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ACCESSIBILITY AND GEOGRAPHICAL CONNECTIVITY IN RURAL AREAS. THE CASE OF MARIA PINTO DISTRICT, CHILE

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1. INTRODUCTION

Accessibility and connectivity are topics of particular interest for Geography as a scientific discipline. Understanding the population's traveling organization dynamics in the geographical space is a question raised by several authors over several decades (ESCALONA ORCAO *et al.*, 2003; GÓMEZ FAYRÉN *et al.*, 1990; FARROW *et al.*, 2001; PIRIE, 1979; SHIMBEL, 1953; WEBER, 2006). In general, in order to examine the phenomena associated to these concepts, the main foci are the commuting flows regarding study and work (WEBER 2006).

In Latin America and especially in Chile, rural areas are spaces that still have traveling gaps with respect to the accessibility and geographical connectivity of the territory (UBILLA BRAVO 2012; UBILLA BRAVO *et al.*, 2014).

Focusing on the specific problem of this research, we point out two aspects. First, there is little academic production from the field of Geography regarding the matters of accessibility and geographical connectivity in rural areas. These investigations are more concentrated on urban areas, preferably metropolitan areas. In this way, we want to contribute with knowledge of how the space behaves in relation to inhabitants traveling time when living in rural environments. Specifically, we want to know their trips from different places towards their main or "head" district, a settlement that provides services to the rural population. Secondly, we note that gaps in terms of access to basic services remain for the population living in rural districts.

The objectives guiding this research are: (i) to characterize the existing road network (type, length, distribution), (ii) to determine the intra-district geographical connectivity using the König and Shimbel indices, (iii) to determine the intra-district geographical accessibility according to the Rodeo index and (iv) to determine homogeneous areas of accessibility by means of isochrones in relation to the district of María Pinto's urban town center.

2. MATERIALS AND METHODS

2.1. STUDY AREA, ROAD NETWORK AND DETERMINATION OF GEOGRAPHICAL CONNECTIVITY BETWEEN SETTLEMENTS

The first methodological step consisted of calculating the length of all the roads that are in the district. Secondly, three categories were considered according to the type of pavement pathways: asphalt, gravel and dirt. This way, the different travel speeds could be determined (FERREIRA *et al.*, 2013). Afterwards, we located the centroids of all the districts' human settlements, which were used as nodes in the analysis.

The second step consisted of assigning the value of arcs to each node in relation to each of the other nodes. The intra-district geographical connectivity was measured by the König and Shimbel indices. The König index consists of the highest value or number of arcs in relation to the most distant node (most arcs). The Shimbel index is the sum of all the arcs that a node has in relation to the others.

2.2. DETERMINATION OF GEOGRAPHICAL ACCESSIBILITY BETWEEN SETTLEMENTS

As mentioned earlier, connectivity was based on a model of nodes and arcs. For

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geographical accessibility between settlements, we maintained that model as basis. The difference lied in that instead of measuring arcs as a value, we calculated two types of distances between populated centers in this objective. The real distance, corresponding to the tracks kilometers between each settlement, and the ideal distance, which is a straight line (minimum distance) between two nodes, also measured in km. This information was used as input to calculate the Rodeo Index (IdR) (DEL CANTO FRESNO *et al.*, 1998). This index consists in dividing the values of the real distance with the ideal one (or minimum) in relation to two populated centers or with the total distances (dividing sums) (ANDRADE GARCÍA *et al.*, 2008; GÓMEZ FAYRÉN *et al.*, 1990).

2.3. DETERMINATION OF HOMOGENEOUS GEOGRAPHICAL ACCESSIBILITY AREAS

The determination of the homogeneous units of geographical accessibility was developed from the application of a model of accumulated surface cost that considered the following points:

- To transform all the vectorized paths of the district into a raster format (grid). The raster grid represents a value of five by five meters.
- To give a 'zero' value to the grid where a path crosses and to apply a buffer from the path. This means that all the off-road spaces were going to have a distance value from the road. The result of this was a map of Euclidean distances from the roads.
- To make a digital elevation model from georeferenced data with contour lines and to calculate its slope gradient.
- To apply the slope gradient map to the map of Euclidean distances. The formula was applied to the Euclidean map to make the distances' map considering the slope.
- The values of friction surfaces within the district were applied to the map of distances that considered the slope gradient. These values were obtained from field work.

Following the investigations of several authors (ESCALONA ORCAO *et al.*, 2003; FERREIRA *et al.*, 2013), the final product of all this work was the map of accessibility by isochrones that has any location of the district towards María Pinto's town center, whose analysis was treated in the results section.

3. RESULTS

3.1. CHARACTERIZATION OF THE ROAD NETWORK IN MARÍA PINTO

The majority of the roads of the district of Maria Pinto are composed of dirt and they make up almost the 60% according to the data produced by GORE RMS. Afterwards, we observe that roads made of gravel represent 24% of the total, being the fastest to pave. Finally, the paved roads where the travel speed is greater represent the 16%.

3.2. GEOGRAPHICAL INTRA-DISTRICT CONNECTIVITY BETWEEN SETTLEMENTS

The villages Malalhue (I) and La Estrella (D) are the most connected ones according to the König index (value equal to 4). The same situation occurs with the Shimbel Index in the case of La Estrella (D) having a value of 21. In contrast, Villa Santa Luisa (B) and Chorombo Bajo (J) present the highest values of geographical connectivity with respect to other populated centers. If we consider the Shimbel index, Villa Santa Luisa (B) presents by far the highest value with 41.

3.3. GEOGRAPHICAL INTRA-DISTRICT ACCESSIBILITY BETWEEN SETTLEMENTS

In terms of the geographical accessibility, there are three types of results from the road

network: the real accessibility (AcR), the ideal accessibility (AcI) and the Rodeo index (IRd).

In the case of the actual distance, the populated centers Chorombo Alto (E) and Chorombo Bajo (J) show the greatest distance of all the rural villages. The explanation for these values is based on their location, because they are in a peripheral zone with respect to the other villages, near the slopes zone. The settlement Rosario (H) is the one that presents the shortest distance across the settlements, because it is in the center of the district, near the urban center.

The situation presented in the real accessibility is similar to the ideal accessibility (AcI). The three populated centers indicated above: Chorombo Alto (E) and Chorombo Bajo (J) and El Rosario (H) are the ones that show extreme values. The difference lies in that the AcI have fewer km associated with the method used.

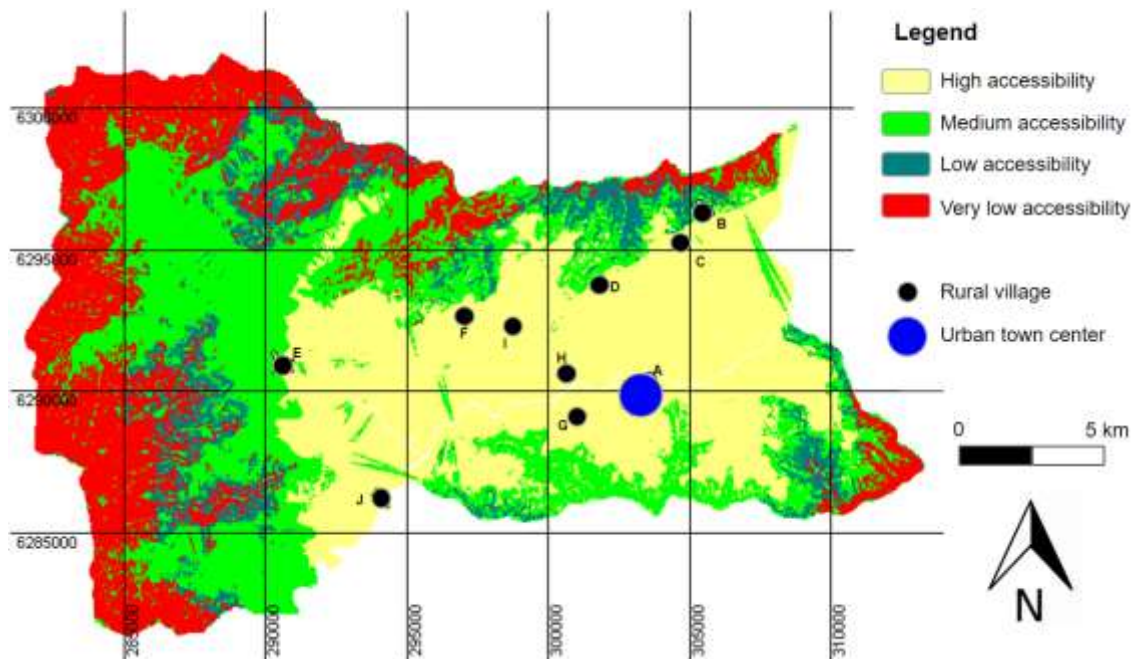
Concerning the Rodeo index (IRd), Las Mercedes (F) shows the highest value. This means that it is the settlement that presents the greatest distance (it is the farthest from the optimal one, ideal distance), given by the distribution of roads that bring them closer to the other settlements. In contrast, the closest center to the optimal '1.00' is Chorombo Alto (E) with a value of 1.17. Regarding the other values, we observe an IRd 3.83 between the settlements of Baracaldo (G) and El Rosario (H), which is explained by their location, because the road that crosses Paungue estuary does not go in a straight line, but it is necessary to pass by the district capital (A).

3.4. DETERMINATION OF HOMOGENEOUS INTRA-DISTRICT GEOGRAPHICAL ACCESSIBILITY AREAS

The determination of the homogeneous areas of intra-district geographical accessibility was carried out considering as point of origin (or destination) Maria Pinto's town center (A), since this is the settlement that constitutes the district center and provides services to the surrounding rural population. In this way, we notice that the first typology of *high accessibility* is equivalent to a bit more than a third. Another third is represented by the category of *medium accessibility*, which shows that the district presents disparities in terms of intra-district accessibility.

In FIGURE 1, we observe the ten populated centers (villages and town center) of the district. The first category is the *high accessibility*, which covers almost the entire sector of the valley, with the exception of some foothills due to the presence of sloping land. The *medium accessibility* category is spatially distributed around the previous category, represented, partially, by the slopes to the south and north of the district, and more developed to the northwest. *Low accessibility* comprises a travel time between one and two hours. Its spatial distribution is part of the slopes towards the north and the west of the territory and none of the settlements that were analyzed is located within this category. The last category is *very low accessibility*, and just as in the former case, there are no populated centers located in this typology. The travel time is more than two hours and it is located on the high peaks of the foothills of the Coastal Range.

FIGURE 1
Homogeneous intra-district areas of accessibility in relation to the town center of the district of María Pinto, based on isochrones



Source: prepared by the author. * name of the rural villages: María Pinto (A), Villa Santa Luisa (B), Santa Emilia (C), La Estrella (D), Chorombo Alto (E), Las Mercedes (F), Baracaldo (G), El Rosario (H), Malalhue (I), Chorombo Bajo (J).

4. DISCUSSION AND CONCLUSIONS

The present research contributes with the determination of spatial gaps in terms of geographical accessibility and connectivity in a rural-type district of central Chile. In this case study, it has been useful to use the application of a mathematical model that allows understanding of the spatial phenomenon of accessibility. In addition, this research contributes with a concrete diagnosis that can be used as a tool for policies development and territorial planning (PÁEZ *et al.*, 2012; UBILLA BRAVO *et al.*, 2014). Thanks to the reflection by AUNTA PEÑA(2014), we ask ourselves whether María Pinto is an integrated territory or not. From the results obtained, we think that a large part of the rural population of the district is integrated in terms of its geographical accessibility and connectivity. This implies that the rural population has relatively high access to satisfy some services needs that are in the main populated center. Along with being a contribution to the diagnosis of a district's rural territory, this work also contributes to a stream of studies that have analyzed these phenomena in other countries of the global south.

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