TOWN NETWORK ANALYSIS USING ORBITAL REMOTE SENSING DATA

Maria de Lourdes Neves de Oliveira Kurkdjian
Juana Gomez Blanco
Federative Republic of Brazil
Secretariat of Science and Technology
Brazilian Institute for Space Research

ABSTRACT

The town network in the region of Paraiba Valley and the North Coast of São Paulo State was mapped using basically 1988 TM LANDSAT data. Positive transparencies were interpreted at the scale of 1:50,000 using an amplifier projector. The cartographic final product was presented at the scale of 1:250,000 using GIS. The urban area expansion was regionally analyzed comparing this map to a previous one of 1978 and with other maps related to physical characteristics of the region and to demographic and socio-economic data. This work was done as part of a major project whose main objective was to develop a method for regional land use planning using remote sensing data.

1. INTRODUCTION

The objective of this study was to analyse the urban growth in each of the urban centres which compose the region of Paraiba Valley and the North Coast of São Paulo State, as well as the regionally significant changes in its town network. The data set used refers to the timespan 1977 to 1988.

The participation of the study region on São Paulo State industrialization process, which has been characterized since 1970 by internalization policies, has been growing. With approximately 11% of its labour force at the agricultural sector, 40% of them at the industries and the others at the commercial and service sector, the region has its labour force concentrated on urban activities. It is the third (among 12) most industrialized region of São Paulo State. Factors that contribute to this situation are: the geographical localization of the region between the two biggest brazilian cities (São Paulo and Rio de Janeiro, which are connected by railway and motorway) and the proximity to the biggest airport and harbour structures of the country.

Since 1940, when urban and rural population of the country were counted for the first time by Demographic Census, the region has been one of the most urbanized areas of the State. The reasons for this are:

1) It was occupied before most of the other regions from S.P. State and therefore it was one of the first to have its town network formed.

2) The decadence of coffee production in the region caused an intense rural exodus.

These processes of industrialization and urbanization have not occurred equally on the whole region. These processes were already spatially concentrated since their beginning creating some acentuated differences within the region.

The ultimate purpose of this work was to provide useful information to feed back the regional urbanization process. It was considered as part of an integrated effort of regional land use integrated planning (Kurkdjian, 1992).

2. METHODOLOGY

The urban areas in 1988 were mapped using TM/LANDSAT images and when available HRV/SPOT images. The TM/LANDSAT products utilized were positive transparencies while the SPOT ones were images on hardcopy at the 1:50,000 scale.

The positive transparencies of the colour composition TM 4,7,2 and of the isolated band TM3 (passages in 3/7/88 of 218/76 orbit and in 19/9/88 of 219/76 orbit) at the scale of 1:1,000,000 were enlarged to the 1:50,000 scale using the amplifier projector PROCON-2. At this scale the orbital data were adjusted to correspondent topographic maps produced by IBGE - Brazilian Institute for Geography and Statistics.

In this work the residential, commercial, business and industrial areas were included as a unique class ("urban area"). These uses were not mapped separately due to the objective of the work, to the scale of the final map and to the ground resolution of orbital data.

After extracting thematic information from transparencies and hardcopy images

and adjusting these information to the cartographic bases, the results of the photointerpretation process were evaluated using a photo-index at the 1:50,000 scale. Although this product did not have geometric accuracy, it was useful to evaluate the content of thematic information.

In areas not covered by the photo-index, the results of the mapping activities were evaluated through ground survey.

After the necessary corrections, the final map of urban areas was reduced to the scale of 1:250,000 using GIS.

Comparing this map to an older one of the same scale obtained by photointerpretation of aerial photos from 1977 at 1:45,000 it was possible to obtain useful information about the urban growth in this region. This comparison was done considering each one of the municipalities and the regional town network as a whole.

Comparing this information to other thematic maps related to physical aspects of the environment it was possible to evaluate the suitability of the terrain to the urban land use growth.

3. RESULTS

The forty (40) municipalities which compose the region were classified according to the extension of its urban expansion.

The municipalities with the gratest urban expansion were those with the most dynamical economy based on industrial or, in some cases, touristic activities. These are the most populated municipalities in the region and/or those with the highest demographic growth rates.

Looking globally at the town network, some changes that occurred between 1977 and 1988 could be noticed clearly. They were:

a) at the surroundings of President Dutra Highway.

The discontinuous growth of different urban centres, which was promoted by the installation of numerous allotments disconnected from the original nuclei and predominantly along the highway, approximated the towns and made it difficult to identify their limits and to maintain their identity. Synoptically, the urban tissue presents itself highly fragmented.

During this period from 1977 to 1988, the urban area along the highway was consolidated as an important part of the Rio-São Paulo urbanized and industrialized axis. One of the factors which contributed to this development was the intense migration to this area. The conurbation process became more intense in this period requiring energic actions to control it.

b) At the North Coast

At the North Coast of S.P. State, the urban use in 1977 was restricted to some isolated nuclei.

During the period from 1977 to 1988 an intense and disorganized urban growth occurred. According to physical and accessibility constraints the urban use defined a linear area that grew along the coast line and the road system.

A new urban axis was formed in the region where the main problems related to population congestion and traffic jam are occurring now.

c) At the other parts of this region.

Besides the two urbanized areas (President Dutra Highway surroundings and the North Coast), the remainder of the regional territory presents the urban use basically on small and isolated centres with insignificant urban growth also during the 1977 to 1988 period.

These towns are centres of municipalities with poor economy, predominantly rural population and historically negative migration.

Analysing the town network changes and comparing them to physical characteristics of the region, it was clearly noticed that one of the factors which greatly contributed with the urban growth process was the relief. It influences this process because its adequateness, or not, for massive human settlements, as well as because it also defines the design of the regional road system.

The towns along President Dutra Highway surroundings, according to the geomorphological map (Florenzano at al, 1992), were initially settled on gently undulated hilly lands. Some of those towns improperly grew on flood plain areas along the Paraiba do Sul River as well as on undulated highlands.

The towns on the North Coast of São Paulo State were initially settled and grew until 1977 inside the limits of the coastal plain. According to Veneziani at al (1992) these areas presenting a flat relief have some constraints to the urban development. These constraints are related to the unconsolidated material they are composed of.

After 1977 the scarps of "Serra do Mar", which are very steep mountains ridges, began to be occupied by buildings. These areas present strong limitations to urban land use, because of the erosion risks.

Most of the other urban centres in the region are small and isolated towns with unexpressive urban expansion. This expansion occurs mainly due to rural exodus and not to the dynamics of the urban economy itself.

According to urban population projections (SEADE, 1988) in the year 2010, if the general demographic tendencies and the land use arrangement are maintained, some problems now observed will be worse. It is necessary to implement some new corrective actions such as:

. creation of new industrial centers in the region, contributing to a more balanced distribution of the industrial activities along the President Dutra Highway and consequently with a rearrangement of the urban growth.

. stimulation of the productive potential of the poorest municipalities, contributing to a more balanced generation of the regional product and promoting the reversion of the intra-regional migration flows which contributes with the "urban swell" in other municipalities.

. controlling the urban growth process along the President Dutra Highway and the North Coast of S.P. State, which has occurred in an accelerate and chaotic way.

Along the President Dutra Highway, this study proposes to control the urban use avoiding its growth at flood plain areas and the conurbation process at the gentle sloping areas.

At the North Coast it is proposed to adequate the urbanization process to urbanistic and environmental constraints. A special emphasis should be given to those issues related to sanitation of the area. The urban land use on very steep slopes as well as on important ecosystems under preservation, should be avoided.

4. CONCLUSIONS

The use of orbital remote sensing data, complemented by cartographic and statistical data, proved to be an important tool for town network analysis.

Concerned to the image interpretation process itself, the difficulties were found mainly at the rural-urban fringe. At these areas the scarce urban occupation and the presence of numerous lots with bare soil, makes it difficult to identify clearly the urban boundaries. Because of this, some urban areas at these fringe areas may be under or overestimated.

Nevertheless, the orbital data with its synoptic, multispectral, multitemporal and geometric characteristics, turns the regional mapping process more efficient. This is the case of the specific work related to town network analysis, presented here.

5. REFERENCES

Florenzano, T.G.; Czordas, S.M. Geomorfologia da Região do Vale do Paraiba e Litoral Norte do Estado de São Paulo. São José dos Campos, INPE (in press).

Kurkdjian, M.L.N.O.; Valério Filho, M.; Veneziani, P.; Pereira, M.N.; Florenzano, T.G.; Anjos, C.E.; Ohara, T.; Donzeli, P.L.; Abdon, M.M.; Sausen, T.M.; Pinto, S.A.F.; Bertoldo, M.; Blanco, J.G.; Czorda, S.M. Macrozoneamnto da Região do Vale do Paraíba e Litoral Norte do Estado de São Paulo. São José dos Campos, INPE, 1992. 176 p. (INPE-5381-PRP/165).

Fundação Sistema Estadual de Análise de Dados (SEADE). Projeção da população dos municípios e distritos pertencentes à região II de Planejamento da SABESP, segundo a situação de domicílios urbano e rural, até o ano 2010. São Paulo, 1988.

Veneziani, P.; Anjos, C.E. Carta indicativa para a expansão urbana, obras de engenharia e riscos geológicos da região do Vale do Paraíba e Litoral Norte do Estado de São Paulo. São José dos Campos, INPE. (in press).