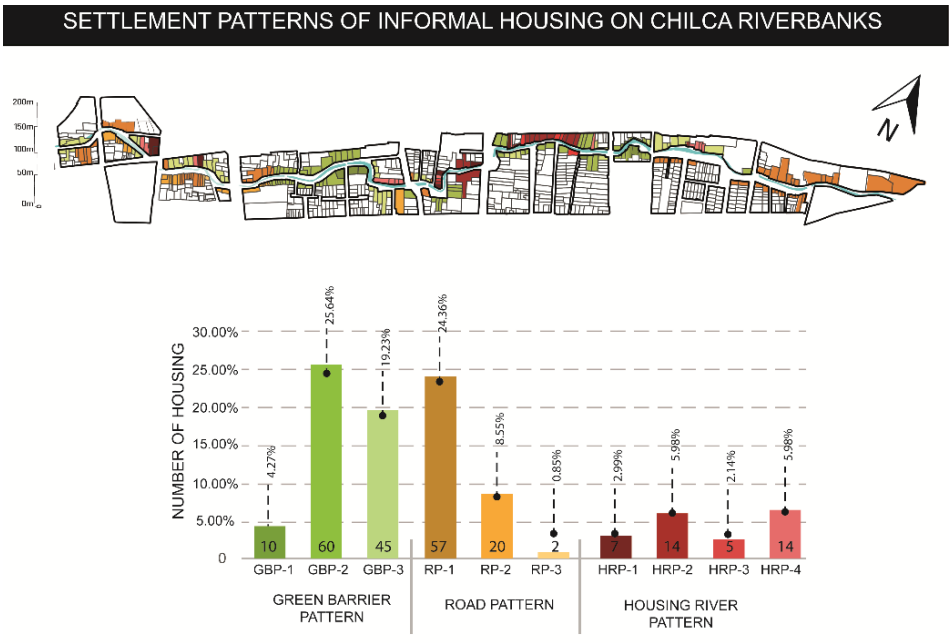

Figure 9. Patterns of the houses located on the banks of the Chilca River

Urban planning in the countries of the global South requires a detailed understanding of riverbank settlement processes. This research shows that there are diverse settlement patterns and typologies along riverbanks. It is also shown that the patterns present a continuity by blocks, as evidenced by the fact that the inhabitants face the location in a very similar way, forming clusters of residence. These characteristics are visible in the materiality of the dwellings, in the facades, in the orientation of the facades of the dwellings and in their relationship with the river. Therefore, the characterization of housing location and occupancy is essential for decision making in local government urban development plans.

5. Conclusions

The process of housing occupation along riverbanks is a continuous phenomenon. In the study area, it was observed that there are dwellings with an occupancy of more than 10 as well as dwellings with an occupancy period of less than 5 years. It was observed that the dwellings are adapted to the needs and respond to the economic capacity of their inhabitants. This corresponds to the process of informal occupation of the territory, which is characterized as an empirical and long-term process.

The process of housing occupation on riverbanks is a continuous phenomenon that adapts to the topography and does not always occupy defined territories, given that their densification spaces are dynamic and are in a constant process of occupation adapting their needs more quickly in these areas, and this makes them produce habitat outside the framework of the law avoiding all types of bureaucracy, but the inhabitants are exposed to repression processes by the authorities. In the study area it was observed that there are dwellings with an occupation of more than 10 years as well as dwellings with an occupation period of less than 5 years. It was observed that the houses are adapted to the needs and respond to the economic capacity of their inhabitants. This corresponds to the process of informal occupation of the territory, which is qualified as an empirical and long-term process.

The presence of vegetation along the riverbanks is mostly unplanned. In the study sector, it is observed that the GBP recognizes vegetation as an element of harmony and/or protection against the river edge. Therefore, residents adopt empirical urban design strategies, transforming the existing vegetation according to their needs. For example, we observed that dwellings have an interest in preserving their green areas from an aesthetic or ecological perspective, but not a normative one. Therefore, it is concluded that the GBP is interpreted as a response of integration into the intended natural environment.

The PR establishes a more respectful relationship with the river's edge. Specifically, the houses are connected to the river through a public space that provides accessibility through pedestrian and/or vehicular routes. The urban design in this type of settlement evidences the recognition of public space as part of its urban spatial requirements. In addition, this location has several environmental and social environmental and social benefits, such as improving urban heat air quality, creating green spaces, and promoting recreational and leisure activities.

The HRP is a response that is mainly explained by the morphology of the river. Specifically, in the case studied, the river has a width that ranges between 1 and 2 meters at most, being the narrowest of the entire area studied. This characteristic of the river has allowed the constructions to advance towards the riverbed, limited by walls that extend to the river's edge. This phenomenon has generated a limited connection between the houses and the river, where the former practically turn their backs on it and consider it as an entity separated from the urban context. It should be noted that this type of pattern presents a series of technical challenges and technical and environmental challenges in the face of flooding, riverbank erosion and water pollution.

In this sense, it is crucial to adopt an integrated approach that combines risk management and environmental land use planning, and in this way to have better urban planning, which actively involves neighborhoods and surrounding sectors in decision making and promoting city awareness; in this way also significantly consider management organizations, in this case municipalities, local governments or other public institutions, in the search for sustainable development.

The conservation of river ecosystems and land use planning are two interrelated aspects that complement each other.

6. Supplementary Information

In this section the researchers attach the surveys carried out in the field, as well as the photos and videos of the houses analysed in the three sectors of the Chilca river.

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