PART I : INTRODUCTION TO THE CONTEXT OF THE ISSUE UNDER QUESTION

1 MARGINAL AREAS AND THEIR URBAN CONTEXT

Ivana Arruda Silveira

Large cities are today affected by a decline in the quality of life, following a booming population and physical growth, which has contributed to the widening of the social, economic and cultural gap in different areas of the same city. The lack of effective control mechanisms which would have allowed the Public Administration (P.A.) to manage the land, thus assuring its protection and pooling all the social forces, has led to a chaotic and disorderly development of occupation processes in urban areas. This lack of control has led to an actual segregation between so-called "noble districts", "popular districts" and "favelas". The population is usually highly concentrated in the town centre, with a medium density in the areas around the centre and with a lower density at the outskirts.

Some sectors of the favelas' population actively participate in the town's production process, even though they are cut out from the urban context, given their limited economic means to purchase consumer goods in the town. Following the booming population growth, which has boosted real estate speculation, due to the demand increase, control mechanisms allowing the P.A. to regulate the urban and suburban land value have become ineffective, thus making it difficult to manage the public welfare. In fact, the urban land high costs discourage the purchase of land for collective purposes. Therefore, the costs of houses, public infrastructures and basic services have increased so much that they have prevented low-income population brackets from having access to the housing market.

Hence, the urban space includes a sort of stratification of society, which consequently leads to the emergence of specific phenomena. Favelas develop within this framework, as a possibility of expropriation of urban space by migrants, at first, and by low-income population brackets, successively.

"The favelas areas are characterized by specific location, size, shape and density, which vary according to the ratio between the land availability - which is not used by the P.A. for public purposes or which belongs to private owners - and the interests of low-income citizens, who struggle for their right to the city" (PROFAVELA).

The favelas' structure is thus different from the standards characterizing other urban areas. Nevertheless, these areas must be considered to be fully part of the town. The redefinition of town planning standards and rules must take place within this town context, taking into account the whole complex's social, economic, cultural and urban structure.

Until the early Eighties, favelas were not recognized by P.A. and were considered to be just "empty spaces" in the town's map. The dwellers of these areas lived in poor conditions, without basic infrastructures and services, with the ever present threat of having their shanties demolished and their families evicted by the Governmental authorities, which are responsible for the clearance of favelas from the occupied areas.

Due to these problems, favelas' dwellers set up Community Associations, through the Favelas Outskirts Workers' Unions, in order to claim their right to be recognized by society. Their aim was to share and enjoy the benefits granted to all the other citizens, upon the recognition of their right to participate in the management process of urban spaces and services.

It has taken no less than twenty years to claim and obtain the issuing of the Law 3532/83 followed by the Regulation Decree 4762/84, which makes up the present Legislation of the so-called PROFAVELA, the Favelas Regularization Municipal Programme.

Thanks to the promulgation of this Law, marginal areas are recognized as social interest areas and are entitled to benefit from town services, through special programmes. One of the instruments envisaged by the Law is that of the so-called "social welfare parcelling out", which allows the needy people to have access to the urban land.

The Law 4.034/85 has included Special Sector 4 (SE-4) in the town parcelling out, taking PROFAVELA's fundamental contents into account. Town planning parameters - cadastral parcels, divisions and groupings - were reviewed, being adjusted to the reality of marginal areas in Belo Horizonte.

PROFAVELA envisaged the legalization and urbanization of the 128 favelas, which were officially registered in the BH's Prefecture's cadastre. It aimed at promoting their reclamation and integration in the urban structure.

PROFAVELA not only enabled the favelas community to acquire a socially important law, but also made society aware of this problem, which was then tackled from a different point of view. Until the

promulgation of this law, favelas were considered to be an urban "problem", according to the parameters and standards of the "officialtown". Indeed, marginal areas are a manifestation not only of structural problems at regional level, but also of social and economic problems. Therefore, they require special attention and must be considered within the framework of municipality's competences. Two aspects, in particular, must be thoroughly analysed:
- the recognition and preservation of the specificity of each area, integrating it in the urban context.
- the recognition of their inhabitants' citizenship right. In this way, the "favela" can be integrated in the "official town" and regarded as a "solution" to the housing problem by the low-income population.
According to the census data, Belo Horizonte is today the fourth city of Brazil, with a population of 2.4 million inhabitants, out of whom 400,000 live in marginal areas. 224 marginal areas were surveyed by the Prefecture aerial map (1989), out of which only 128 were identified as SE-4 areas. In this map, the growth and thickening of some already existing favelas can be observed, as well as the creation of new marginal areas. These data have shown that the surface occupied by favelas has grown from approximately 850 ha to 1100 ha, with an average density of 332 inhabitants/ha, an average parcel surface of 167 m2 (including the road network) and an average value of 5.2 inhab/parcel and 4.2 inhab/house (URBEL data 1992).
These data show that the BH population, as a whole, has not grown as much as that of favelas. Furthermore, it can be pointed out from new available data that the migration process is no longer the only and main growth cause. At the same time, there has been a reduction of the medium class (due to structural problems), who has started resorting to these areas as a housing solution. It should be pointed out that 85% of favelas are concentrated in the town center within a 10-Km radius from Praça Sete and are located in strategic areas for their accessibility to services, trade and the labour market.
Favelas are characterized by specific features, such as a remarkable internal dynamics, which distinguishes them and establishes interrelations with their urban surroundings. As a consequence, the study of a reliable planning methodology is essential in order to closely follow the town's development phases. Therefore, an up-to-date and suitable planning is required to allow the town and its surrounding region to recover and promote its values, starting from concrete development actions, thus assuring a more balanced growth at the social organization level. This is the role which should be played by town and country planning.

2 RECENT TRENDS IN TOWN PLANNING AND THE ROLE OF THEMATIC MAPPING

Ana Clara Mourão Moura

Recent trends in the analysis studies of the urban space and the kind of actions to be taken in it are characterized by the notions of urban design and co-operative planning, by perception studies and by the interest in environment protection and man-environment interaction. The new variables, which must be taken into consideration in the developer's work, require a systematic approach, highlighting correlations and the overall view of the urban complex, at the same time.

The movement in favour of town plan, as a complementary instrument for the planning process, is set up as a criticism of the towns' chaotic situation, tackling the problem of the search for the most suitable location within urban space. It improves urban qualities, which generate urban facts, thus operating on the basis of environmental perception, with the symbols and signs of each space, as well as with the study of the users' behaviour, of preferences and space values.

The town planning's main instrument is the two-dimensional level functional zoning, which is based on the space division into watertight compartments according to their specific use. These concepts are at the basis of the functionalist current, which was led by the architect Le Corbusier starting from the Thirties and which believed in the existence of universal solutions for urban land use.

Urban design, in its turn, operates at a three-dimensional level, enhancing the human aspect, spontaneous activities and the integration of different uses, instead of the division into watertight compartments. It is order in disorder. It favours the priority of local scale implementation and the community's participation in the decision-making process.

In addition to the new urban design proposals, a constant attention to the man-environment relationship emerges from the most recent town planning studies. The sustainable development concept, which tries to demonstrate the balance to be reached between environment protection and technological development, is thus worked out. A greater awareness develops that environment deterioration, due to the land exploitation, occurs at local level, yet with consequences spreading at world level, because the ecosystem is a set of interrelated parts.

On the other hand, the tendencies towards co-operative planning and the change of the implementation scale are also part of the sustainable development concept. According to it, local level activities generate apropagation effect, which produces benefits at global level. Furthermore, working at a smaller scale leads to an improvement in the community's involvement and management skills.

The implementation of a sustainable development policy requires the sharing of responsibilities and of decision-making powers, allowing the community to participate in the management of their own physical space. In the case of developing countries, the achievement of an environmental awareness is hindered by a few obstacles, due to the more difficult involvement of the less prosperous people, whose very basic needs are still to be met. The solution to environmental problems requires long-term investments, because the poor community is still too concerned for the urgent problems related to their own survival.

The dynamics of the urban space requires an approach based on an overall systemic view. The representation of space elements, which are related to one another and which can, at the same time, be individually identified, points out the importance of thematic cartography, as a visual communication element of the analyses and proposals concerning town problems. The cartographic representation, which results from data analysis and synthesis processes, provides a picture of the land reality, thus facilitating its diagnosis and the possibility of actions.

A thematic map is a vehicle of communication, which is expressed through graphic representation. The themes illustrated by maps represent photographs of different aspects of reality, seen from a quantity and quality point of view. Partial or overall views of the space under question result from the data processing and representation.

In relation to the implementation of co-operative planning and to work development by means of multidisciplinary work groups, the thematic cartography visual communication resources serve as a common language, which promotes the exchange of opinions and information.

The considerable development of data automatic processing resources - which have led to the setting up of geographical information systems and digital mapping - has enabled the implementation of thematic

cartography concepts, through the ability to manage information levels and to link different levels. These resources have acquired further importance thanks to the possibility of linking cartographic and alphanumerical data and above all of managing the topological relations between the cartographic elements.
The thematic mapping-based urban diagnosis (through the production of thematic maps, synthesis maps and final diagnosis maps) finally provides the social and economic profile and the physical and environmental features of an area, highlighting the occupation limits and the development potentials of a certain physical space.
Thematic mapping, therefore, is a language which translates the present trends of the systemic view of urban problems. It allows the complex and dynamic database analysis and management. It is a language which not only enables the community to participate in the knowledge of the urban space and in its development proposals, but also allows the exchange of opinions within a multidisciplinary work group. The urban space partial and final diagnosis processing characterizes the present situation and outlines its potential borders, thus becoming the basis for the development plans proposal, with the participation of both developers and users within the sustainable development framework.

3 THE PRESENT SITUATION AND THE POTENTIALS OF THE GEOGRAPHICAL INFORMATION SYSTEMS (GIS): their spreading and applications in Europe in the field of town and country planning

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3.1 Introduction

Today, town and country planning may avail itself of effective work instruments, which are the result of the computer technology development.

The fundamental concepts, the potentials and application fields of the Geographical Information Systems (GIS) should be briefly illustrated in order to:

- broadly outline the research subject, as far as Geographical Information Systems are concerned, in order to compare them with different technologies and experiences, even though in general terms;
- reflect upon possible research to be developed on the basis of applications in European countries.

3.2 GIS definition and performance in relation to the present (hardware and software) technological development

Since the Sixties, the technological revolution in the field of computer science and the growing need for effective tools able to manage an increasingly larger quantity of geographically referenced information and especially of town and country planning-related information - which is the scope of our research - have led to the study and development of computer-based systems specifically intended for geographically-referenced data automatic collection, management, analysis and representation. Over this period, literature has reported applications, which explicitly refer to the GIS definition - such as the Canadian Geographic Information System (Tomlinson, 1987) - or to theHarvard Laboratory For Computer Graphics and Spatial Analysis (Parent and Church, 1987).

In our opinion, to date there is no universally accepted definition and, in fact, GIS concepts change mainly according to the application field in which spatially-referenced information is used. Starting from the Eighties, the technical characteristics and the theoretical bases underlying the design of these systems are being more clearly and precisely defined. At the same time, the development and spreading of hardware and software capacities have occurred at world level, thanks to the substantial drop in their costs. It could be argued that the lack of a clear definition of the GIS term is actually due to two main reasons, namely:

- firstly, the development of computer technology itself, whose capacities have not yet been fully investigated and are not foreseeable;
- secondly, according to the present approach, traditional concepts of geography and cartography are being revisited and redefined, in the wake of technological innovation, namely: geography could be seen as the theoretical framework and cartography as the operational instrument for the study of phenomena in space.

At the same time, over the past few years, the interest in GIS has rapidly increased, both from an application and a scientific point of view, given an increasingly greater demand for low-cost information for the management of various types of resources.

Today, this demand is continuously growing above all at local, regional and State Public Administration level, but also in the private sector. Furthermore, research and development and/or services companies specialized in resource management are now well-established and widely spread over the country in support of local authorities. More than 1000 GIS were recorded in 1983 and the forecasts for 1990 were more than 4000 only in Northern America (United States and Canada) (Tomlinson, 1984). In addition to that, starting from the Eighties, they have also considerably spread over Europe and the Developing Countries; investments have been made in this sector, especially in relation to the setting up of facilities, such as road networks, telecommunications, services, natural resources exploitation (Tomlinson, 1984). The GIS implementation scale has also gradually changed over time, in the attempt to tackle not only "local" but also "global problems", namely environmental resources monitoring and inventory.

To conclude, it can, therefore, be stated that the GIS development and their rapid diffusion have derived from:

- a growing interest in the land issue, seen from many different angles, namely from the geographic, town planning and environmental standpoints, especially in the awareness of the land resources' finiteness; - the consequent greater need for information due the corresponding development of information technologies, with an

increasingly more favourable cost-benefit ratio.
As already mentioned, different definitions have been given to the term GIS, often depending on the field of application.
Marble et al. (1983) regarded GIS as the instrument intended for land resources management in the planning, circulation, marketing and military field, etc.
On the other hand, Crain and Mc Donald (1983) suggested that GIS are long-term implementation instruments in the development from a data acquisition and classification tool to a data analysis and management tool.
Furthermore, Marble (1984) listed a series of GIS requirements, namely:
- an input subsystem for different types of spatial data collection and processing, such as those deriving from the cartography already existing on paper, from remote sensing, etc;
- a spatial information storage and retrieval subsystem, in such a way as to facilitate access to their analysis and updating;
- a multi-purpose management and analysis subsystem to accomplish different tasks, ranging from data transformation, through aggregation rules which can be defined by the user, to the assessment of parameters and constraints for space and time organization and simulation models;
- a data report subsystem able to fully or partially display the original database and to manage the spatial data processing output in the form of tables or maps.
Finally, Muller (Muller, 1985) generally defined GIS as large-scale systems, with a high initial investment cost to be financed by the Public Administration, at local and national level.
The main purpose of these GIS is to provide support to the Public Administration in the decision-making process concerning natural and human resources management.
As can be noticed, the common element of all these definitions is the consideration of GIS as an "instrument or system" with common features, which can be applied to different situations.
Even if one tends to consider GIS to be an end in themselves, it is generally thought that the most appropriate GIS definition is to regard them mainly as an instrument made up of different (spatial and non-spatial) data, disciplines and technologies, whose aim is to produce information aimed at resource management and control in relation to the land.

3.3 GIS field of application

GIS field of application is traditionally bound to Public Administration activities, whose institutional role is to run land management and control. Some private enterprises in the sector of public services (gas, water, power, etc.) are compared, up to a limited extent, to the Public Administration, whose main reference for the implementation of their activities is the land. P.A. has been the market which has made the GIS development possible, in spite of inevitable difficulties deriving from a brand-new subject linked to technological innovation. Therefore, the GIS have been set up to support the P.A. common activities, such as land register management at urban and rural level, environmental control, monitoring and inventory, the assessment of forestry, water and geological resources, whereas services companies or boards have carried out the technological networks mapping and management.

As far as the land management and planning aspects are concerned, GIS are widely used in the setting up of inventories but scarcely implemented as a support to the planning practice.

This situation, though, could partly derive from the fact that GIS capabilities as a decision-making support have not yet been fully explored.

In this extremely important activity for the planner, the nature and complexity of the problems hardly find already pre-packaged solutions.

On the one hand, in fact, the necessary analysis of phenomena related to town and regional planning is rather complex, because it implies the knowledge of both physical and quantitative components and social-economic components, which are generally expressed through statistical data.

On the other hand, during the implementation or planning stage, it is often difficult to reconcile political and cultural aspects of the decision-making process with the not always univocal scientific indications.

It must finally be stressed that over the past few years, geographical information systems have aroused a great interest in the academic world, just because GIS are an integration between different technological and scientific disciplines.

In this field, of course, attention is mainly focused on the basic and applied research development. Several examples could be mentioned in support of these statements, such as the pioneer activity carried out by the previously mentioned Harvard University and also by European Universities, especially in the United Kingdom (Masser, 1992).

3.4 GIS and technology evolution

From a technological point of view, GIS development and potentials are strictly related to the hardware and software evolution and, more generally, to information technology, which have been accompanied by a parallel increase in performance and cost reduction.
Just to give a rough idea of the hardware evolution, it can be recalled that in the Sixties the cost of an IBM 1401, with a storage capacity of 16 Kbyte RAM and 1000 instructions per second, amounted to approximately $600,000.
In the Eighties, the VAX/780 minicomputer, with a storage capacity of 2-4 Mbyte RAM and 1 million instructions per second, cost $250,000 (Tomlinson, 1984).
With the introduction of 32 bit microprocessors, these capacities have now been achieved and overcome by Personal Computers and Notebooks, which are now accessible at a cost of a few thousand dollars.
Even as far as the acquisition and representation of geographical data are concerned, hardware potentials have today been remarkably improved as against the past few years. The various data acquisition techniques differ from one another and each of them shows advantages and disadvantages. In this regard, the best GIS-dedicated software is able to process and integrate data which have been acquired in different formats.
The traditional cartography manual digitization technique, which was implemented on a digitizer table in vectorial (or object) format, is still valuable today and sometimes irreplaceable, even though it is very time-consuming in terms of data acquisition.
New automatic scanner techniques, reproducing point images in the raster format, have now been introduced thus matching this type of traditional spatial data input. These new techniques allow a substantial time reduction in data acquisition, but they are not yet fully reliable, due to a whole series of problems, such as the various types of space distortion and interpretation, which are still to be solved.
Futhermore, several and time-consuming problems still exist in the conversion process of the raster format into the vectorial format, required for the successive data processing by most types of GIS software available on the market.
More sophisticated techniques are used for the raster format processing of images acquired by satellite or other remote sensing surveys. They provide the great advantage of constantly updating data bases (which is essential for some specific applications), but especially as far as the satellite survey is concerned, the resolution and detail level may be insufficient for some types of applications. For instance,

in the research work on marginal urban areas, images surveyed by remote sensing would be useful from the data updating point of view, but less from their detail level point of view.

In fact, the urban phenomena of the marginal areas under question show a very rapid time evolution; yet, at the same time, the object thickening on the land requires a very accurate resolution level, especially in relation to cadastral information.

The use of the traditional (high quality) output pen plotters now seems to be in decline in comparison with the faster - still very expensive - electrostatic plotters. Substantial progress has also been made in the mass storage capacity and in the data base management techniques, thanks to the introduction of optical disks having a powerful storage capacity up to hundreds of Gbytes, in an attempt to facilitate the managing of an increasingly larger quantity of information. Just as an example, it has been calculated that (Light, 1986) a complete data base containing 54,000 7.5′ quadrangular sheets, covering the U.S.A. 48 states, would require about 10^14 bits with a 1.7m resolution and, consequently, also thousands of optical disks with a capacity of hundreds of Gbytes.

A remarkable evolution has also concerned the conceptual structures and models adopted in the representation of digital spatial and non-spatial data. Finally, the first GIS software were specifically written with their own data management procedures. Successively, the DBMS (Data Base Management System) (Date, G. J., 1987) commercial packages have been introduced and generally used only for the management of spatial date attributes. This so-called hybrid or mixed solution does not often fully fit the representation requirements of the complex relations existing among the spatial elements. Therefore, the tendency is to adopt integrated spatial database DBMS structures, which allow both attribute and geometrical data management. The most commonly used conceptual model is the relational one (van Roessel, J.W., 1987; Abel, D.J., 1989).

The fundamental concept underlying the new GIS spatial data base models is that of the representation of topological relations between the entities present in space and of their attributes.

It can be concluded that the solution adopted by the GIS implemented in the present research is that based on the mixed structure. As already pointed out, this solution does not provide the best results. Nevertheless, for reasons which will be further explained in the second part of the paper, this solution has been considered sufficiently adequate to the purposes set in this research.

3.5 GIS in Europe

A brief overview of the spreading of GIS and their applications throughout Europe will now be provided, with a special reference to planning. To have an idea of the "GIS reality" in Europe, reference could be made to the international conferences which have been held on this subject - among which, EGIS, UDMS and AM/FM (Automated Mapping/Facilities Management) - and which have seen an increase in the number of participants and of countries represented. In 1990, more than half of the participants came from The Netherlands and the United Kingdom, whereas 25 countries, out of which 10 Eastern European ones, were present in 1992 (Craglia, 1992).
The other aspect characterizing the GIS development in Europe is the economic one. It can be roughly estimated that the investment in this sector has grown from 332 million dollars in 1989 to 413 in 1990 and finally to 546 in 1991.
Despite all these signals showing the great interest and development of GIS, it is difficult to draw up a balance and to make forecasts on the state of the art and its applications. As can be noticed from the above-mentioned data, even though the first applications at European level date back to the late Sixties and early Seventies, almost all the achievements have been accomplished over the past decade.
The reasons which have determined this "acceleration of interests and applications" in Europe, as well as in the rest of the world, are linked to the computer technology development, which has led to increased potentialities and to a dramatic drop in prices matched by a growth of the available data quantity and an easier access to them.
The overview of GIS applications still remains, though, very fragmentary, especially at local level.

3.6 GIS meaningful experiences in European countries

No thorough overview concerning this matter at European level can be outlined, given the limited number of studies collecting and providing information on the subject. Nor would it be possible or correct to make a thorough presentation of all European cases in this paper.
It seems, instead, interesting to mention a few examples of GIS applications in some European cities and finally to outline an overall view of the Italian situation.
The first GIS example which can be provided is undoubtedly the most advanced one in France, namely COURLY GIS (Communauté Urbaine de Lyon), comprising the metropolitan area of Lyon with its 55 municipalities and 1,100,000 inhabitants.

The tasks of this Lyon Authority range from town planning and land policy to plant construction, management and maintenance operational duties - water, road network, etc. - and, finally, to public services organization and management - town transport, waste collection and management, etc. This wide-ranging set of competences, which implies an accordingly wide-ranging set of data to be collected, has led the COURLY Local Authority to resort to the so-called SUR (Système Urbain de Référence), an urban geographical system, implemented at the Urban Data Centre (CDU), within the COURLY Department of Development.

The CDU GIS was first implemented in 1987 and uses a VAX/8350 central server, connected to two SUN graphic stations and to a series of input/output peripheral control units (graphic and alphanumerical terminals, digitizers, plotters), by means of an Ethernet network. It uses the French APIC software. The databases which are managed by the system - which is still being set up - concern:

- general small-scale bases with streets, blocks, technological networks for thematic maps;
- cadastral bases (1:2000, 1:5000) with parcel and proprietary information, level curves;
- fine topographical base (1:200) with the objects, which are located on the road network's public property and the building sides looking over it;
- databases resulting from aerial photographs.

In addition to these common data, other more specific ones exist, which are managed by the competent authorities, such as the technological networks management boards (water, electric power, telephones, etc.).

At present, two pilot projects for the system application to concrete cases are at the experimentation stage. One concerns the management and maintenance of the sewage system and the other one is related to the Land Occupation Plan (POS), which serves as decision-making support for the best use of the land, on the basis of the knowledge of the existing public property assets.

Another meaningful European example concerns the Frankfurt information system. Unlike the Lyon system - which is mainly a management type system - it has been worked out at the same time as the town-land development plan of the metropolitan area.

GIS were first introduced in Frankfurt in 1978, then consolidated by the purchase of a dedicated software in 1986.

From an organization point of view, it concerns land description, including 41 towns and countries within the Franfurt hinterland.

The databases used include those on land real use, administrative borders, level curves, etc. Environmental data are also present, concerning dumps, soil composition, forestry types and natural reserves. The hardware resources used include a host computer, 11 graphic terminals, 21 alphanumerical terminals and I/O devices. The system is networked with other computers, on which different data files are implemented.
The best-known applications concern country planning and the assessment of environmental impact.
In the first area of activity, GIS are used not only for the presentation of the area's land plan but also for the spatial management of texts containing information related to it.
This aspect is particularly interesting because it is the only known case in which the authorities-users relationship is highlighted.
In the second field of activity, GIS are used to assess surface and ground water pollution, as well as acoustic pollution deriving from noisy activities, flood simulations and the impact of a potential use of areas destined to building or dump location.

3.7 A few notes on the Italian situation

To conclude, a short overview of the Italian situation is outlined below.
At national level, different organizations have been set up for many years, which are specialized in the field of GIS-supported geographical information automation and digitization.
The major ones are the Military Geographical Institute (IGM) and the Land Registry Office.
The former has traditionally been concerned with map production at a small scale (1:25,000, 1:50,000, 1:100,000), whereas the latter operates at a large scale (1:4000, 1:2000, 1:1000 and even larger scales).
This division of roles, related to the representation scales, has become less clear after the creation of Regions in the Seventies, when these new local institutions started producing planning- oriented technical cartography at a scale of 1:5000 and 1:10000.
At present, I.G.M. deals with small-scale map production (1:50000), Region works at medium-scale (1:10000-1:5000) and the Land Registry Office at large scale (1:4000 or more). This role division enables to integrate different cartography information levels. Since 1984, I.G.M. has implemented GIS (Intergraph TIGRIS and SYSCAN) for map production automation, and in 1991 it completed a land digital model for the whole national territory.
In 1986 the Land Registry Office started an automation programme of its information and cartography, which had not been adequately

updated after the rapid urbanization of the Sixties/Seventies, to the detriment of municipal planning departments, which make use of the cadastral cartographic support.

They have adopted the Syscan/Digital computer programme, but so far, due to technical, organizational and financial problems, the cartographic automatic management procedures have been installed only in 27 out of 95 Italian Provinces, whereas the alphanumerical procedures related to the Institute's administrative data have been introduced over the whole national territory (93 Provinces).

Apart from the other GIS applications, it is probably more interesting to shortly dwell upon the metropolitan areas, above all for two main reasons:

- the recent administrative reorganization of large Italian towns in metropolitan areas;
- the size and the problems faced here, which highlight them as strategic places in relation to the role played by information.

Information has acquired an increasing value as far as both social and economic transformation strategies and the problems related to environmental and housing conditions (traffic congestion, air pollution, the deterioration of housing assets, etc.) are concerned. Therefore, GIS find their most adequate application at this land size level, given the need for plan development through adequate knowledge, due to the complexity of problems to be tackled (Secondini et al., 1992).

The Bologna metropolitan area belongs to this size typology. Initiatives have been undertaken for the setting up of geographical information systems, even though no detailed information is available yet.

The most advanced metropolitan area in the GIS sector is probably the Turin area, where different actions have been carried out, namely:

- the digitization of a high quality single reference cartography, which is distributed to the various service boards (electric power, gas network, water network);
- map production of the Turin hinterland;
- coordination of its own programmes with those belonging to the Province and the Region;
- unification of Municipal numerical cartography with the Cadastral cartography.

3.8 Conclusions

At the end of this short overview of geographical information systems, it is possible to draw some general conclusions, whereas it is more difficult to draw any conclusions on the actual effectiveness of these systems from a cost-benefit point of view, especially in the field of regional planning. So far, the GIS technology has not yet apparently facilitated the decision-making task, as the previous paragraphs have attempted to point out.

The first obvious consideration is that information technologies are changing the various approaches adopted in land planning (i.e., geography and all the other disciplines which refer to "space") - as also happens in other sectors.

It seems quite evident that, for example, traditional cartography is bound to be superseded by digital cartography, due to the advantages deriving from computer technology itself, namely: speed, reliability, large capacity to store information and to easily update data.

As for the contribution of automatic cartography to the development of scientific insight, it cannot be stated with equal certainty that its role is fundamental.

As a whole, it can be observed that in those disciplines and applications where GIS are used as support and analysis tools - with increasingly greater technological potentials and clearer formal and conceptual features - no proportionate scientific or application benefits seem to correspond to the use of these systems.

This consideration particularly seems to fit regional planning, where the scientific contributions provided by this discipline and the benefits to the decision-making process support applications are difficult to assess.

At least two favourable considerations can be made in relation to GIS application in a marginal urban area of a developing country.

The first one relates to the production of diagnostic maps of the whole area's housing situation in a short time, which could allow reclamation actions with a more rational and specific use of resources.

The second one concerns the possibility of integrating the GIS applied to marginal areas - where data are difficult to be acquired and change rapidly - with the GIS related to the other non-derelict metropolitan areas.

This data integration would not only complete the GIS setting up on the whole metropolitan areas, but it would also allow to identify the specific developments to be implemented, taking into consideration the relations between good urban quality areas and marginal ones, thus allowing their full integration in the urban fabric.

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4 AUTOMATIC TOPOGRAPHICAL SURVEY

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The automatic topographical survey is at present an advanced technology in the town planning studies and actions. Therefore, it is interesting to consider the procedure followed by "Total Station", which is equipped with electronic theodolites, electronic diastimeters and automatic data collectors.

In order to take linear measures, the Total Station emits an infrared ray, which is reflected by a prism and then sent back to the station. The distance is then calculated comparing the wave length of the emitted ray and that of the reflected ray. The angular measure is made automatically, by means of two overlayed magnetic disks. These linear and angular measures, which are electronically taken, are displayed on a screen and may also be transferred to the data collector, which is connected to the Total Station by means of a coaxial cable.

The data collector is an automatic storage system, which actually replaces the field notebook. Data are then automatically transferred to the computer, once they have been stored in the collector. In this way, mistakes normally deriving from the use of a traditional system - i.e. angle or distance reading, note-taking, typing, etc. - are thus eliminated.

Once data are transferred from the collector to the computer, the traverse calculation phase starts for the definition of the area under question. After the traverse, angular and linear error distribution are calculated, the cadastral topographical points are also calculated.

The cadastral map is obtained by means of a CAD (Computer Aided Design) station, where all the points which have been surveyed and calculated in the field are stored. The cadastral map is produced by means of this data base and the sketch drawn in the field, by associating a number to each topographical point, which then becomes part of the data base. In this process, a mouse and a digitizer table can be used, according to the number of points surveyed per hectare. The larger the number of points per hectare, the greater is the difficulty in working with the mouse and the graphic screen. This problem can be solved thanks to the digitizer table, which allows to draw irradiated points by means of the plotter and to obtain the base map, by

manually connecting these points on the basis of the sketches drawn in the field. Such a base map facilitates the production of the definitive digital one. The CAD system tools can be used to this purpose.
The cadastral map calculation, production and drawing procedure can be schematically summed up as follows:
a) activities carried out in the field:
-construction of the traverse which defines the area to be surveyed;
-survey of the points which define the Cadastre units (road network, parcels, buildings, urban infrastructures, etc.), starting from the traverse station which has been set up;
-sketch drawing of the cadastral units and of the topographical points which have been surveyed.
b) activities carried out in the study:
-traverse, linear and angular error distribution calculation;
-calculation of the surveyed topographical points;
-topographical points drawing by means of the plotter;
-connection of topographical points according to the field sketch, manually defining the base cadastral map;
-digital production of the definitive base map, by means of the CAD station and the digitizer table, starting from the previous map;
-drawing of the definitive plant by means of the plotter or its export in the IGES format towards other kinds of software, which allow to improve the drawing editing and handle it according to the technical specifications.