

SOCIO-DEMOGRAPHIC ATLAS OF THE VILLARRICA SUB-BASIN USING GEOGRAPHIC INFORMATION SYSTEMS AND REDATAM + SP

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Introduction

One of the advantages of counting with georeferenced information on social and demographic variables spatially disaggregated is that it allows the identification of priority areas for social intervention. Thus, benefiting decision makers that require management tools in order to guide public and private investments more efficiently in space. Regarding the territory of the sub-basin Villarrica, IX Region of the Araucanía, Chile, the socio-spatial situation is fairly heterogeneous, highlighting isolated areas with extreme poverty conditions, and other areas, such as the urban locations of Villarrica and Pucon, present better life quality levels.

In the context of the project "Territorial Information System of the Toltén Basin" and the sub-project "Territorial Information System for the Development Economic Sub-Basin Villarrica (*SIT-SCV* in Spanish)", headed by the Villarrica Campus of the *Pontificia Universidad Católica de Chile* along with the Institute of Geography of the same University and the following institutions: Laboratory of Territorial Planning of the *Universidad Católica de Temuco*, *Università Degli di Trento*, Aerophotogrammetric Service (*SAF* in Spanish) of the Air Force of Chile and the Natural Resources Information Center (*CIREN* in Spanish), developed the present Atlas. It was led by the Institute of Geography, that also had the mission to coordinate the Territorial Information System and model bioclimatic variables for the sub-basin. Then it devised a digital atlas by means of the TNT Atlas application of the SIG TNTmips 7.4, joined to other products generated by the project *SIT-SCV*. It is foreseen that in the future all the information be implemented in a public accessible internet platform.

The purpose of this study is to introduce the elaboration process and the results of the Socio-Demographic Atlas of the Villarrica Sub-Basin (SDAVS), that includes the

communes of Curarrehue, Pucón, Villarrica and Cunco, with emphasis on the commune of Curarrehue, highlighting the potentialities of integrated use of Geographic Information Systems (GIS) and REDATAM+SP program in the retrieval of census data and the confection of sociodemographic indicators.

Methodology

The Atlas analyzes a series of demographic variables and of social aspects that realize the characterization and evolution of strategic indicators for the socioeconomic development of the sub-basin Villarrica.

From a methodological point of view, the Atlas is based on the adaptation of the Social and Environmental Atlas of the Metropolitan Area of *Concepción*, in VIII Region of *Biobío* elaborated by the EULA Center of the University of Concepcion and the UFZ Center of Germany (ROJAS et al., 2006).

The geographical disaggregation of the census information has been an important aspect of the cartographic result. It is important to indicate that the geographical division census in Chile contains the following hierarchical levels: region, province, commune, district, area, zone, urban block / rural entity, and census sector.

The SDAVS is structured into two analysis scales: the first level is census district, covering the communes of Pucón, Curarrehue, Villarrica and Cunco. In the figure 1 these communes are shown and the basin is emphasized by means of a hillshade (figure 1). The second level is only for the Curarrehue commune (purple tones) on urban block/rural entity.

The main source of data corresponds to the digital data base of the Population and Housing Census of 1992 and 2002 years, of the National Institute of Statistics (INE in Spanish), that were recuperated and processed through REDATAM+SP program (CELADE, 2004). For both years, the following demographic variables were worked:

- total population
- urban and rural population
- growth rates
- intercensal variations by total, urban and rural population
- projection of population for 2008
- population by rank of age: less than 15 years, between 15 and 65 years and greater to 65 years
- intercensal variations by rank of age
- population density
- dependency index
- number of households
- number of population per households

While the socioeconomic variables considered were:

- population according to ethnic conditions
- poverty types
- socioeconomic strata
- percentage of illiterate population

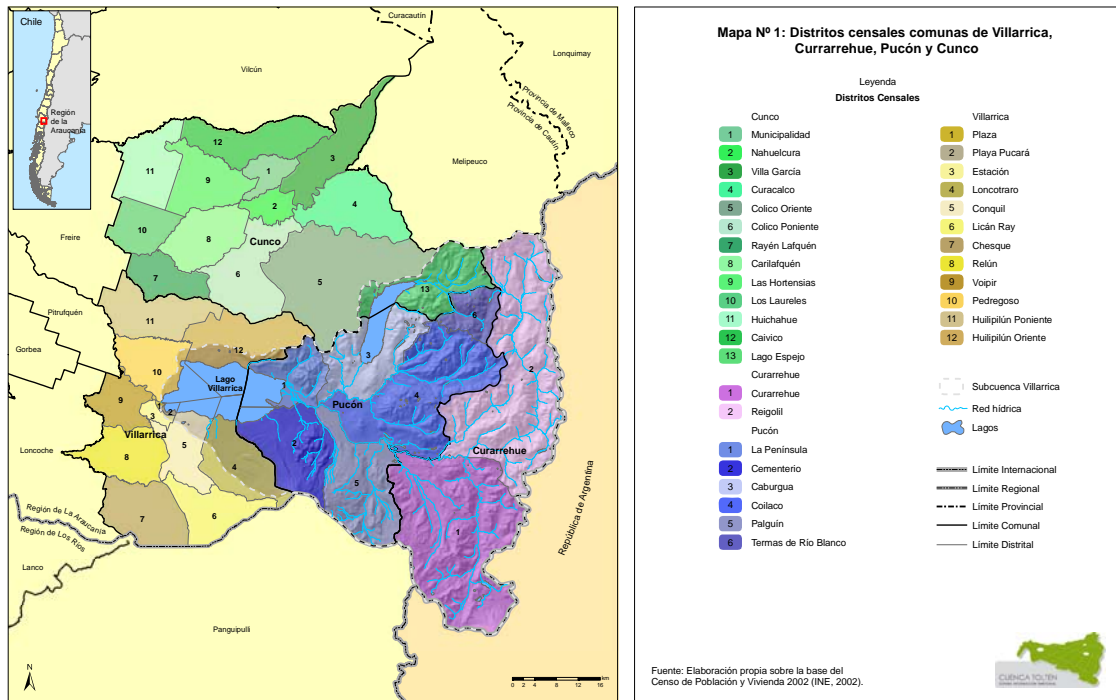


Figure 1. Map of area of study

For the second scale, that is to say the commune of Curarrehue, it was only worked with the REDATAM database from the 2002 census.

REDATAM is a family software developed by the Latin American and Caribbean Demographic Center (CELADE) belonging to the Population Division of the Economic Commission for Latin America and the Caribbean (ECLAC) of United Nations, that allows any professional to process censuses and other database sources very easily and fast, for any geographical area. REDATAM+SP is the fourth generation of these software, it runs in Windows environment and has the following modules: R+PROCESS, R+CREATE and R+XPLAN. This program can be downloaded free of charge, from the CELADE web site: <http://www.eclac.cl/celade/redatam>.

In the R+PROCESS module it is possible to load and to process the censuses database, called Dictionary. This can be defined as the metadata, where all the information about the entities and variables are stored. Entities are a set of logical objects that are hierarchically organized in the database (CELADE, 2004): in the case of the INE

Dictionary the selectable entities corresponds to geographical division census above mentioned, while that non selectable entities corresponds to households, homes and persons. A variable is a property (characteristic or attribute) of each individual, that is, a common property of all the individuals of that entity (CELADE, 2004); for example the entity for persons in the INE Census has the variable SEXO that has two attributes: male and female.

In general terms to retrieve data, the module R+PROCESS should be utilized, following three basic steps: define a geographical selection, choose a statistical processor and export the results. Once it generated the selection file, one should enter to the Statistical Processor and select the appropriate application that includes: Frequencies, Crosstabs, Average, Count and Arealist. To easily integrate the output table to the SIG, Arealist should be used, this application allows you to obtain a table where the rows correspond to the individuals of an entity and the columns to values of the variable chosen directly from the Dictionary. It is important to mention that REDATAM can also map the results directly, but does not offer tools so advanced of cartography as the ones that offer ArcGIS. Finally, the results of the variables processed were exported in Excel format, these files can be read for ArcGIS and then execute a Join with the spatial layers.

For poverty indicators and socioeconomic groups, specific programs in REDATAM+SP program have been elaborated, according to the ILPES methodology (1995) and an adaptation of the ADIMARK methodology (2004). By trying complex indicators that involve the relation of multiple variables, it was necessary to do advanced programming in Pivot Language where the programs are stored in files with the extension **.spc* (Statistical Processor Commands). For this phase the work included the valuable assistance of CELADE.

Thereupon, a digital cartography was elaborated corresponding to 36 maps in district level and 13 maps of the Curarrehue commune. A personal geodatabase was created using ArcGIS 9.2 program which stored the base layers of administrative limits and census limits, along with other support layers, such as roads, hydrography, areas protected, topography and DEM. For the case of the urban block / rural entity and census sector for the Curarrehue commune, the information from the 2002 census had to be digitized, since it was only found in paper format. The projection utilized was Transverse Mercator, Datum UTM WGS-1984 and Zone 18 South, just like the remaining layers.

The categories of the legend for the majority of the maps was carried out by means of the method of natural breaks to define the intervals, rounding up the resulting values so that they could be easily interpreted.

For the projection of population on the 2008 map, the geometric projection of growth rate was utilized, calculating the annual growth rate with the following geometric projection formula:

$$AGR = \left(\sqrt[n]{\frac{Pob}{Pob - 1}} - 1 \right) \times 100$$

Were:

AGR: annual growth rate

n: number of intercensal years

Pob: current population census (2002)

Pob - 1: previous population census (1992)

For the quantitative variables a ramp of hot color was employed (yellow to red) for the positive values and cold for the negative values (cyan to blue) in the legend. For poverty maps and socioeconomic strata, these values have been represented with a simbology chart (pie).

During the process of elaborating the thematic cartography many tools where used to improve the graphic representation in ArcGIS, specifically in ArcMap module, such as annotations and representations and layout tools, for example: automatic legends, charts, effects like transparency, extent rectangles, layer masking, amongst others. Specially important was the use of a template of common layout (MORENO, 2007) that permitted to automate the making of the multiple maps for the two scales of analysis.

Results

The results of the SDAVS were interpreted though a report where the situation of each variable was described. As for the results of the demographic variables, it can be established that: Villarrica has the greater quantity of population, compared to the four other communes, with 45.531 inhabitants for 2002, then follows Pucón (21,107), Cunco (18,702) and Curarrehue (6,784). The district number 3 Estación of the Villarrica commune is the most populated one, and practically is a 100% urban. The population projected for 2008 concentrates fundamentally in this last district and the district number 2 Cementerio of the commune of Pucón, which presents 85% of urban population. Both districts represent the most important urban centers of the Sub-Basin: Villarrica y Pucón, respectively.

The major decreasing of growth rates for the period 1992-2002, corresponds to the districts Colico Oriente, Lago Espejo and Caivico in the commune of Cunco, the two first with a smaller density to 1 hab/km². At the same time the districts that present greater growth rates in the area of the sub-basin correspond to those tha agglutinate urban population by the cities of Villarrica and Pucón, and in a smaller way by Curarrehue and Caburga (see fig. 2). This situation can find its explanation by the economic impact from tourism activities due to the presence of large natural attractions such as lakes, rivers, volcano, protected areas, forests and many associated activities during summer and winter.

On the other hand, the greater percentages of rural population is concentrated on the districts of the communes of Curarrehue and Cunco, they also coincide with greater proportions of indigenous population, especially in the district of Reigolil that reaches up to 68.5% (see fig. 3), fundamentally Araucanian (*Mapuche*”). Additionally this district exhibits the major proportion of population under the age of 15 (34.5%) and it registers the major percentage of illiterate population of all the districts (22.5%). The most rural districts and less dense, they present the worse conditions of accessibility and economic growth, as it will be shown later on. It is interesting to note that in this district there is a great surface of protected areas (National Reserve Villarrica).

As for the intercensal variation of the population over 65 years of age, it is interesting to note that all the districts show a growth of the population from this age rate, which shows a process of constant aging. In this age rate, it is possible to calculate the dependency index –relation between passive population (children and elderly) and active population (between 15 and 65 years)- varying on average from 61.7 the year 2002 to a 65.9 in 1992, corroborating a tendency of greater dependence of the passive population on the active population. Examining the relationship of population per households, it is possible to notice that this varied from 3.4 to 2.6 during the 1992-2002 period, implying a change in the size of families.

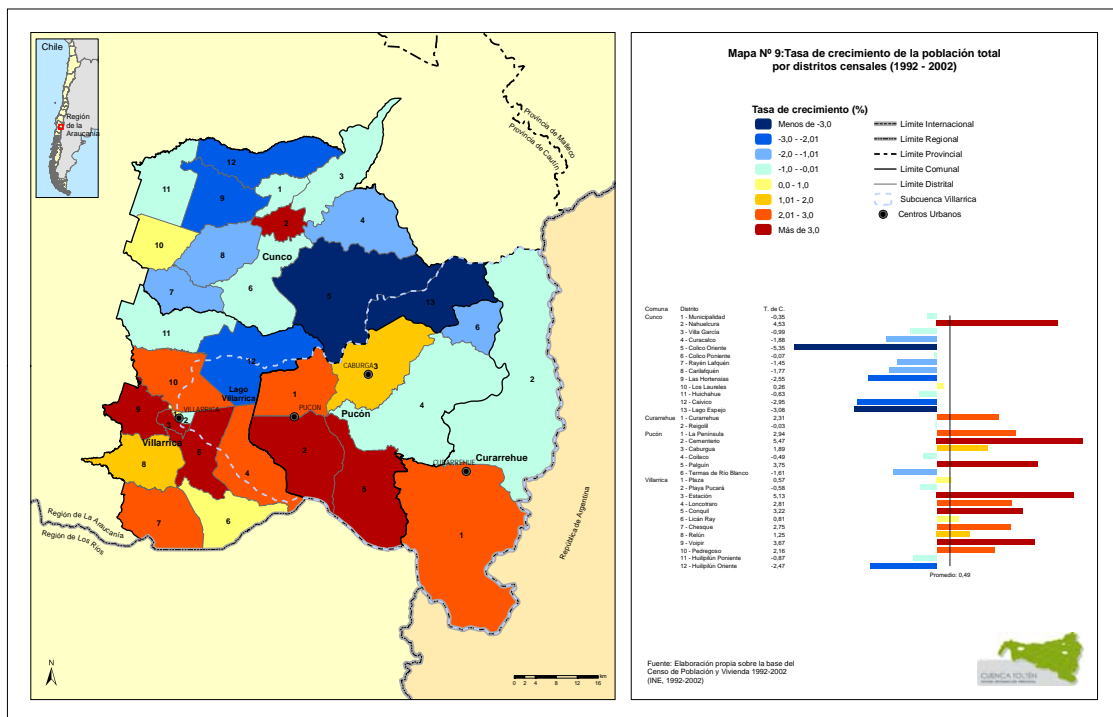


Figure 2. Population growth rates 1992-2002

From a socioeconomic point of view, poverty has been reduced strongly during the intercensal period, considering the three categories of poverty. The critical poverty, that

is, households that present some structural deficiencies related with the materials used in the walls, floor and roof, also in the support of drinking water, electricity and sewer system, and overcrowding condition (called NBI) and households that also present a social vulnerability of the leader of the house, measured as homes that have more than three passive persons per one active person, and a leader with four or less years of schooling (called LP), diminished from 40.1% to 6.5%. The inertial poverty (only NBI) has increased softly from 14.2% to 18.4%; and the recent poverty (only LP) descended from 15.6% to 10.2%.

As for the distribution of socioeconomic strata in the year 2002 - where the class ABC1 corresponds to the stratum of greater income and the class E to the poorest one -, a clear tendency towards the consolidation of the medium strata is observed, the general dominance was displaced, from the E group to the D stratum with a 52.5% of the total, experiencing the group E a significant decrease (59.6% to 22%). Likewise the group C3, enlarges considerably its general value, covering up to 20.4% of all the households of the study area. The strata ABC1 and C2, also they experience a positive variation.

It is important to mention that the methodology ADIMARK estimates indirectly the monetary income of the homes, considering the possession of a series of sumptuary goods (shower, television set, cooling, washing machine, boiler, oven microwave, cable tv or satellite, computer, internet and car) with the educational level of the leader of home.

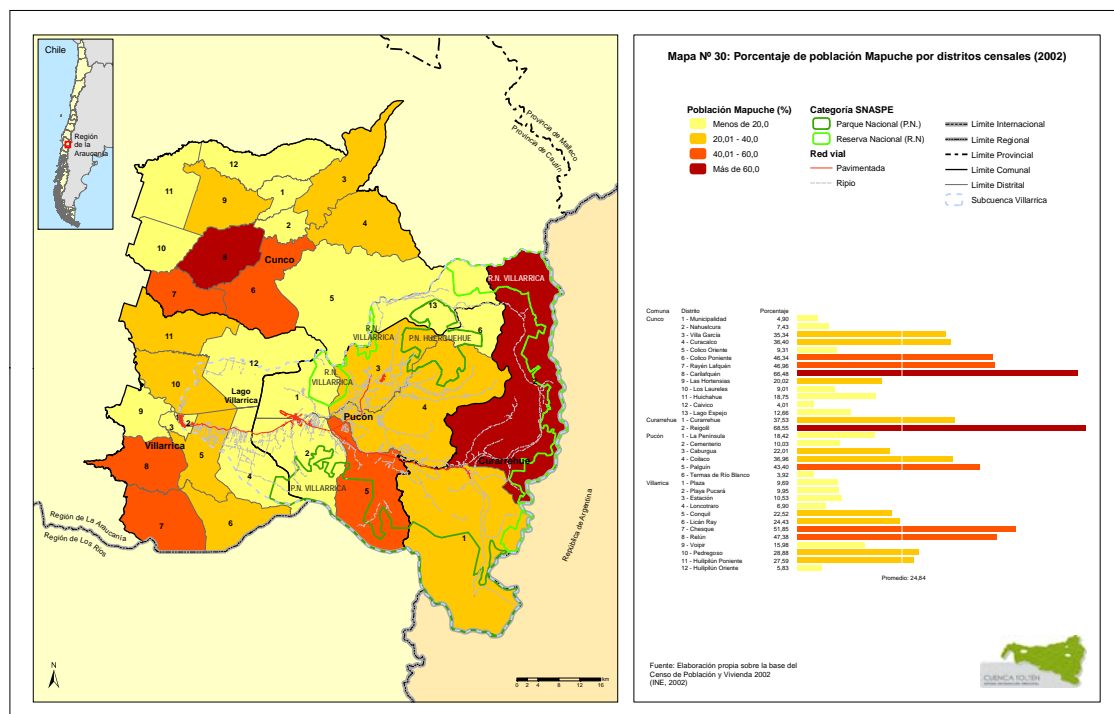


Figure 3. Indigenous population 2002

As for the the second level of analysis of the SDAVS, the situation of the commune of Currarehue is outstanding, composed by the districts of Currarrehue and Reigolil, where 77.5% and 90.5% of households in 1992 were considered under some form of poverty, either inertial, recent or critical, however this percentages descended to 50.6% and 84.6% in 2002, respectively.

On the other hand, the social program “Chile Solidario” and “Programa Puentes”, with a duration between 2 and 5 years, benefiting 203 persons through FOSIS funding, which is concentrated in the Currarrehue district (69%), south of the commune, while a big part of the population of the Reigolil district present areas which are not yet covered by the social program and have large deficiencies, especially in the southern area. The next map shows that 11 rural entities in Currarrehue district and 16 in Reigolil are in poverty conditions in more than 75% and they are not being benefited by social programs (see fig. 4).

In the urban area of Curarrehue (see fig. 5) the better social conditions are presented, as for a greater quantity of not poor dwellings (426 households) and greater media socioeconomic strata proportion (22,3%).

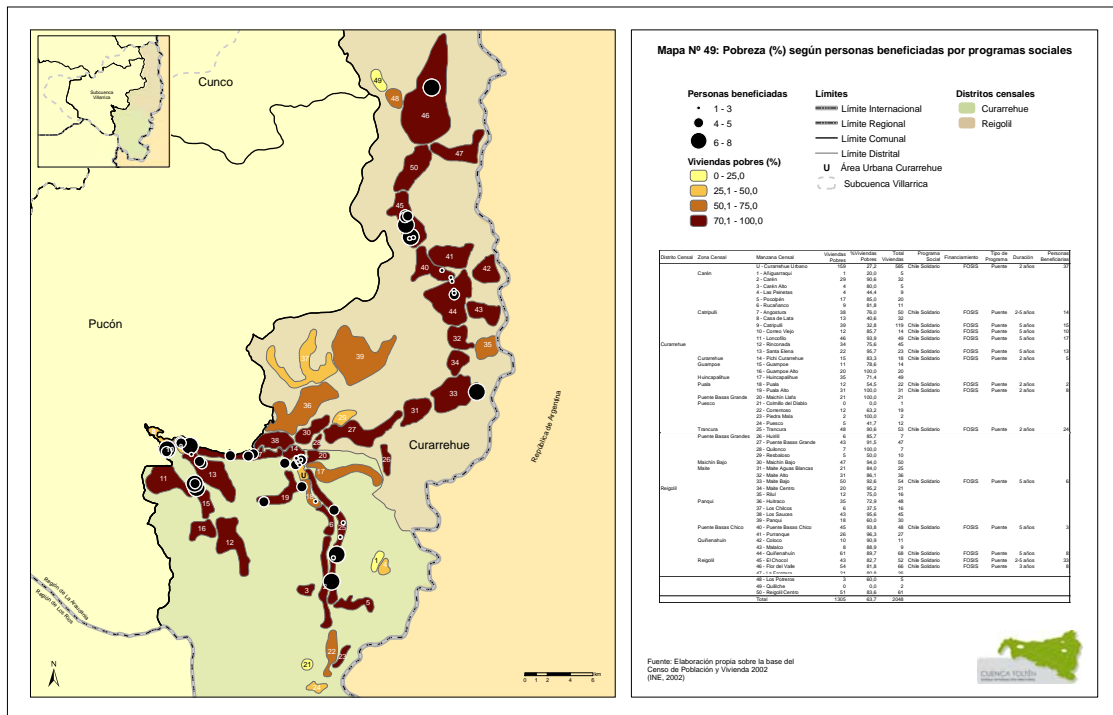


Figure 4. Poverty and families benefited by social programs

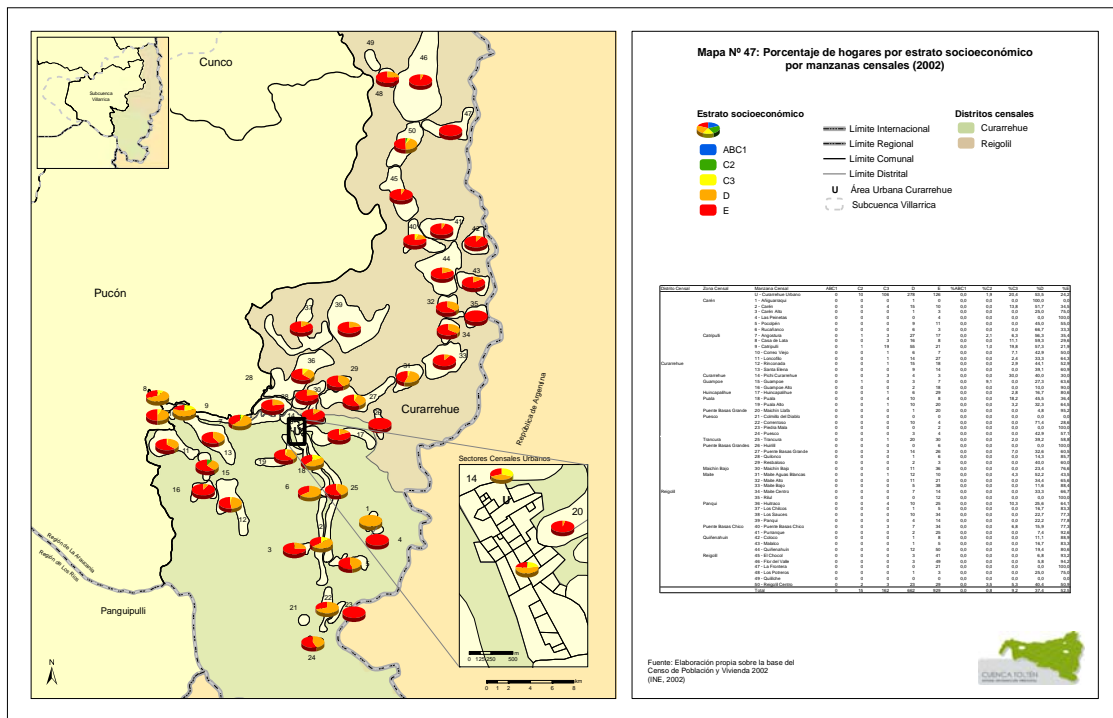


Figure 5. Socioeconomic strata in Curarrehue commune- 2002

Conclusions

The work developed, allows us to conclude the enormous value present in census database, which allows to carry out demographic and socioeconomic diagnosis, due to the great quantity of information that can be extracted from them. Besides this, due to the potentialities of the REDATAM program and the use of SIG, it is possible to adapt or to build new indicators in function of the geographical scale that is desired to intervene.

In this way, the multi-scalar dimension, along with the multi-temporal dimension of the census information, transforms the SDAVS in a powerful tool for decision makers that need to know the spatial location of the most dispossessed groups or vulnerable sectors and improve their life quality. In the case of Curarrehue is especially important to offer social assistance to the native population.

Likewise GIS plays a fundamental role in the digital cartography elaboration process, upon decreasing the time of processing of information and reproduction of maps, due to the automation of certain reiterative tasks. Also GIS offers a series of tools that help to carry out thematic cartography of high quality.

As for the relationship between GIS-REDATAM-INE databases, three recommendations can be presented:

- It is important to have all the information of rural zones, entities and sectors of the country in digital format with its respective codes, to exchange easily with the GIS. At present, only information of urban blocks exists.
- It is necessary to have the rural and urban covers for the 1992 and 1982 censuses and if it is possible the 1970 census, to be able to carry out diachronic studies.
- Suggest to agencies and institutions that generate social information of spatial character (Municipality, FOSIS, MIDEPLAN, etc.) to incorporate INE codes, especially for the next 2012 Census of Populations and Households.

The main challenges of the SDAVS are to revise or to modify the indicators utilized according to the opinion of actors involved, and to divulge the information amongst the general public as well as decision makers and thus help them in planning and managing a participative and sustainable territory.

Acknowledgements

Special thanks to Rodrigo Jara for his support in the cartographic production, to Alejandra Silva for assisting in the programming with REDATAM+SP and to Antonia Biggs by the aid in the translation.

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