

# **Urban Planning Utilizing Geographic Information System: Case Vila Cai, Porto Alegre, RS - BRAZIL**

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**Keywords:** Urban, planning, geographic information system.

## **SUMMARY**

The participative budget policies work in association with specific local government programs within the different municipal agencies, as exemplified in the Sustainable Community Tele-centres (TCs) Program, managed by the Data Processing Company (PROCEMPA). Non-Governmental Organizations (ONGs) also play a main role in the success of the implementation of these participative policies throughout their hands on work within social movements, at local level. In this conception, this paper exploits the possible contributions of Geoprocessing technologies to enhance participative planning process at local level. It studies the use of Geographic Information Systems (GIS) to deal with the official data within the municipal government agencies. It emphasises the data concerning irregular settlements, exemplified in the case of Vila Cai, Cristal neighbourhood, Porto Alegre, Brazil. It deals with the potentialities of the use of GIS technology for structuring and visualizing data concerning the design of housing policies and implementation of municipal programs.

In the case of the city of Porto Alegre, the present Land Use Plan (PDDUA) and the Municipal Program of Regularisation of Land Tenancy (PRF) are the main tools for regulating the urban growth towards more social inclusion practices and better quality of urban life. The Participative Budget (OP) encompasses the model of direct democracy participation at local level, which is already a worldwide well-known successful experience.

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## 1. INTRODUCTION

Porto Alegre is the capital of the Brazilian State of Rio Grande do Sul (RS). The municipality was founded on 26 March, 1772, and emancipated on 23 August, 1808. It is located next to the Guaíba estuary, in the Southern region of the country, at longitude 51°13'48" West and latitude 30°01'59" South.

According to the Brazilian Institute of Geography and Statistics [*Fundação Instituto Brasileiro de Geografia e Estatística* (IBGE)], the municipality covers an area of 496.8km<sup>2</sup>; the estimated GDP for 2001 was R\$10,164,445,391.00 and the population in 2005 was 1,428,696 inhabitants.

The reality of housing in Porto Alegre presents two aspects: first, a housing deficit, representing a lack of newly constructed housing, and another deficit, as cruel as the former, characterised by the precariousness of conditions of the sub-housing existing in irregular areas. This is the common reality of most Brazilian municipalities, especially concerning problems in areas with irregular settlements, which may be exemplified by Vila Caí, in the neighbourhood of Cristal, in this city.

This study was carried out in 2002 and 2003. The land where Vila Caí is belongs to the municipality. The government intended to transform this land into a green area, but it was invaded by squatters before that happened. Figure 1 shows Brazil, the country's States, Porto Alegre on a bigger scale, the State of Rio Grande do Sul and a detailed view of Vila Caí.

Porto Alegre's Land Use Plan [*Plano Diretor de Desenvolvimento Urbano e Ambiental – Directing Plan for Urban and Environmental Development (PDDUA)*], the integrated social actions of the Municipal Secretaries, the Programme for the Regularisation of Land Tenancy [*Programa de Regularização Fundiária (PRF)*], the Regional Administrative Centres, the Participative Budget, as well as the creation of Tele-centres may be understood as part of the policy of social inclusion.

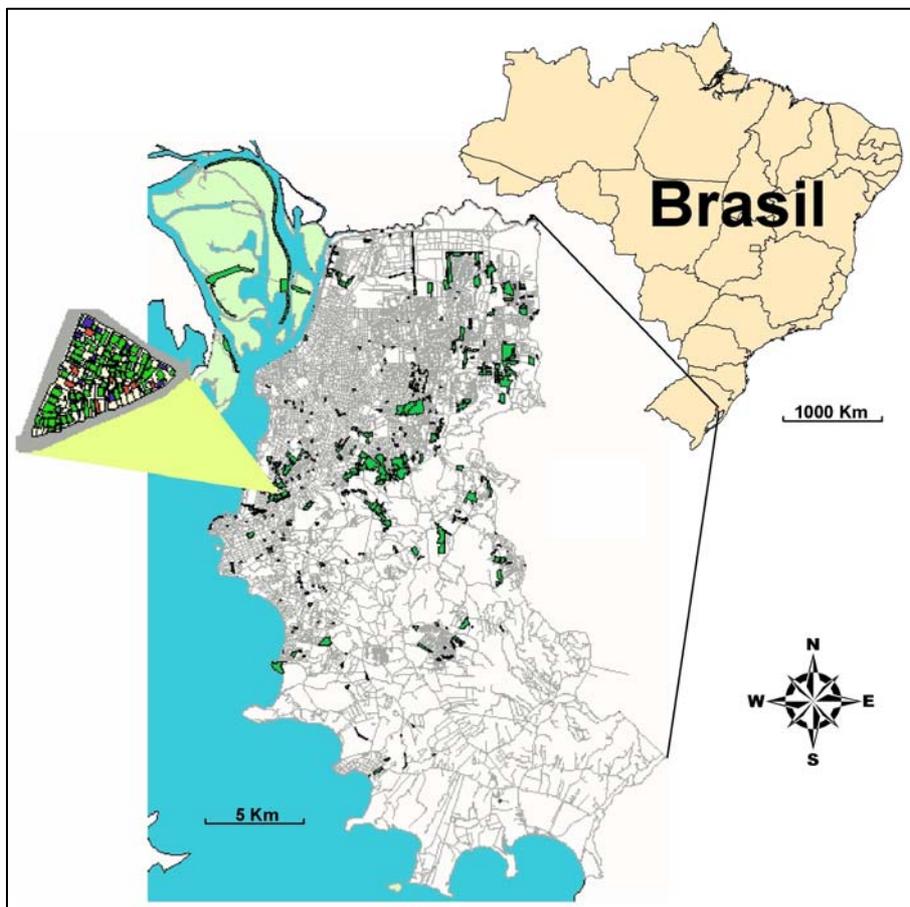
The objectives of these policies of social inclusion are organising, planning and managing public actions. They are able, through the Geographic Information Systems - GISs, to treat data and to express those data through maps, easy-to-understand plans, which can even be visualised through the use of new technologies and the Internet.

A computerised databank was organised about the families in situations of poverty and their profile according to the registers: income, type of residence, size of family, education and nutrition levels. When a family fills out the registration forms, it is automatically involved in one or more social projects.

The registration of Porto Alegre families in a situation of social vulnerability was proposed by the Federal Government through the registration of 24,039 families, which had become vulnerable due to poverty. Those families were registered through a specific software, belonging to the Federal Savings Account Bank of Brazil [*Caixa Econômica Federal do Brasil*], made available to all Brazilian municipalities through the Internet.

This project has been recognised as making a major contribution to the creation of a Map of Inclusion and Exclusion in Porto Alegre, making it easier to access a larger scope of information and consolidating the georeferential indicators about the process of exclusion and the social inequalities which affect the city, as well as the unification of administrative records about the users of social policies.

The Geographic Information System has begun to be applied as a structuring device for these records, on a municipal level.



**Figure 1** - Map of Brazil, with its States, showing the location of Vila Caí in Porto Alegre -RS.

## 2. OBJECTIVES

The rapid process of growth of the greater urban areas in Brazil has brought about many social, economic and environmental problems, made possible through a great concentration of people, forming nuclei or communities in areas which, most times, are inappropriate to housing.

The formation of such communities is the result of administrative negligence and a reflection of the lack of opportunity, access to the job market, to education, as well as to health system, depriving them from the right to free access to shopping, sanitation, transportation, and security, among other rights, and excluding those communities socially.

Social, economic and environmental information about these communities is fundamental to create a social and spatial databank.

Within the scope of the formal city the lack of reliable information is quite obvious, with often outdated data, distorting the reality of the more deprived areas, such as popular settlements. The action in these regions is intimately linked to the situation and the existent problems. In this case, the municipal structure often does not have precise information neither the tools appropriate to managing such situations.

The incorporation of a Geographic Information System to the technical record becomes an extremely important ally in the collecting and organisation of record data, making it easier and quicker to visualize those data.

The implementation of a Geographic Information System aiming at the management of the city helps in the assessment and the recognition of the municipal realities, which, apart from the formal city, contemplates informal situations, such as Vila Caí, where, for example, the increase in population density and other factors interfere directly with the quality of life.

In order to plan and manage the quality of life, information about the distribution of housing units, their use and land occupation, about the means of circulation, among other factors, is fundamental in order to inform the political decisions.

This project has tried to demonstrate that it is possible to construe spatial-oriented information through the Geographic Information System. The collecting of descriptive data and the vector-based, georeferenced profiles help us make better decisions about public areas. The planning processes, as well as the assessment of social inclusion policies, are made easier through the use of the system. They expand the radical changes in the priorities of investment of public resources, make information about life conditions in the neighbourhoods and other regions of the city more democratic, and encourage the communication with the communities, through visual representation, leading to a better understanding of the situation by the community associations, as well as the dwellers of the settlement, who may then participate more intensively in the future reurbanisation projects.

The registration obtains, besides the information on the identification of individuals, some data about the characteristics of his/her housing unit. The relationship between geographic and social space related to housing and to the individual allows us to characterise the demand for social policies, as well as for the regionalisation of services and the creation of resource flows.

It is necessary to integrate the administrative systems of the many different Secretaries involved in issues related to those families, which makes it possible to create a historic record of municipal assistance.

Thus, the Geographic Information System allows for the compatibility with the other municipal systems, and works as a database for integrated applications in the many different spheres of social policies in the municipality.

### 3. ALPHANUMERIC DATABASES

At the start, we based our survey on the topographic data and the records we obtained from the Municipal Department of Housing [*Departamento Municipal de Habitação (DEMHAB)*]. Then we needed to georeference this drawing, on the CAD platform of the cartographic survey. We used as the cartographic basis for this survey the digital map of Porto Alegre, which had a lot of information which could be cross-referenced and analysed in this project. The maps were executed using the “dwg” graphic format, made compatible with the “shp” format of the software Arcview 3.2.

The graphic data were worked on the software Arcview 3.2 itself, which made it possible to create the topological structure of the two levels of information: blocks and buildings. The alphanumeric data were taken from the tables of the topographic surveys and records, obtained through an analogical query, and became part of the database, initially normalised though the use of Access, structured into spreadsheets and saved in “mdb” format. Those spreadsheets were then converted into DBF files, dbase3 files and finally unified into one DBF spreadsheet.

The alphanumeric information was then organised into two tables: one for buildings with a classification of different types of building, and another with the blocks, with the social and economic data taken from the query and other sources. It was thus possible to create a social and spatial databank of Vila Caí, as it can be seen in Figure 2. The division aimed at making it easier to search the databank.

The collecting of information began when the Foundation for Social Assistance and Citizenship [*Fundação de Assistência Social e Cidadania (Fasc)*] started the process of a unified registration for social programmes, in its regional centres. Teams from the Federal University of the State of Rio Grande do Sul [*Universidade Federal do Rio Grande do Sul (UFRGS)*], contracted by the Fasc, performed the door-to-door survey. An analogical query was then carried out among the dwellers of the settlement. This query was not meant to be digitalised, and the data had to be manually compiled.

Special care and attention to some principles were observed throughout: privacy, integrity of information, treating the information as true, perceiving the relevant facts, adjusting the answers in order to better identify the problems, identifying the overall information in order to obtain better results and other relevant factors, inherent to the process of the survey.

In brief, all the data were compiled into spreadsheets, a layout was designed for a databank, and the different degrees of privacy, relevance and reliability were considered and then compiled into the software Arcview 3.2.

Area	Date	Area	Plot Area	Area	Date	Name	Sex	Age	Area	Fund	Fund	Fund	Name	Name	Sex	Estimate	Cost	Month
37.00000	19910725	192.80660	60.89672	120.00000	19910725	CAI	AV CAI	1032	N	2.00000	119.00000	CRISTAL	PORTO ALEGRE	AV	JORGE	3	4.0	
36.00000	19910725	198.21300	57.37937	113.00000	19910725	CAI	AV CAI	1031	N	2.00000	119.00000	CRISTAL	PORTO ALEGRE	AV	MARIA	2	10.0	
38.00000	19910725	163.38670	58.57227	130.00000	19910725	CAI	AV JAGUARI	158	N	2.00000	119.00000	CRISTAL	PORTO ALEGRE	AV	JUPACI	1	4.0	
35.00000		189.18160	71.00553							0.00000	119.00000	CRISTAL	PORTO ALEGRE					0.0
34.00000	19910725	139.99510	47.64816	121.00000	19910725	CAI	AV CAI	1049	N	2.00000	119.00000	CRISTAL	PORTO ALEGRE	AV	ILSA	1	2.0	
39.00000	19910725	149.72400	64.30000	129.00000	19910725	CAI	AV JAGUARI	154	N	2.00000	119.00000	CRISTAL	PORTO ALEGRE	AV	JOAO	3	5.0	
33.00000	19910725	120.81930	50.68547	122.00000	19910725	CAI	AV CAI	1059	N	2.00000	119.00000	CRISTAL	PORTO ALEGRE	AV	NEVALI	1	5.0	
32.00000	19910725	104.60060	46.26570	125.00000	19910725	CAI	AV CAI	1069	N	2.00000	119.00000	CRISTAL	PORTO ALEGRE	AV	MAURICIA	2	2.0	
40.00000	19910725	181.14840	68.41850	128.00000	19910725	CAI	AV JAGUARI	152	FRENTI	N	2.00000	119.00000	CRISTAL	PORTO ALEGRE	AV	EVA	1	3.0
31.00000		61.07012	31.37369							0.00000								0.0
64.00000	19910729	53.57031	29.28102	186.00000	19910729	CAI	AV CAI-BECO D	1051-3	S	2.00000	119.00000	CRISTAL	PORTO ALEGRE	BECO	GISLAINE	3	2.0	
41.00000	19910725	211.18360	71.65991	134.00000	19910725	CAI	AV JAGUARI	178	FRENTI	N	2.00000	119.00000	CRISTAL	PORTO ALEGRE	AV	EDSON	3	4.0
30.00000	19910725	102.50990	52.07037	116.00000	19910725	CAI	AV CAI	1075	N	2.00000	119.00000	CRISTAL	PORTO ALEGRE	AV	LUIS	4	4.0	
29.00000	19910805	137.02540	46.77952	119.00000	19910805	CAI	AV CAI	1041	FUNDO	S	2.00000	119.00000	CRISTAL	PORTO ALEGRE	AV	MANOEL	0	3.0
65.00000	19910729	64.96242	34.50816	185.00000	19910729	CAI	AV CAI-BECO D	1051-2	S	2.00000	119.00000	CRISTAL	PORTO ALEGRE	BECO	EDINO	1	7.0	
42.00000	19910725	93.85254	48.99837	133.00000	19910725	CAI	AV JAGUARI	176	N	2.00000	119.00000	CRISTAL	PORTO ALEGRE	AV	ORTIZ	4	3.0	
63.00000	19910729	97.06641	41.58825	181.00000	19910729	CAI	AV CAI-BECO C	1969-1	S	2.00000	119.00000	CRISTAL	PORTO ALEGRE	BECO	JOAO	4	5.0	
66.00000	19910729	101.04200	45.04914	184.00000	19910729	CAI	AV CAI-BECO D	1051-1	S	2.00000	119.00000	CRISTAL	PORTO ALEGRE	BECO	EPONINA	3	2.0	
38.00000	19910725	210.34860	62.67185	124.00000	19910725	CAI	AV CAI	1085	N	2.00000	119.00000	CRISTAL	PORTO ALEGRE	AV	ANILDO	4	5.0	
43.00000	19910725	63.12695	46.37864	136.00000	19910725	CAI	AV JAGUARI	180	N	2.00000	119.00000	CRISTAL	PORTO ALEGRE	AV	MARIA	1	2.0	
58.00000	19910729	82.29785	50.65963	179.00000	19910729	CAI	CAPIVARI-BECO A	5	N	2.00000	119.00000	CRISTAL	PORTO ALEGRE	BECO	DIONISIA	1	15.0	
60.00000	19910729	96.35645	37.91623	115.00000	19910729	CAI	AV CAI	1075	FUNDO	S	2.00000	119.00000	CRISTAL	PORTO ALEGRE	AV	SERGIO	1	2.0
67.00000	19910729	43.55961	26.77105	191.00000	19910729	CAI	AV JAGUARI-BECO	180-1	S	2.00000	119.00000	CRISTAL	PORTO ALEGRE	BECO	MARIVONE	1	6.0	
27.00000	19910731	108.67190	50.92892	118.00000	19910731	CAI	AV CAI	1089	N	2.00000	119.00000	CRISTAL	PORTO ALEGRE	AV	ADELINA	3	6.0	
44.00000	19910725	213.37520	68.09685	137.00000	19910725	CAI	AV JAGUARI	184	N	2.00000	119.00000	CRISTAL	PORTO ALEGRE	AV	GUARADI	2	3.0	
62.00000	19910901	51.75900	30.21844	183.00000	19910901	CAI	CAI-BECO C	1069-3	S	2.00000	119.00000	CRISTAL	PORTO ALEGRE	BECO	SANDRA	1	4.0	
68.00000	19910803	79.19531	40.24181	187.00000	19910803	CAI	AV JAGUARI-BECO 2		N	2.00000	119.00000	CRISTAL	PORTO ALEGRE	BECO	TEREZINHA	3	4.0	
59.00000	19910725	104.77150	41.05953	114.00000	19910725	CAI	AV CAI	1041	FUNDO	S	2.00000	119.00000	CRISTAL	PORTO ALEGRE	AV	JOAO	4	8.0
61.00000	19910803	45.43862	28.74760	182.00000	19910803	CAI	AV CAI-BECO C	1069-2	S	2.00000	119.00000	CRISTAL	PORTO ALEGRE	BECO	MANOEL	4	7.0	
55.00000	19910729	121.06500	44.03454	175.00000	19910729	CAI	CAPIVARI-BECO A	1	N	2.00000	119.00000	CRISTAL	PORTO ALEGRE	BECO	MARIA	1	10.0	
45.00000	19910725	36.06348	25.51408	139.00000	19910725	CAI	AV JAGUARI	186	N	2.00000	119.00000	CRISTAL	PORTO ALEGRE	AV	ELIANE	4	9.0	
26.00000	19910731	227.41410	67.82188	126.00000	19910731	CAI	AV CAI	1430	N	2.00000	119.00000	CRISTAL	PORTO ALEGRE	AV	FULANO	2	5.0	
57.00000	19910729	38.81152	25.27032	178.00000	19910729	CAI	CAPIVARI-BECO A	4	N	2.00000	119.00000	CRISTAL	PORTO ALEGRE	BECO	MARIA	3	8.0	
71.00000		40.40234	20.02195							0.00000								0.0
19.00000	19910729	257.87110	89.84658	173.00000	19910729	CAI	CAPIVARI	1486	N	2.00000	119.00000	CRISTAL	PORTO ALEGRE	AV	DIONE	4	4.0	
46.00000	19910725	82.30273	41.26406	139.00000	19910725	CAI	AV JAGUARI	188	N	2.00000	119.00000	CRISTAL	PORTO ALEGRE	AV	WEDALVINA	3	2.0	

Figure 2 – Table with the data of the families in Vila Caí.

#### 4. CARTOGRAPHIC BASIS

The digital cartographic basis was organised in a 1:15,000 scale, using a Gauss Kruger projection, constantly updated to a 1:10,000 scale, based on information from the Secretary of Municipal Planning, which updates the city's Street Registry.

The basic levels used were the contours of the municipal limits, showing the Guaíba estuary and the archipelago, the axes of the streets used to georeference the area, related to Vila Caí and the division of neighbourhoods.

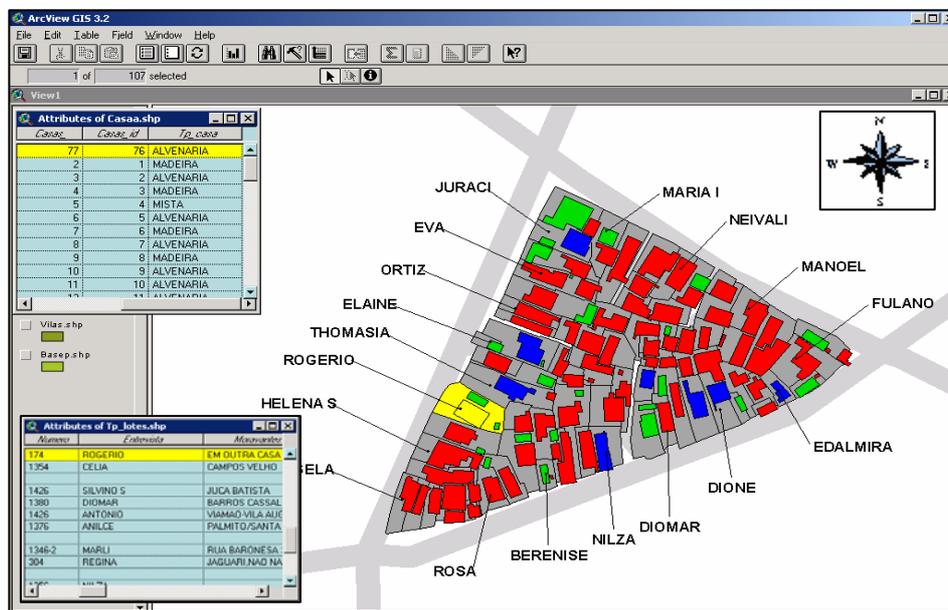
In this project, we used the theme of sub-housing, based on graphic and alphanumeric information belonging to the Municipal Department of Housing, created for the Land Tenancy Regularisation Programme, through the Coordination of Urbanisation and Land Tenancy Regularisation, related to the settlement of Vila Caí.

Based on the CAD maps, two basic graphic levels of information were created: one on the level of the blocks, with social information added, and another with specific data about the buildings, as it can be seen in Figures 3 and 4.

After we had formatted the information about Vila Caí, we were able to make several consultations to the databank, expressing visually the intended questions, according to the examples of theoretical questioning and graphics which will be discussed later.

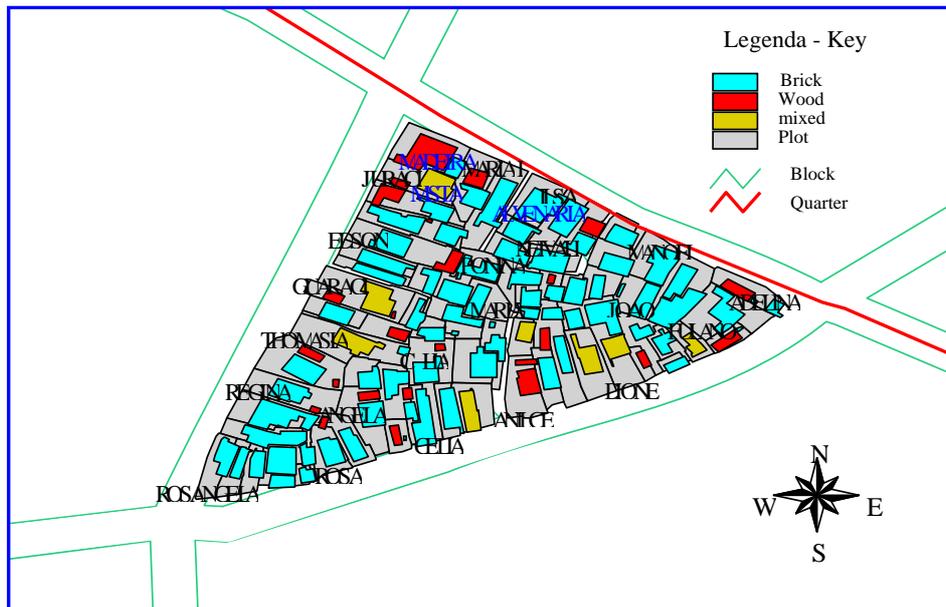
Based on this georeferenced digital databank, as well as the other pieces of graphic and alphanumeric information, obtained through the other municipal databanks, we may also create many other thematic products. However, the new information must be previously elaborated and geocodified.

When cross-referencing the generated data, we based our analysis on the overlaying of layers of information based on topographic surveys and records and on the area that would be analysed, divided into blocks and buildings, according to themes. Those levels of information were then overlaid over other existing digital bases for the municipality of Porto Alegre, aiming at verifying the positioning with the georeferencing of the location of Vila Caí and other spatial municipal information. Some information could not be visualised in this project, because it did not belong to our main subject.



**Figure 3-** Consultations of the databank on buildings and plots.

In this consultation, we can observe Vila Caí, its plots, buildings and the names of the dwellers. Figure 4 shows the materials used in the building and the name of the owner.



**Figure 4** – Consultations of the databank – Dweller’s name vs. type of building.

## 5. GIS AND THE THEMATIC MAP

Besides the aspects of scale precision inherent to the process of generation of different bases found in the distribution of dwellings and blocks within the Municipal Digital Base, we generated a reliable graphic base of the settlement, enabling us to visualise it thematically and spatially, which has made it possible to print many different scenarios for future studies with alternatives for local re-urbanisation.

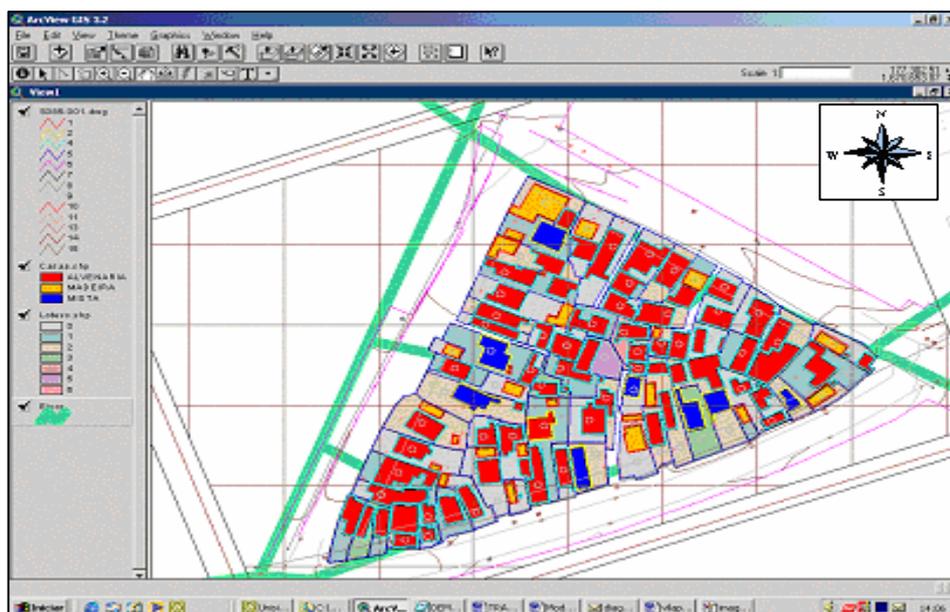
With the mapped information, we were able to make a series of analyses, both through the consultation of the databank and/or visually, through the overlaying of different levels of information. For example:

- The distance between the community and several items of urban infrastructure, such as hospitals, schools, security, communication, transportation, etc;
- Land price per square metre in Vila Caí, as compared to the price of land in the region;
- The size of plots, as compared with the size of the buildings;
- The built area per inhabitant;
- Type of building;
- Types of leisure of the family and the age groups;
- The number of dwellers per family, and the number of families per plot;
- The ratio of men to women and the degree of kinship;
- Types of diseases according to age group and gender;
- *Per capita* and family income;
- Education levels;

- Job status and main professional activities;
- Commercial establishments, the existence of child care facilities, public bars and churches;
- Where the children stay when mothers go to work;
- And others.

Through a Geographic Information System, it was possible to visualise the information we wanted, showing the reality in the area, as it can be seen in Figures 5 and 6. With the help of thematic maps, we could identify the heterogeneity of social data, which was not previously possible. We also noticed that there is a lack of more integrated work on the institutional level, which is harmful to the maintenance of essential data. It is necessary to assess the production processes of this information, creating new solutions for the issues of generation and updating.

The maintenance of the database as a continuous process is still a great challenge, made obvious by this analysis. This difficulty found in public institutions springs from the dynamic character and the mobility of urban occupation, especially in illegally occupied areas, as is the case with Vila Caí and other parts of the informal city.



**Figure 5** – Map of the plots and the buildings with a topographic survey.

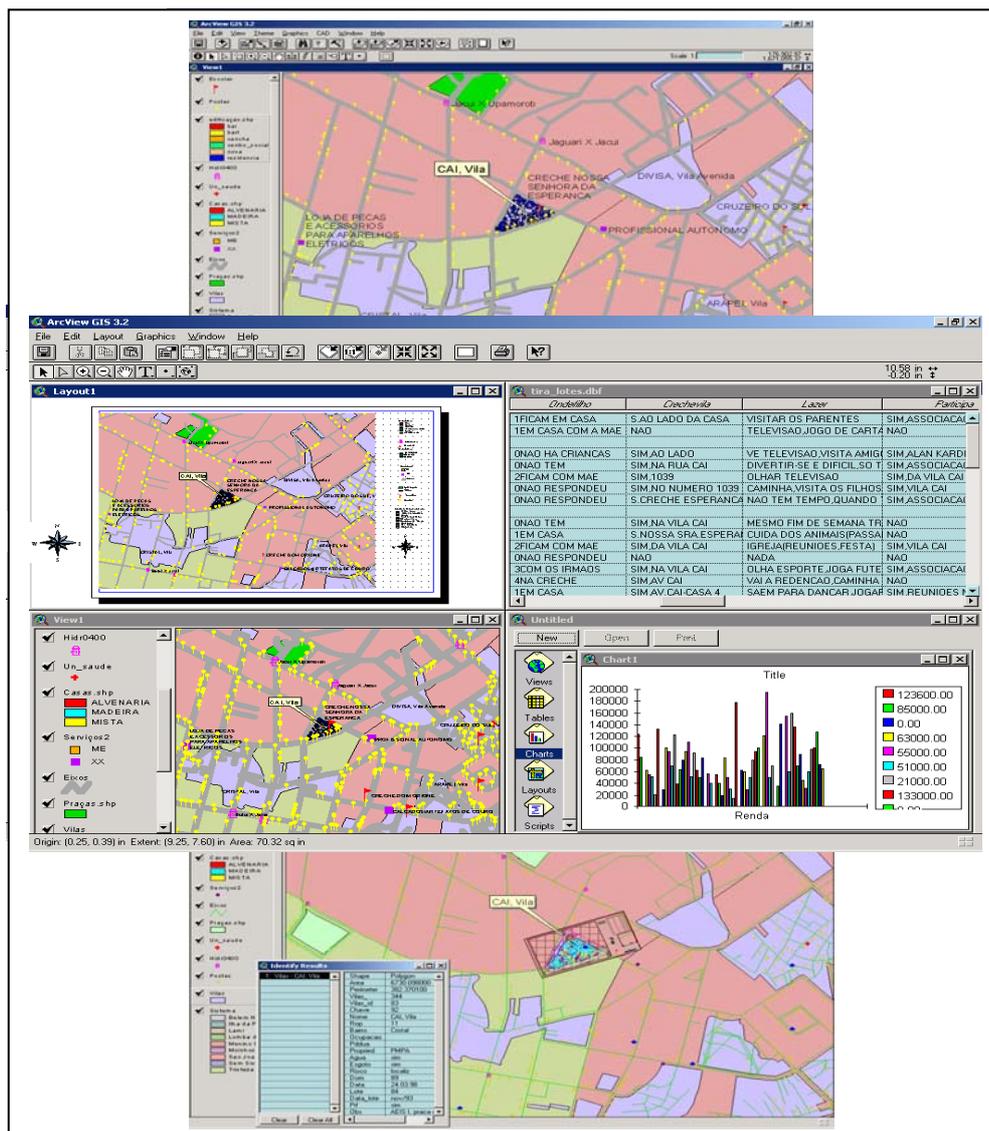


Figure 6 – General visualisation of the application.

## 6. APPLICATIONS AND RESULTS

An alternative is necessary in order to overcome social exclusion, making it possible to integrate all the population into the economic and social life of the city. Through this participation dilemma, land tenancy regularisation has established itself as one of the most important aims of the community.

It has been proved that the use of a Geographic Information System as a complementary tool for urban planning and management may provide new perspectives for the management of services, mainly in the social area, through the expansion of multiple insights into the reality and into the future.

This project began with the registration of the social and economic characteristics associated to the graphic entities, providing subsidies for the future elaboration of a plan for basic urban restructuring of the area, with some housing units being relocated in order to give room to urban and landscape treatment, improvement of the urban infrastructure, and the location of urban movables, providing the area with an architectural and urban conception, more appropriate to the present situation of the area, as well as to the aspirations of the community. It is worth to point out that all this must be done according to legal and technical standards, in order to form an harmonic and comfortable whole, with security, ease of circulation, in a humanised space, bringing social improvement to the space as a whole.

The Geographic Information System is presently one of the tools that most grow in First World countries, and has already reached a considerable level of expansion in Brazil. The interest in this tool has constantly grown, as a supporting device in decision making and as a possibility for representing the reality and the geo-political, geo-economic and environmental problems, as well as a tool for the analysis and operationalisation of territorial planning, zoning, monitoring and management processes.

This tool may add to the reliable basis of all information, making it possible for it to be used in planning more efficiently the areas irregularly occupied, in situations where they do not exist: spatial ordering; urban control; designing of lanes and winding, narrow culs-de-sac; small plots and in disproportional number to the density of the existing population, which results, most of the time, in housing inappropriate to living in.

The maps are visual instruments which make it easier to understand great amounts of information, synthesising the spatial perception that human beings have of their environment, i.e., a map represents graphically the information of a specific space. Therefore, in order to know a place, we need drawings, maps and, the more intelligent these are, the better they represent reality.

The integration and interactivity of this information (both quantitative and qualitatively) depend directly on the above mentioned surveys and on all the data related to popular settlements for the generation of methods or procedures necessary to the successful designing of public policies for urban and social development.

## **7. DEVELOPMENTS AND CONCLUSIONS**

This project has made it clear that the use of a Geographic Information System, as well as its direct applicability as a supporting tool for the creation of a social databank, is extremely important. Through these tools, it was possible to thematically visualise information. For example: the distribution of dwellings and people in the area of the community, the proximity between plots and other factors which may have an impact on the life of the community and, on a larger scale, on the life of the city.

The summary of actions related to social policies in the Porto Alegre area intended to grasp the applicability of the Geographic Information System in many different areas, where we

were able to experiment with its potentialities, not only in the case of Vila Caí, but also in other areas of the municipality where social degradation was detected, with a wide Participative Planning.

Through visualisation made easier by technology, we can characterise the potentialised social risk, due to lack of basic infrastructure, which has an impact over individuals.

This case study made it clear that the Geographic Information System may be a simple and low cost tool, highly beneficial when used to assess, treat information, and act as a support for decision making and in the construction of instruments aiming at designing public projects related to social policies.

In order to regularise and recover the areas where social degradation was detected, in the case of Porto Alegre, the process of elaboration of an urban project begins with the conclusion of a topographic survey and must be approved by the community. In order to do so, one must first verify what the reality of the area is. The Participative Budget is a popular instrument to find solution for these demands. For land tenancy regularisation, it is also necessary to collect documental data and to verify how long each plot has been occupied, and by whom, in order to reach a judiciary decision. At the same time, projects are gradually developed to build and urbanise the area according to projects of basic infrastructure.

The versatility of the Geographic Information System helps structuring this information, representing it spatially with data from the municipal records and contributing to the application of strategic planning of social policies.

The solution for the problem of housing does not rely solely on the use of a Geographic Information System, nor on the isolated action of one project, but rather on the association of many alternatives which can organise, finance, build and regularise, making it possible to improve the conditions of living and dwelling in irregular areas and integrating them to the formal city.

In order to do so, it is desirable to quantify and monitor the multiple variances of the social, economic and environmental characteristics to better analyse, question, and predict possible changes in social transformation.

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