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Census based selection process of areas with heterogeneous population distribution

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Abstract*— The work herein describes the selection process of areas aimed to study several features of the heterogeneous distributed population settled in the Iberá Natural Reserve (INR) in the Province of Corrientes, Argentina. The process was based on the information given by the last National Census of Population, Homes and Housing, considering the province departments, and their census territory subdivisions called fractions, radiuses and segments. The selection was performed by the method of Sampling by Area. The reserve area was geographically defined in the cartography regarding the boundaries established by law. The INR territory was stratified in urban area and rural area, identifying population settlements that varied in concentration. Within each of these areas the census territory subdivisions were delimited, which enabled to perform a second stratification with independent selection parameters according to the Housing Number per Census Segment. This allowed the selection at random of the segments to be studied within the urban and the rural areas, respectively. The INR was composed of 213 census segments, for the rural area 47 segments and for the urban area 15 segments were included. In order to tackle the human dimension the selection of the segments was essential to allow the approach to the inhabitants of the INR. The relevance of the census based selection process is that constitutes a model that transferred to other regions with heterogeneous population distribution enables comprehensive studies to promote the wellbeing of the population.

***Index Terms*— area, inhabitants, selection process, territory division.**

I. INTRODUCTION

In 2008 the World Health Organization (WHO) stated that the population´s globalization, urbanization and aging were promoting social, demographic and epidemiological transformations. Also, that the sanitary gap was widening, not only among countries, but also within social groups of the same country, thus arising challenges of a magnitude not foreseen during previous decades [1]. In Argentina the health surveillance system has been designed and driven mainly focusing transmissible diseases but, due to the epidemiologic transition, this is, the phenomenon that occurs in countries where the health conditions of the population have been transformed, the profiles of death causes have changed from transmissible pathologies to chronic diseases, which start to acquire higher weight [2]. There are different and varied transmissible –infectious- diseases in Argentina given its wide surface area and the diversity in climates, geographic regions and living forms. On the other hand, two thirds of the deaths that occurred during 2008 worldwide were caused by chronic diseases, being the low-income countries, populations and communities those which showed the higher burden of these combined pathologies, that impose huge avoidable costs in human, social and economic terms [3]. Regarding Non-Transmissible Chronic Diseases and their risk factors, scientific research has been carried out for more than a decade, to investigate related features to these pathologies in university students and other population groups, such as nutrition status, tobacco and alcohol consumption, and physical activity pattern [4-7]. The National Risk Factors Survey for chronic diseases in Argentina evidenced an expansion of the problem since 2005 with more than half of the population showing excess malnutrition –overweight and obesity, increase in sedentary lifestyle, one out of four inhabitants with smoking habit and increased cholesterol, and one out of ten suffering from diabetes [8]. Nevertheless, none of these studies were carried out in the population settled in the Iberá region, thus this is an unexplored area for these pathologies. Iberá means “shinning water” as the natives called the large lagoons in this landscape. It should be noted that this region is located in the Province of Corrientes at the northeast of Argentina, and it constitutes one of the most important water reserves of the planet [9]. Due to this feature, the singularity of its environment and the high diversity of animal and plant species, that need to be protected, it was declared as Iberá Natural Reserve (INR). In order to promote the sustainable development of the region the Universidad Nacional del Nordeste -UNNE-

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(Northeast National University), through the Science and Technology General Secretariat -SGCyT-UNNE, worked out a research program oriented to carry out a multidisciplinary study of the INR through several research projects with a comprehensive approach, including the human dimension, besides other biological and environment aspects [10]. Regarding the population settled in the INR the study focuses on health conditions, environment, resources, occupations, sustainability and awareness of the region as natural reserve. But the inclusion of these study dimensions set out several challenges, starting with the need of a correct selection of the population among all the inhabitants of the reserve. As the territory of the INR shows particular features, the population settlements are very heterogeneously distributed, with varied concentration in urban and rural areas, some are even isolated. Consequently it required a careful selection of the areas to be included in order to gather information from a representative sample. The aim of this study was to describe the process followed to select the areas with urban and rural population settlements, in order to approach to the environment, health and sustainability of the inhabitants at the Iberá Natural Reserve.

II. METHODOLOGY

***Territory features*.** The Iberá region is one of the most important sources of fresh water in Argentina and the planet. The Iberá Natural Reserve is a unique territory of 12300 square kilometers that has a lot of rivers, lagoons, wetlands and marshes, with forests and grasslands showing high plant and animal life biodiversity [9]. Among these geographic features, and caused by them, there are extensions isolated due to the few ways to access or difficult roads to move inside. The Iberá Marshes constitute a remarkable complex of aquatic and land ecosystems, extending from the central region to the northeast of the province of Corrientes.

Legal framework. In 1983 the Iberá region was declared a protected area in the category of natural reserve, becoming the Iberá Natural Reserve by a province law [11]. Ten years later the Iberá Provincial Park which is situated within the natural reserve, was created by another law. In 2008 these laws were regulated, establishing the boundaries of the natural reserve and the provincial park [12]. The INR is partially surrounded by several routes that define part of its boundaries, and the rest are geographically defined by coordinates.

Census information. The Argentinean territory is organized in divisions and subdivisions for political and administration purposes, called respectively provinces and departments. The National Statistics and Census Institute, and the province subsidiaries as the Statistics and Census Directorate belonging to the province of Corrientes, carry out operatives and develop the census cartography that enable information -data- collection. Taking into account the departments, the Institute divides the territory in subdivisions considering hierarchic guidelines for census purposes related to information collection activities. That territory portion is divided into smaller census units called fractions, which are made of radiuses, and these are subdivided into segments. *Fractions* are defined by physical elements of accessibility and surface area, and may have one or more radiuses within. *Radius* is the subdivision of a fraction, containing population as gathered or disperse settlements. *Segment* is the last census subdivision with the lowest territory extension, that contains the least number of housings and inhabitants, which is the area covered by each census officer to collect data [13]. The Institute considers *home* as the person or people that live under the same roof and share their feeding expenses. It defines *housing* or room unit as the accommodation that is structurally separated or independent, if they were built or adapted to be a place to live for people, or if this is not the case, they may be used for that purpose. *Amount of housings per census segment* is the number of housings settled within each of these territory subdivisions at a certain moment, and it is expressed as housings per segment [13].

Population information. From the total population of 40117096 inhabitants in Argentina, 9.2% are at the northeast region, including the province of Corrientes, which has 992595 inhabitants, that is, 2.5% of the country's population [13]. Regarding the distribution of people at the territory, *urban population* is the population that lives in areas with 2.000 or more inhabitants. On the other hand, *rural population* is the population gathered in locations with less than 2.000 inhabitants or that is dispersed in open field [14].

Sampling. The method applied was the Sampling by Area which is probabilistic [15]. The selection of the urban and the rural census segments was at random, and the confidence level was established in 95 %.

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III. RESULTS

The process followed aimed to select the areas -segments- with urban and rural population settlements in order to approach to the environment, health and sustainability of the inhabitants at the INR was based on the information generated by the last National Census of Population, Homes and Housing, that took place in 2010.

The process started with the detailed verification of the boundaries of the INR in order to transfer each reference point or physical element to the cartography.

Taking into account this geographic definition of the territory within the INR, the departments that it comprises were located. There were 7 departments of the 25 in which the province is organized, they were the department of Intuzaingó, of Santo Tomé, of General San Martín, of Mercedes, of San Roque, of Concepción and of San Miguel, as shown in Fig. 1.

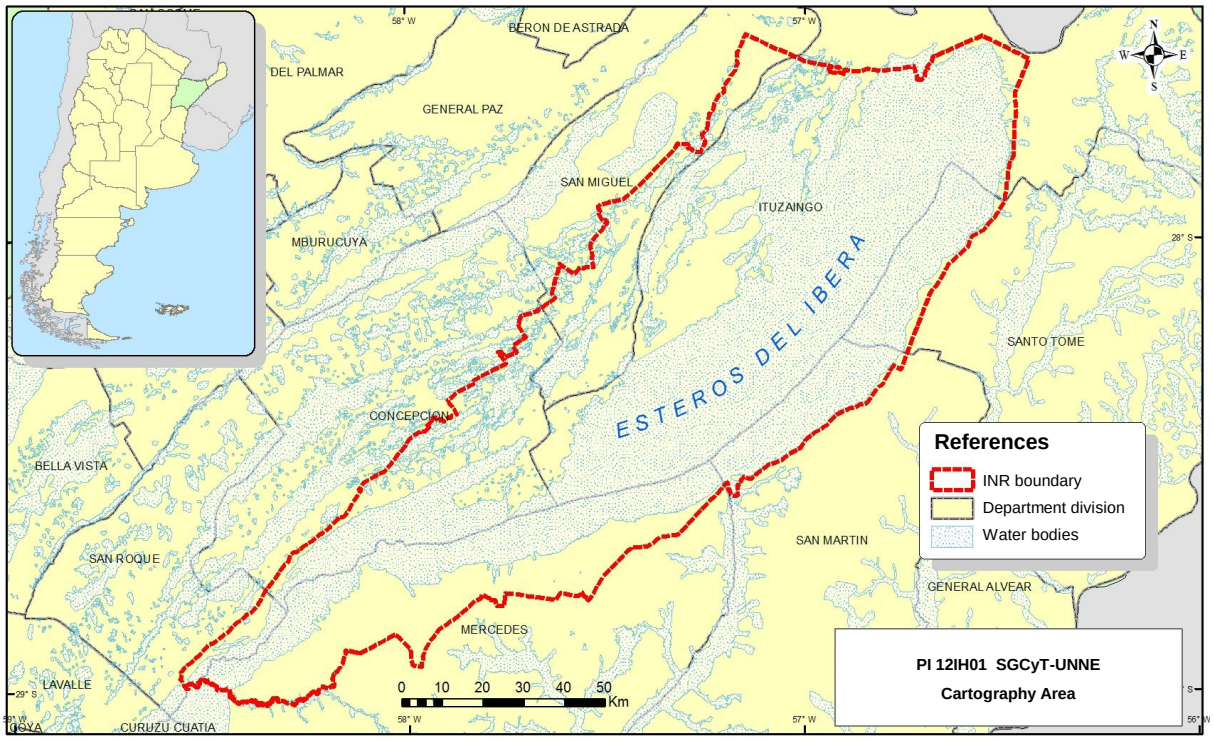

Fig 1. Departments of the Iberá Natural Reserve in the province of Corrientes, and geographic location of this province in the map of Argentina (upper left side).
Source: own generated cartography PI 12IH01 SGCyT-UNNE
Note: "Esteros del Iberá" in the map means Iberá Marshes.

The geographic definition allows to observe the urban areas with their population settlements, and the rural areas with the gathered and disperse population, that were located within the INR. In that way the first stratification of the territory was done in urban and rural areas, each with their own census fractions, radiuses and segments.

According to the last National Census of Population, Homes and Housing the Iberá Natural Reserve covered 213 census segments, from which 82 were urban segments and 131 were rural segments.

Those urban segments of the national reserve were located in the localities or towns of Villa Olivari and Colonia Carlos Pellegrini, including their whole surface area, and Loreto and San Miguel that were partially included. In these urban segments the national census found 1628 housings with a total population of 5760 residents. In the rural segments of the INR there were 1527 housings located with a total population of 4284 residents according to the same source, with different concentrations, most of them very dispersed or isolated.

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Also based on the information given by the national census in 2010, and regarding the INR boundaries, we were able to estimate that the population was of 10044 resident people. The distribution in the territory showed that 42.7% was rural population, and the rest, 57.3 %, lived in urban localities.

By means of the method of Sampling by Area the purpose was to select among all the census segments that are covered by the INR, those in which urban and rural population live and would be included in the study, based on the available information. After the initial stratification in urban and rural segments, a second stratification was performed analyzing the behavior of the *amount of housings per census segment* that showed different internal variability, having independent selection parameters for the urban segments on one side, and for the rural segments on the other.

The urban segments were segregated using the *amount of housings per census segment*, as previously mentioned, according to the following ranges: less or equal to 10; from 11 to 20, from 21 to 30, and 31 or more housings per segment.

The rural segments were organized also according to the *amount of housings per census segment* but with different ranges which were: less or equal to 6; from 7 to 10, from 11 to 15, from 16 to 20, from 21 to 29, and 30 or more housings per segment.

Applying the described process the selected urban segments were 15. Among them, 14 were randomly selected by stratification according to the ranges of housings per segment, and one of them was considered of forced inclusion due to its size. In these segments there were 326 housings with 1253 inhabitants included in the study. In Table 1 the conformation of the urban segments is shown.

Housings per Segment	**Census Segments** (n)	**Housings** (n)	**Population** (inhabitants)
less or equal to 10	*1*	*9*	*104*
11 - 20	*7*	*122*	*459*
21 - 30	*5*	*121*	*428*
31 or more	*2*	*74*	*262*
Total	***15***	***326***	***1253***

Table 1. Population and housings in the selected urban census segments. Source: own data.

Regarding the rural segments 47 were selected where 552 housings could be found and an estimated population of 1.530 inhabitants. The detail for each range of housings per segment is shown in Table 2.

Housings per Segment	**Census Segments** (n)	**Housings** (n)	**Population** (inhabitants)
less or equal to 6	*12*	*44*	*105*
7 - 10	*11*	*94*	*201*
11 - 15	*12*	*154*	*416*
16 - 20	*7*	*127*	*392*
21 - 29	*3*	*67*	*186*
30 or more	*2*	*66*	*230*
Total	***47***	***552***	***1530***

Table 2. Population and housings in the selected rural census segments. Source: own data.

The selected census segments of the INR to be visited in order to study the human dimension belonged to the fractions and radiuses showed in Fig. 2. As urban segments are much smaller than rural segments, mainly the latter are displayed.

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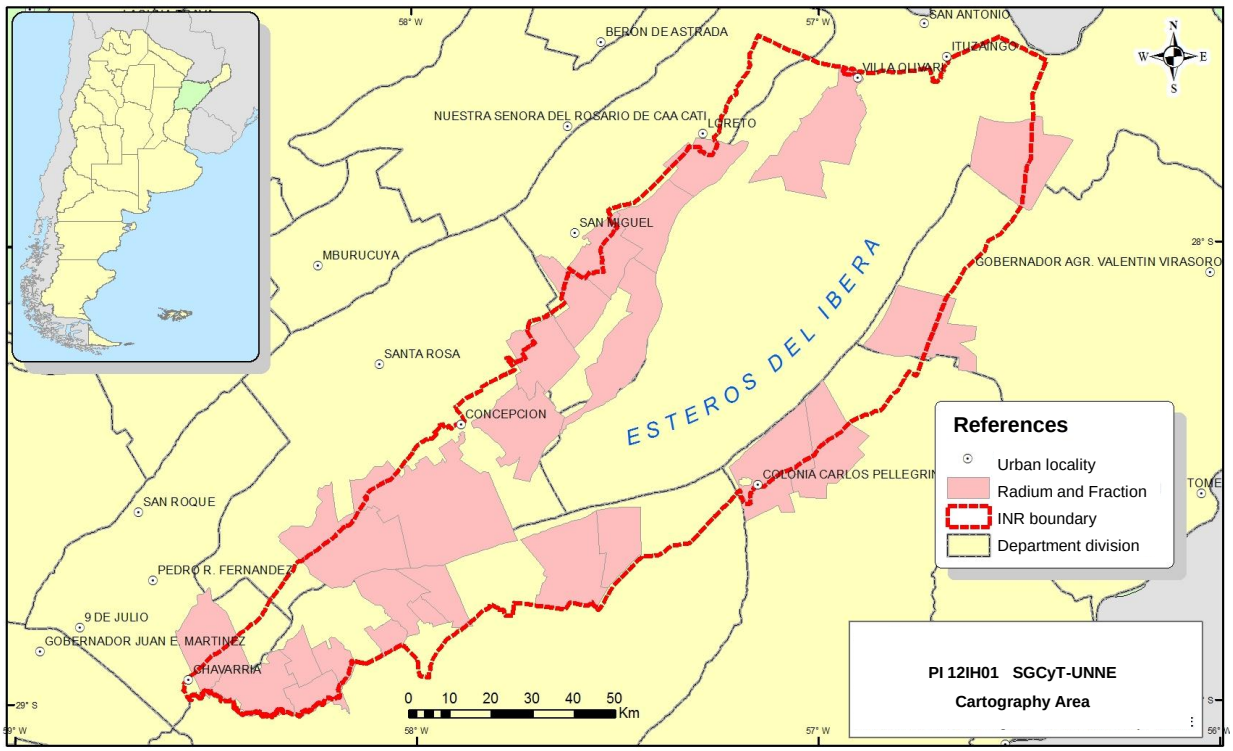

Fig 2. Fractions and radiuses where the selected census segments of the Iberá Natural Reserve were located.
Source: own generated cartography PI 12IH01 SGCyT-UNNE
Note: "Esteros del Iberá" in the map means Iberá Marshes.

It is relevant to mention that for the development of the study maps have been generated to guide the field work. These were the global cartography for the total surface area of the INR, one map for each selected rural segment, and detailed cartography of the selected urban segments in the localities to show the researchers the exact squares or streets to be visited.

IV. DISCUSSION AND CONCLUSION

The main objectives of epidemiologic research are to describe health conditions in human population and contribute to the discovery of the social, environment, and biological factors that affect those conditions, which needs the collection and analysis of empirical data of the population [16]. The recent National Survey of Nutrition and Health gave very relevant information, and it studied only small children and women to 49 years old [17]. In the province of Corrientes it was carried out in 4 localities showing alarming figures but excluded some groups as males, all the rural population, and the population settled in the Iberá due to the difficult access to the region. The previously mentioned demographic transition involves the process of urbanization promoting deep changes in the cultural and feeding patterns. In this sense, the population distribution in Argentina in 2010 showed that 91% is resident in urban localities, and in the province of Corrientes 82.8% is urban population [14]. During the selection process the stratification in urban and rural areas, allowed to analyze the segments in both strata showing that 42.7% was rural population in the INR. The population distribution in the Iberá displays a considerable difference respect the country and the region situation, which is another indicator of the particular features of the INR population. The selection process among the segments covered by the national reserve generated 62 census segments to be included in the study, 47 from the rural and 15 from the urban strata, but both will be considered to report global results for the population of the INR. The social and demographic transformations have highlighted the increasing multi-morbidity, which is especially relevant for the organization of health services provision. Although multi-morbidity mainly affects eldest people, in social disadvantaged populations, children and young adults may also be affected. For this reason, the study focuses the whole family group, and all the inhabitants in each selected census segment have been considered. The selection process resulted in the inclusion of inhabitants

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from the rural and urban segments, having a representative sample of the population, with no exclusion due to age or any other reason. The method of Sampling by Area based on census information [18] resulted appropriate for the selection of the areas of the INR to be included in the study, and allowed the generation of the cartography with the territory divisions applied by official organisms. The selection of the census segments was an essential stage of the study to plan the work in the field to gather information. The relevance of the selection process described herein is that constitutes a model that can be transferred to other places or regions with heterogeneous population distribution, thus enabling the approach to families and communities that may be settled in little explored or isolated areas of the planet, making possible inclusive studies that could promote the wellbeing of the population.

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