

## THE ANALYSIS OF LAND COVER CHANGES IN PIATRA-NEAMT AREA USING GIS TECHNIQUES

BY

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**Abstracts:** The current study is an analysis of land use change in Piatra-Neamt area. The most obvious changes occurred in the field of territorial expansion, so the study analyzes the conditions that lead to producing this phenomenon. The analysis is achieved using Geographical Information System techniques.

**Key words:** land cover, model, analysis, GIS.

### 1. Introduction

Located at the outer limit of the Carpathians, at an altitude of 310 m, the city of Piatra-Neamt marks the spot of intersection of the coordinates  $46^{\circ} 56'$ ,

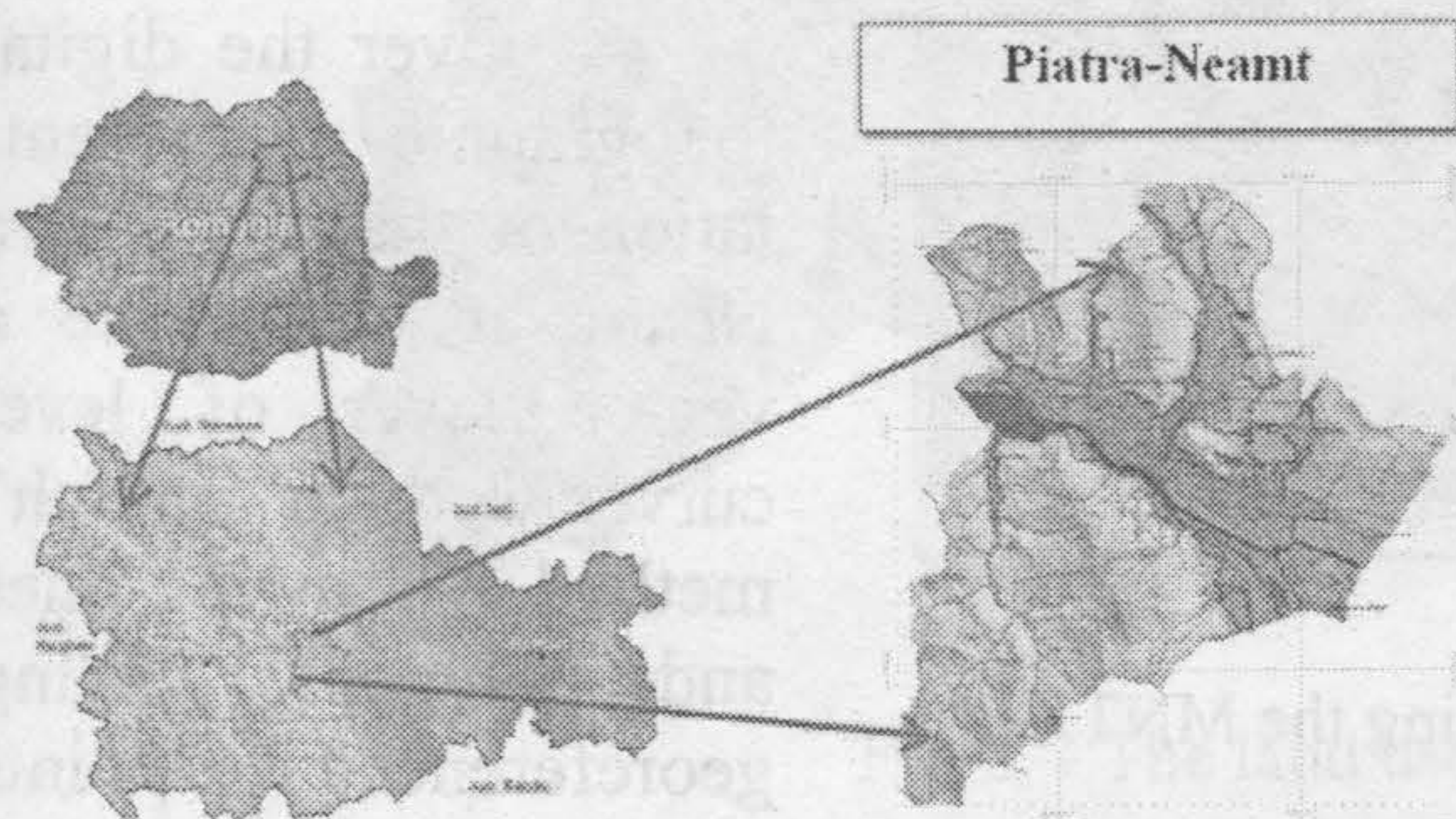


Fig. 1 – Localization of area of study.

$20^{\circ} 22'$  northern latitude and  $20^{\circ} 22'$  eastern longitude, and it is about 220 km closer to the North Pole than the Equator. It has a central position in the Neamt County, representing the largest urban center of the county and most polarizing. Piatra-Neamt city enjoys a special geographical location, being a climate, geological, geomorphological, hydrological, pedological and phytogeographical contact zone.

Due to natural conditions, which are favorable for human settlements,

this passing area of two major relief units, Carpathians and Subcarpathians, was a hearth housing over two millennia for our Geto-Dacian civilization.

The emergence and development of the city was favored by the interference of geographical, historical and economic factors, being an obvious "contact zone".

The objective of this study is a competent analysis of land use change in Piatra Neamt, regarding mainly the phenomenon of territorial expansion, a phenomenon that witnessed an accelerated growth in post-communist period. To achieve this objective, in addition to on-site assessment, it has been appealed to a number of specialized studies and some cartographic material on the studied area. The analysis phase of information is equivalent in this case with the laboratory stage represented by the use of GIS techniques, following the interpretation of data and comparison of results.

## 2. Materials and Methods

For a better analysis of the phenomenon and for a more complex study GIS techniques were used with the help of the professional software MicroImages TNT mips 6.9.

The main materials used for the achievement of the study are the topographic maps at scale of 1:25000 which led to obtaining the numerical terrain model (MNT) of the studied area, going through several stages.

First of all, the 4 topographic maps were imported into GIS software, and then were georeferenced into the Gauss-Kruger coordinate system with the Krassovsky 1938/1940 reference ellipsoid.

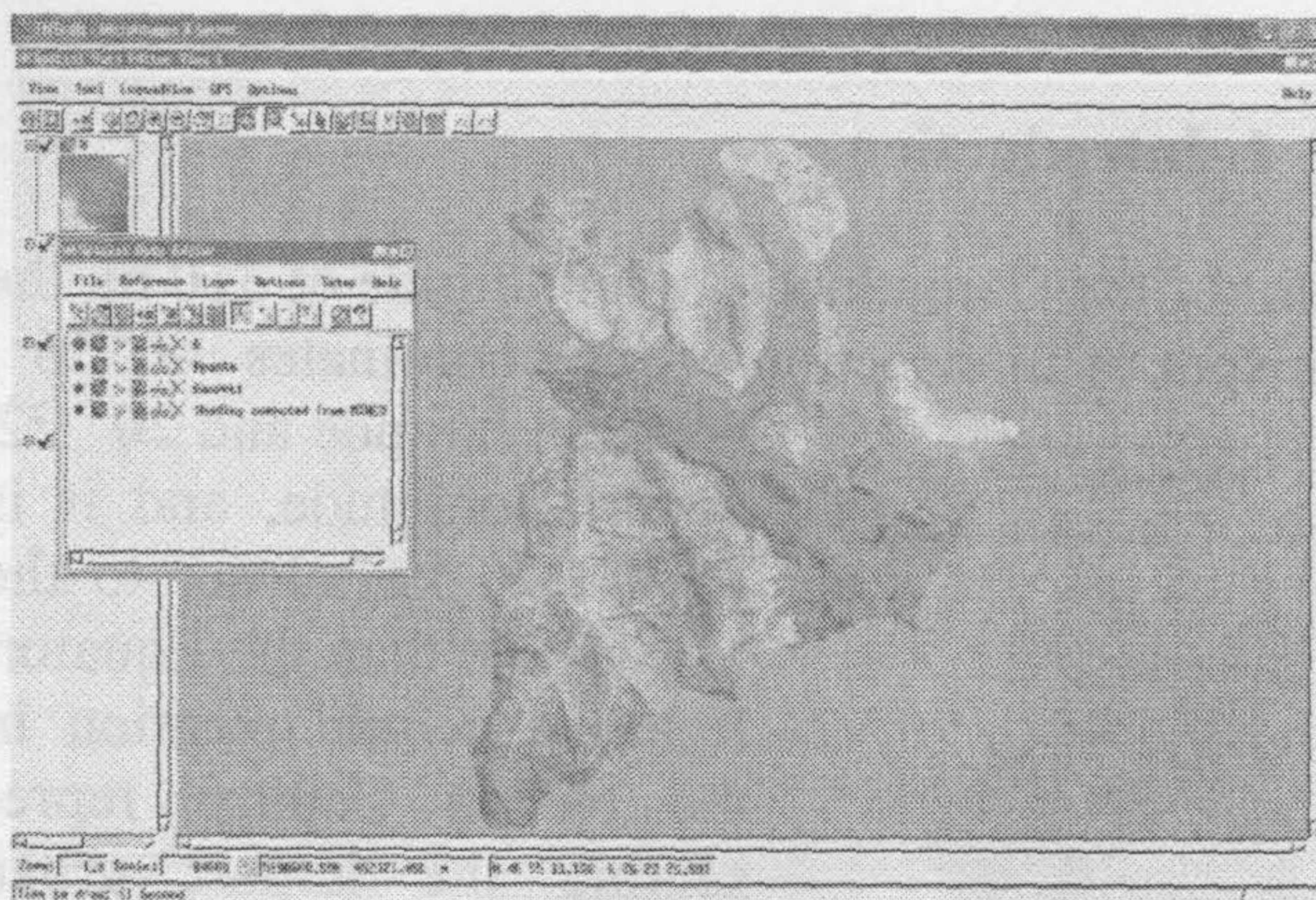


Fig. 2 – The process of obtaining the MNT.

The maps were joined automatically using the georeference points in order to have a topographic base united in a single file.

Over the digital topographic representation of the city Piatra Neamt it was made a vector layer of level curves through "stretch" method of drawing lines and polygons, having georeferenced points

transferred by default from the digital topographic support. Contour Digitization was performed using ON SCREEN method. Afterwards, to the vector layer were assigned "Z" values, essential to achieving MNT. Finally, the numerical terrain model is obtained by applying the operation "Surface Modeling".

Based on MNT were realized three thematic layers that will be used forward in analysis: *shading, slope, aspect*.

By combining the three layers with the MNT and different other vector layers (like human settlements, hydrography, roads, land use, toponyms) will result next maps:

- Hypsometric map;
- Land use map;
- Slope map;
- Slope orientation map;
- Favorability for construction.

The last step consists in making layouts and printing them in graphical format (TIFF at a resolution of 300dpi).

### 3. Research Results

#### 3.1. The Current State of Land Use and Recent Changes

In order to achieve land use map were used in addition to the above materials, orthophotomaps from 2006 over the Piatra-Neamt area.

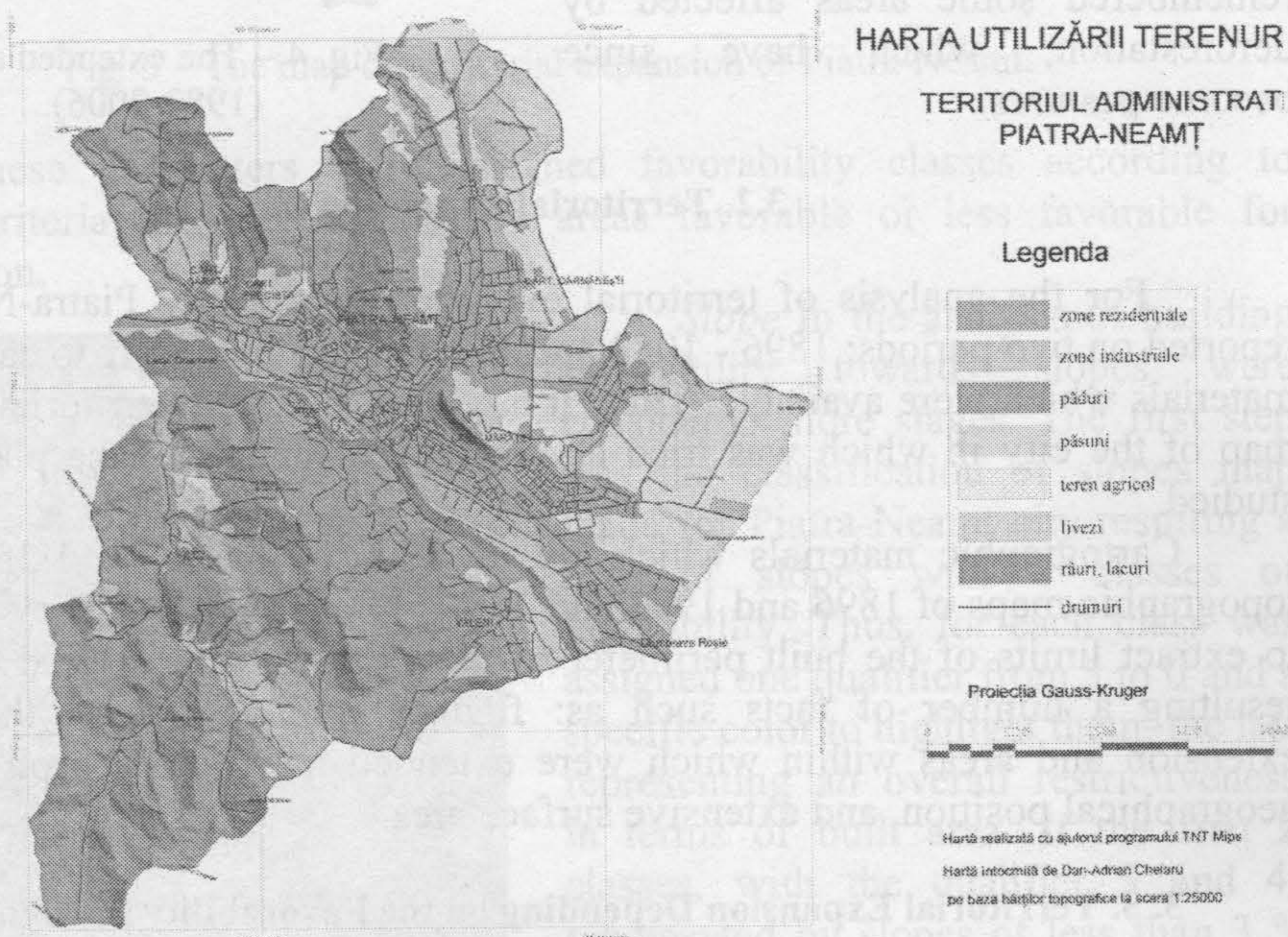


Fig. 3 – The land use map.

By analyzing this map it was concluded that the largest share of the administrative territory of Piatra-Neamt is represented by mountain covered with forest - about half of the city's total 7.700 ha (3.844 ha), followed by actual

built-up area (1.719 ha), pastures (1.090 ha) and agricultural land (850 hectares), while water surfaces represented by the Bistrita River and its tributaries, but also Bâtca Doamnei Lake occupies a share of only 3%, or 196.96 ha.

Regarding the recent changes occurring in land use the most significant are represented by the expansion of the perimeter of the city built. Of the analysis of the map which shows the extended areas of the city built-in period 1983-2006 it was observed that these changes occurred generally at the expense of agricultural land. Overall, the total area in this period is extended by 313 meters, and this is accomplished mainly due to demographic factors.

In the area of study it have been also produced some changes, but in small areas. Thus, it can be remembered some areas affected by deforestation, which have since become pastures.

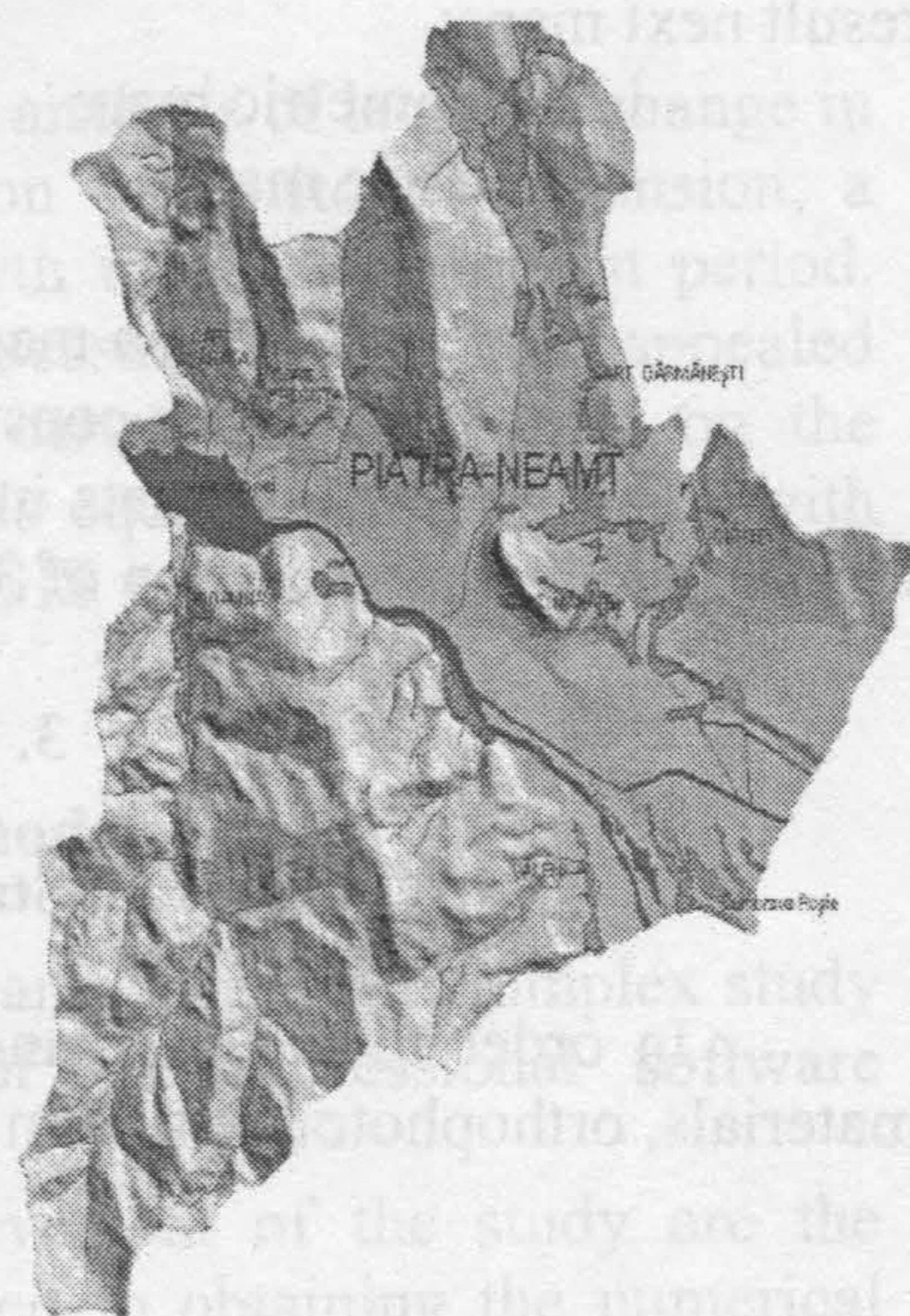


Fig. 4 – The extended areas (1983-2006).

### 3.2. Territorial Expansion

For the analysis of territorial evolution of the city Piatra-Neamt, we reported on two periods: 1896 - 1983 and 1983 - 2006 according to cartographic materials which were available. Thus, it has been made the territorial evolution map of the city in which was tried an accurate rendering of the phenomenon studied.

Cartographic materials which are used as the basis are 1:25000 scale topographic maps of 1896 and 1983 and 2006 orthophotomaps. They were used to extract limits of the built perimeter of each year and then were compared, resulting a number of facts such as: finding extended areas, the type of extension and areas within which were extended in relation to physical and geographical position, and extensive surface area.

### 3.3. Territorial Expansion Depending on the Favorability for Construction

To better analyze the phenomenon and to identify the appropriate areas for territorial expansion of built and build space were considered three factors: slope, slope orientation and distance from roads.

Some of these parameters can have a bigger influence on certain areas in the perimeter of analysis than other factors, and also their contribution is

lower in other areas.

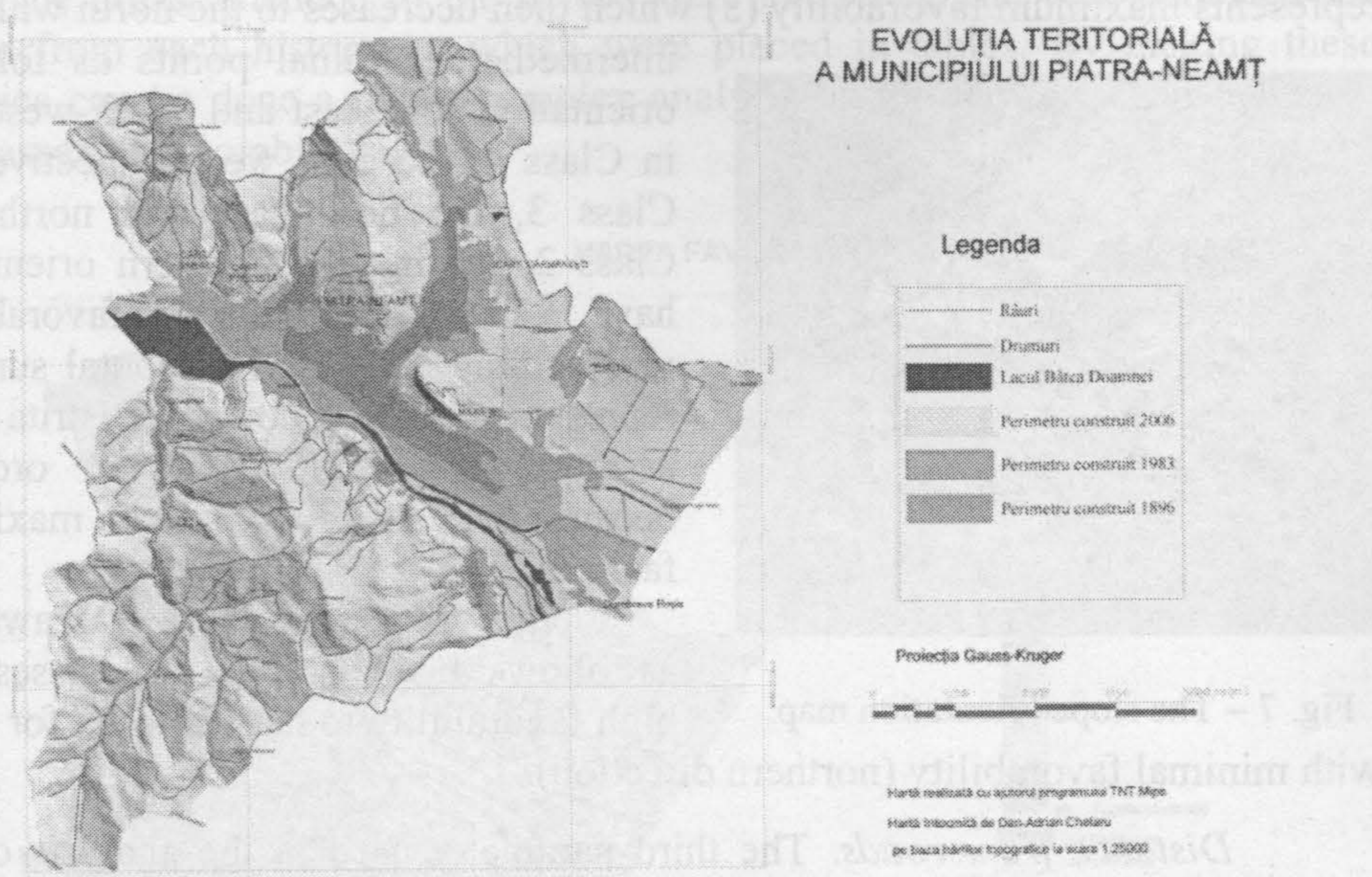


Fig. 5 – The map of territorial expansion of Piatra-Neamt.

These parameters were assigned favorability classes according to specific criteria in order to identify areas favorable or less favorable for construction.

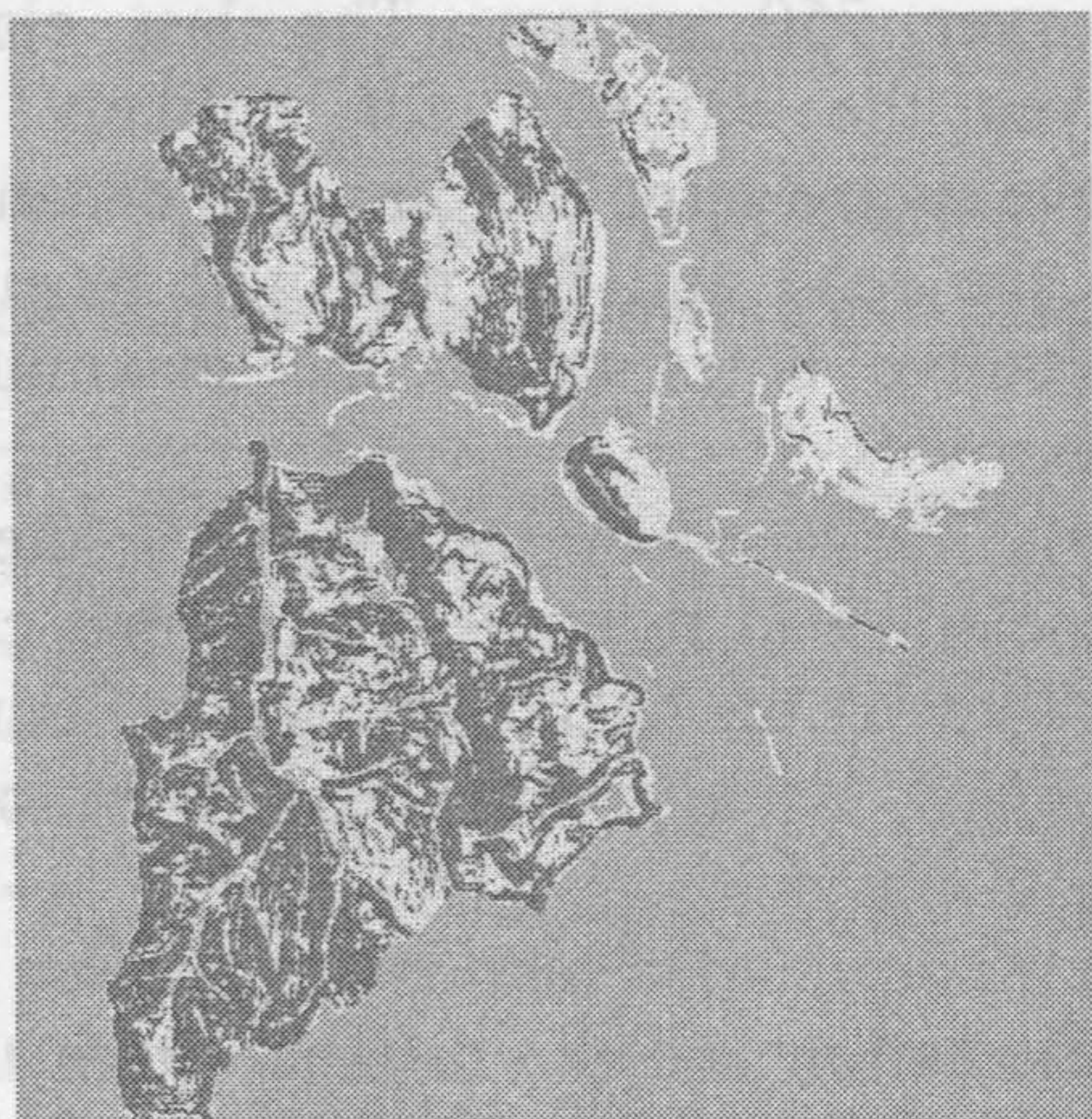


Fig. 6 – The slope map.

restrictive factors.

*Slope* In the analysis of building favorability towards slopes were considered more stages. The first step was the classification of slopes map made for Piatra-Neamt city resulting a map of slopes with 6 classes of favorability. Thus, for each class was assigned one qualifier from 5 to 0 and a specific color to highlight them, the last representing an overall restrictiveness in terms of built area. If the first 2 classes, with the qualifier 5 and 4, represented by slopes of less than  $3^\circ$ , and those between  $3$  to  $5^\circ$  has a high favorability, the more we move towards lower values, the favorability for construction decreases reaching

*Slope orientation.* First stage of analysis was the classification of the orientation map giving 5 classes of favorability. In this case south orientation represents maximum favorability (5) which then decreases to the north with

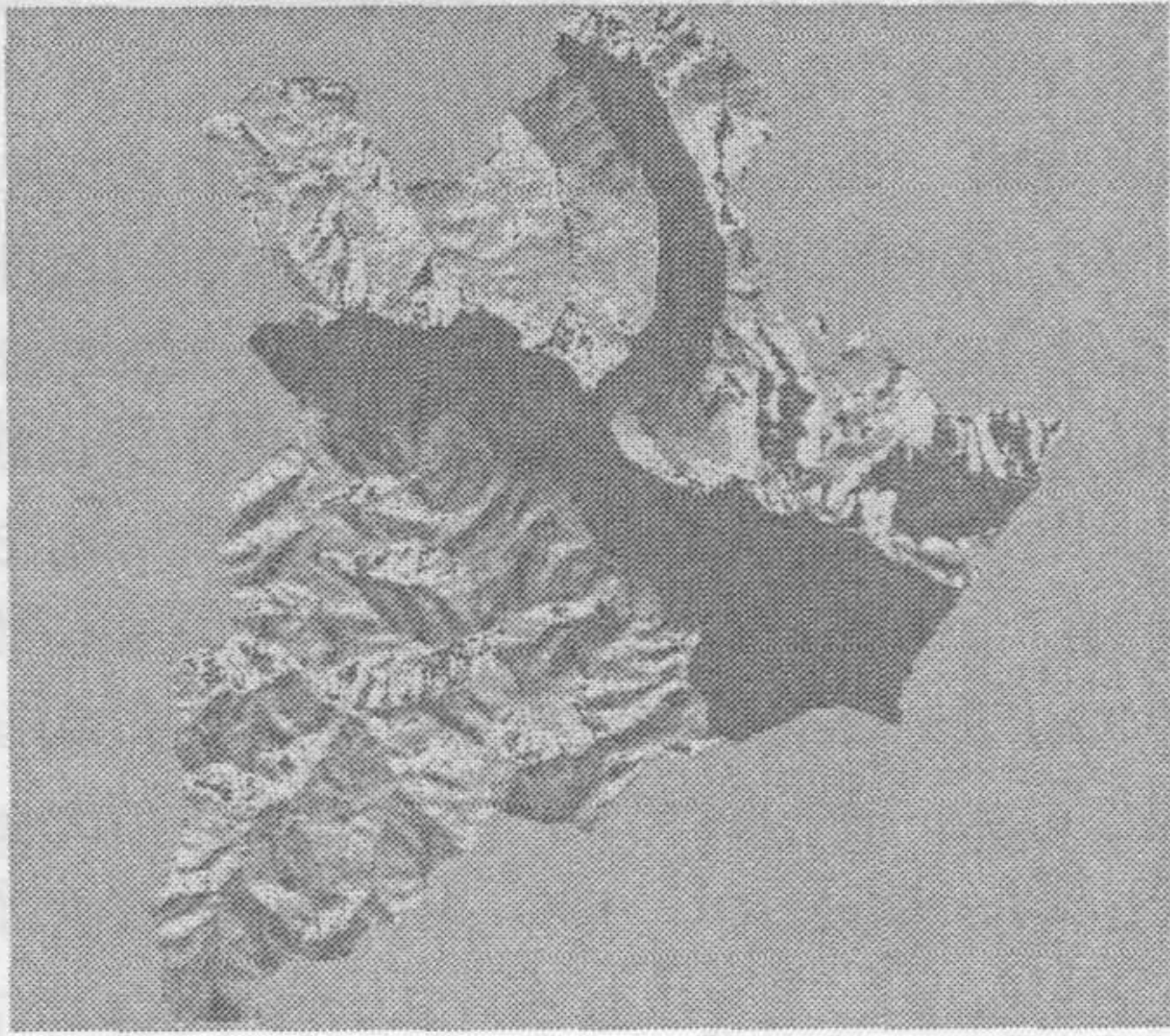


Fig. 7 – The slope orientation map. with minimal favorability (northern direction).

intermediate cardinal points as follows: orientation southeast and south-west falls in Class 4, the east, west respectively in Class 3, the north-east and north-west Class 2, leaving the northern orientation have a minimum favorability, representing Class 1. Horizontal surfaces represented by meadow of Bistrita were assigned favorability class of order 5 because the constructions has a maximum favorability.

The range of colours was awarded as follows: bright colours for classes with high favorability to dark colours for those

*Distance from roads.* The third parameter used in the analysis of the favorability is the distance from the road. To achieve this, it was prepared a map

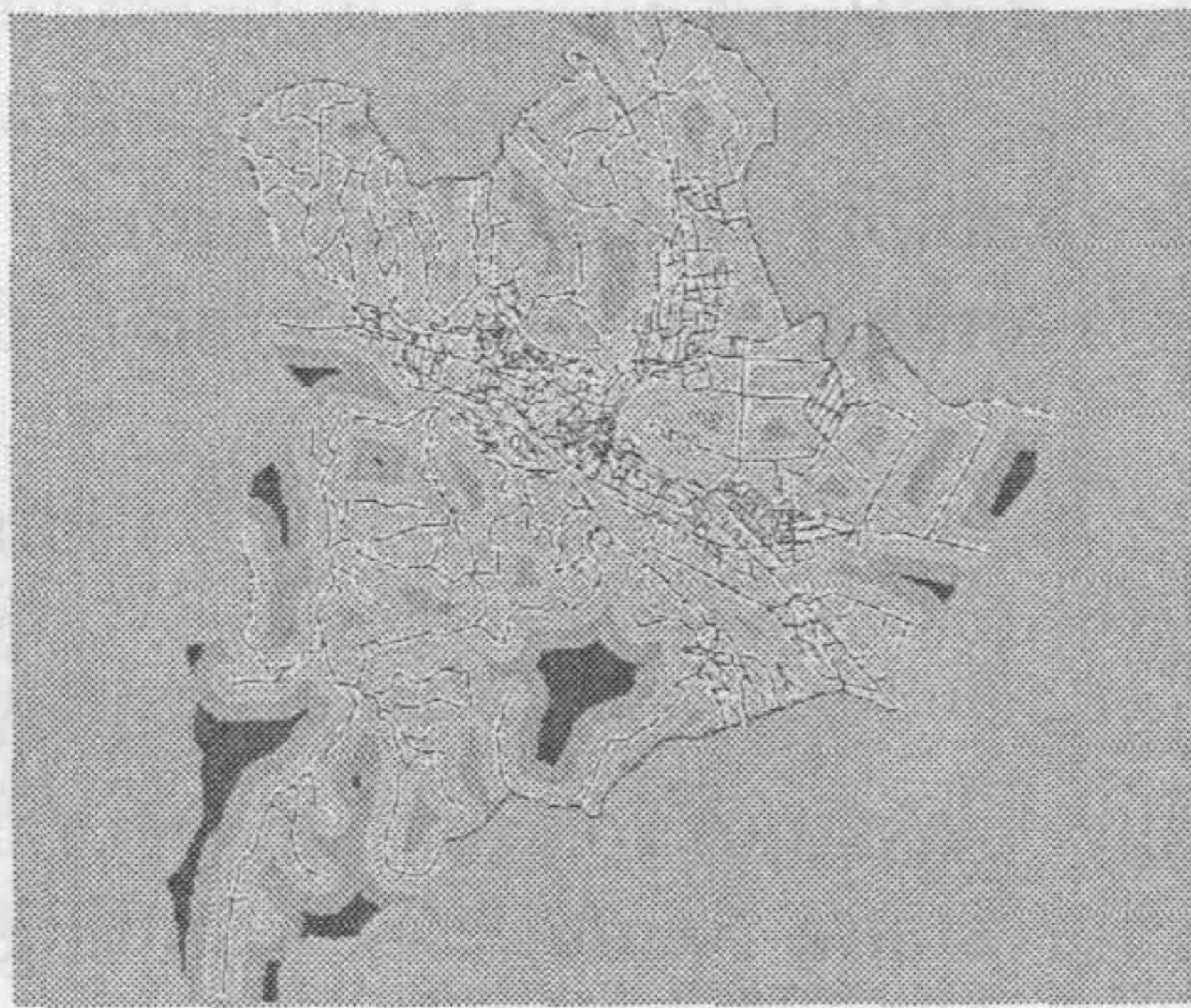


Fig. 8 – Distance from roads (buffer).

which generates one buffer (a so-called "buffer zone") for each value of remoteness. Chosen values are less than 50 m (which corresponds to the highest class and favorability), between 50 - 150 m, 150 - 250 m, 250 - 500m, 500 - 750 and over 750 meters. The last class receives the value 0 for unlikely to achieve such a large building at a distance from the road and the rest will receive consecutive notes up to the maximum (respectively 5).

The separate analysis of these parameters lead to some results that can be improved by creating a general favorability with the operations of combining classes of favorability values of previous maps. By applying these operations resulted two maps: the summation and multiplication.

The value of the parameters on the multiplication map is the product of the values of the maps of slopes, slope orientation and the distance from the road, while the summation map was obtained by adding the values of the parameters studied.

Examining the general favorability of the relief and each trait it can be said that there is similarity of graphic expression and localization.

Based on these two maps were drawn up a series of graphs showing the

evolution of territorial expansion of the city Piatra Neamt according to the 2 considered periods: between 1896 and 1983 and from 1983 to 2006. To obtain them, the areas extended in the period were extracted, and then collected the values from each histogram, which were placed in tables. By making these graphics can be done a rather complex analysis on the territorial expansion to the classes of favorability.

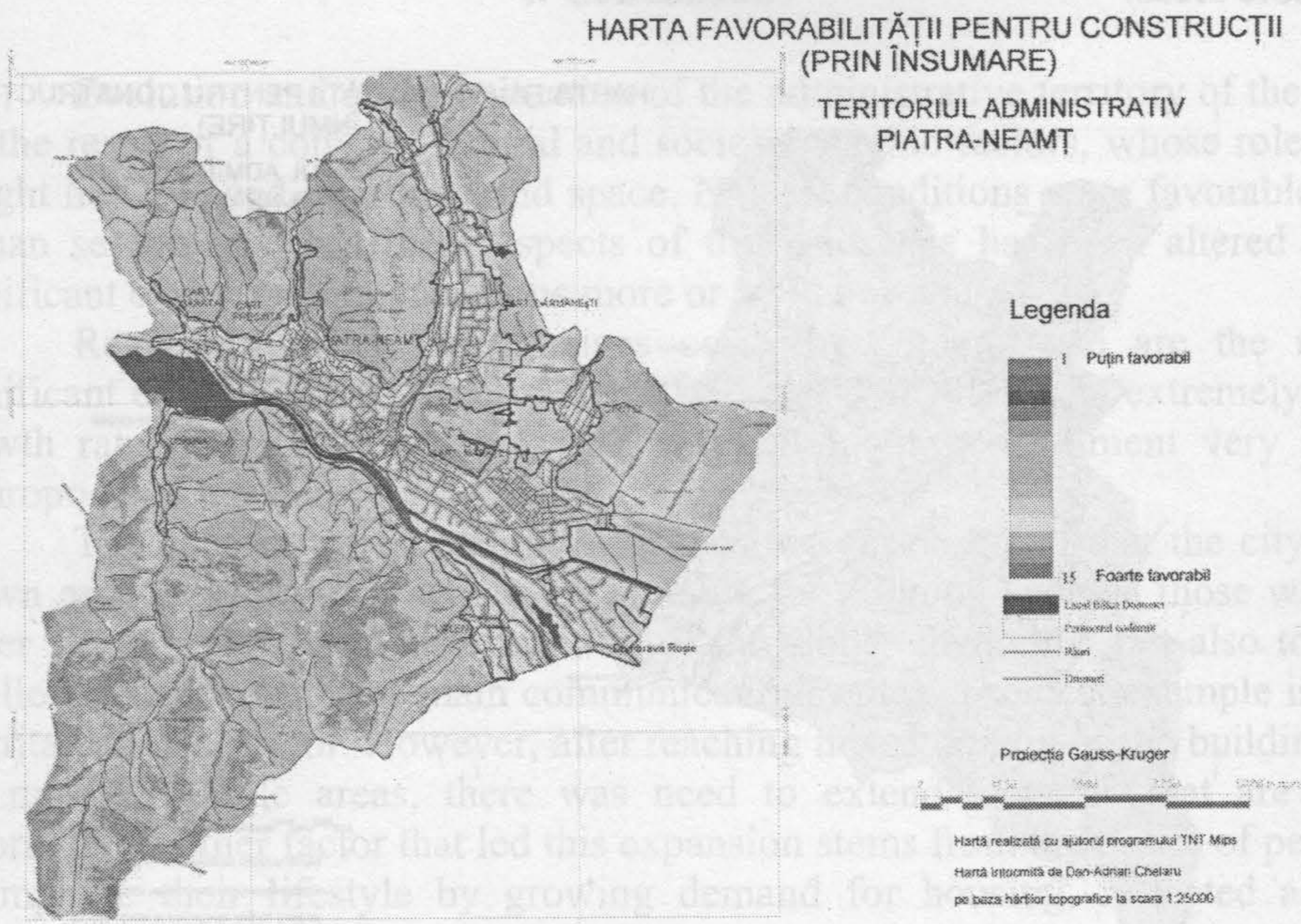


Fig. 9 - The map of favorability for construction made by summation.

Given the map of favorability for construction made by summation were achieved the following two graphs:

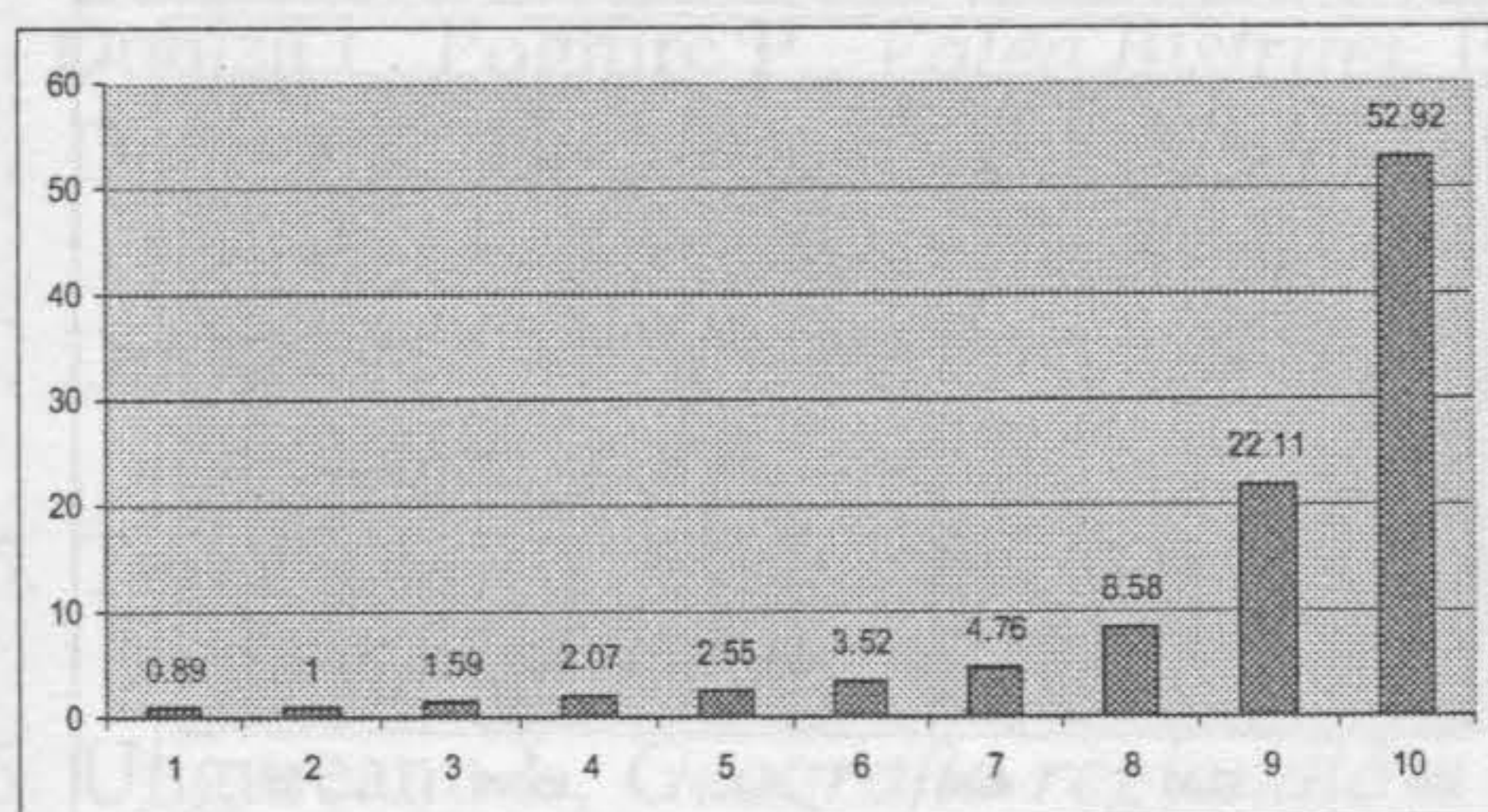


Fig.10 - (1896-1983)

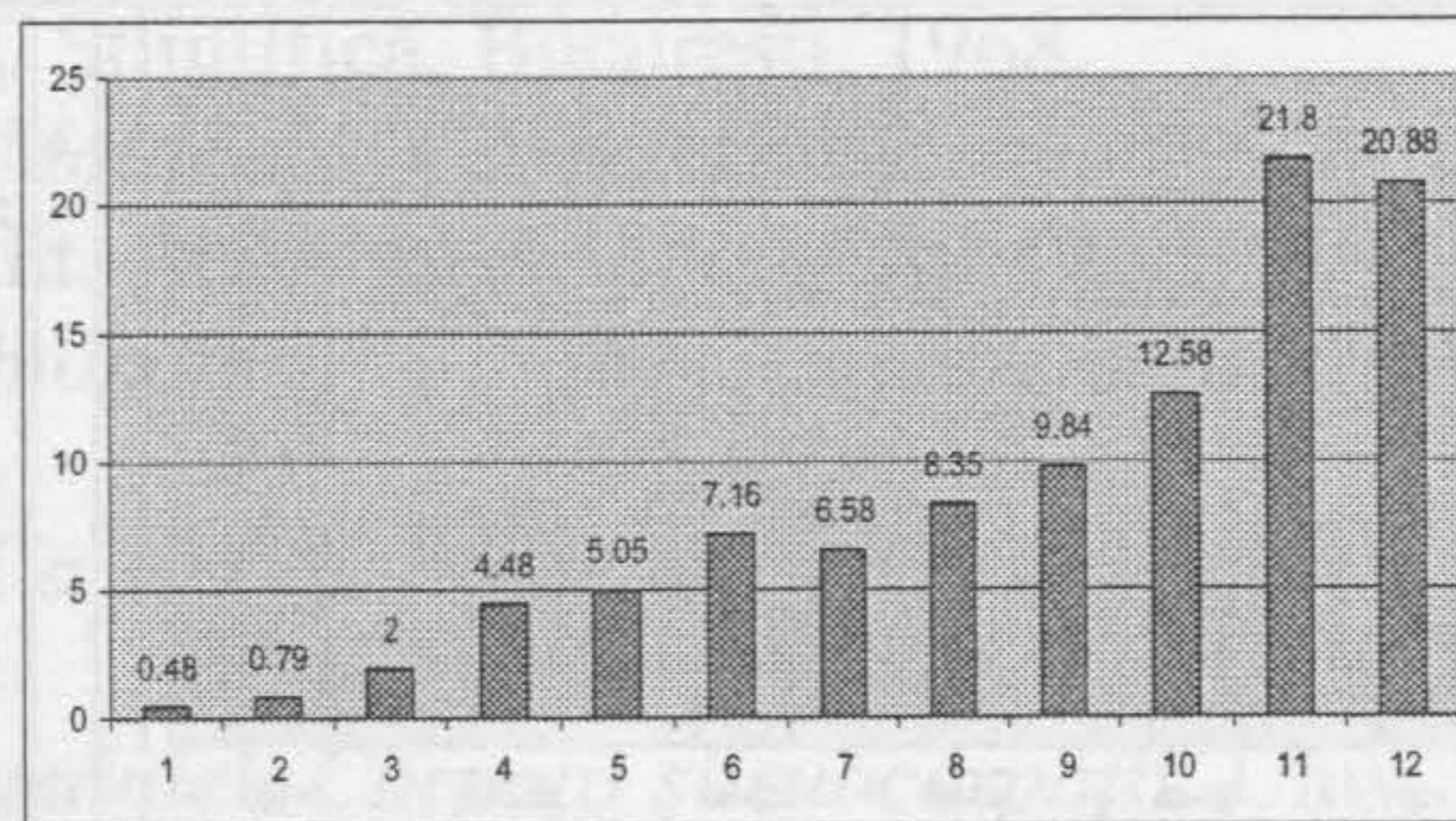


Fig.11 - (1983-2006)

From the first graph can be seen that in this period the highest share of construction was on areas with high favorability classes, more than half of them being found in the most favorable class, thanks to the favorable physico-geographical conditions. We notice some construction areas that are less

favorable but they are just a few and are located in isolated areas.

The analysis of the second graph leads to an obvious increase on the classes with smaller favorability; hence we can deduce that territorial expansion was achieved as a result of reaching a saturation level of the building in the most favorable areas. The main reason is the explosive growth of population during this period, thus imposing the need for city development even on less favorable areas.

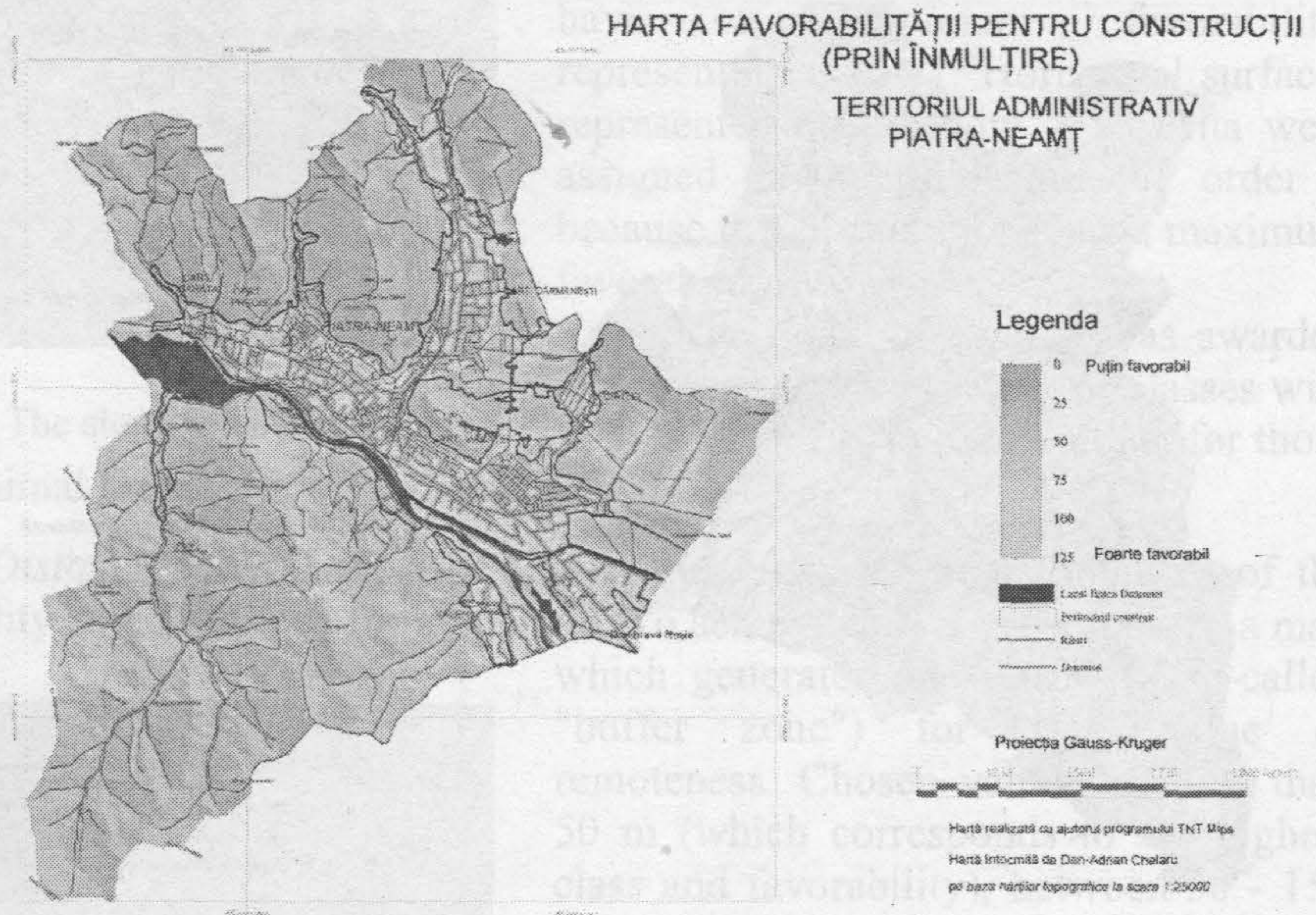


Fig. 12 - The map of favorability for construction made by multiplication.

From the analysis of the map based by multiplication also resulted two graphs for each period of development.

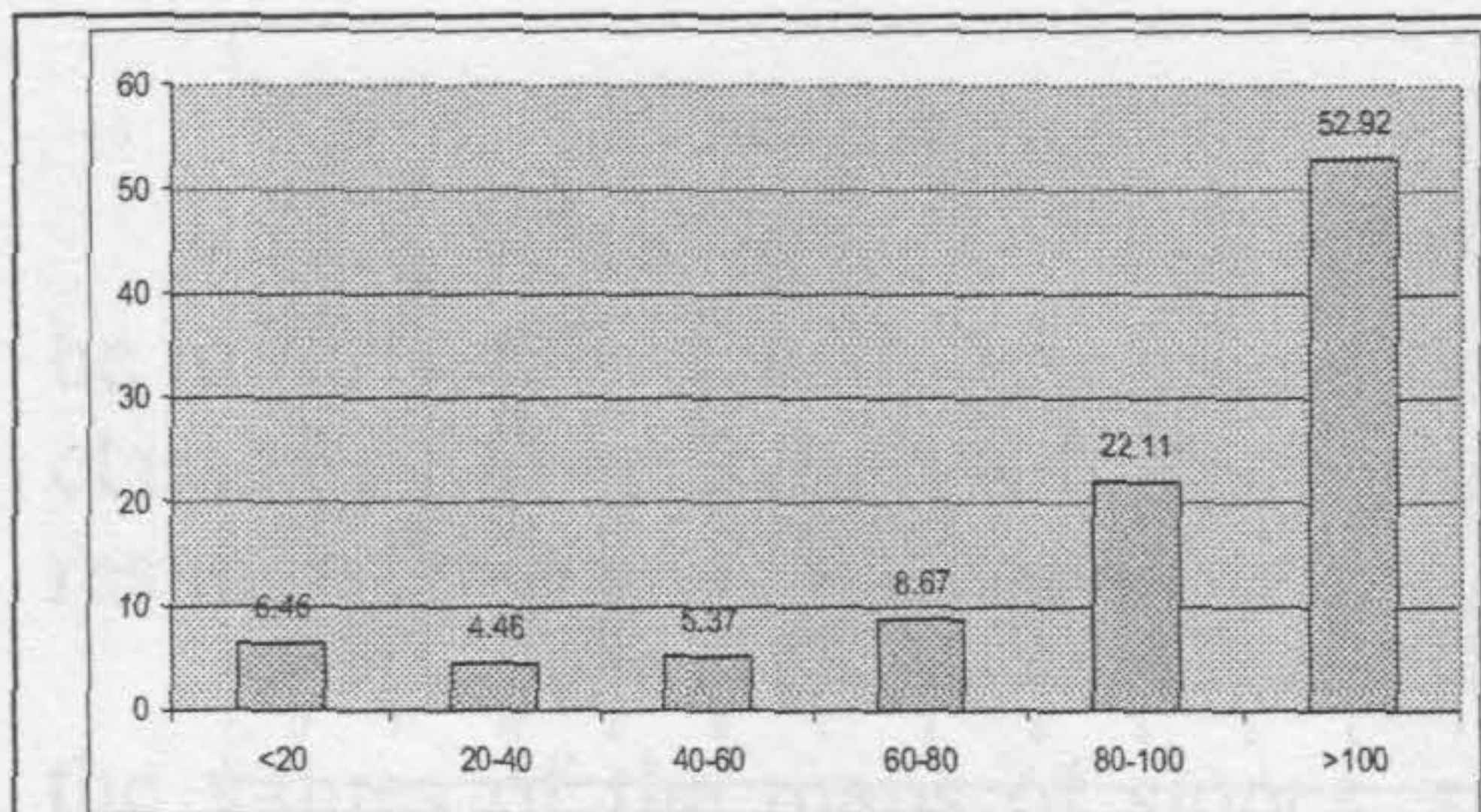


Fig.13 - (1896-1983)

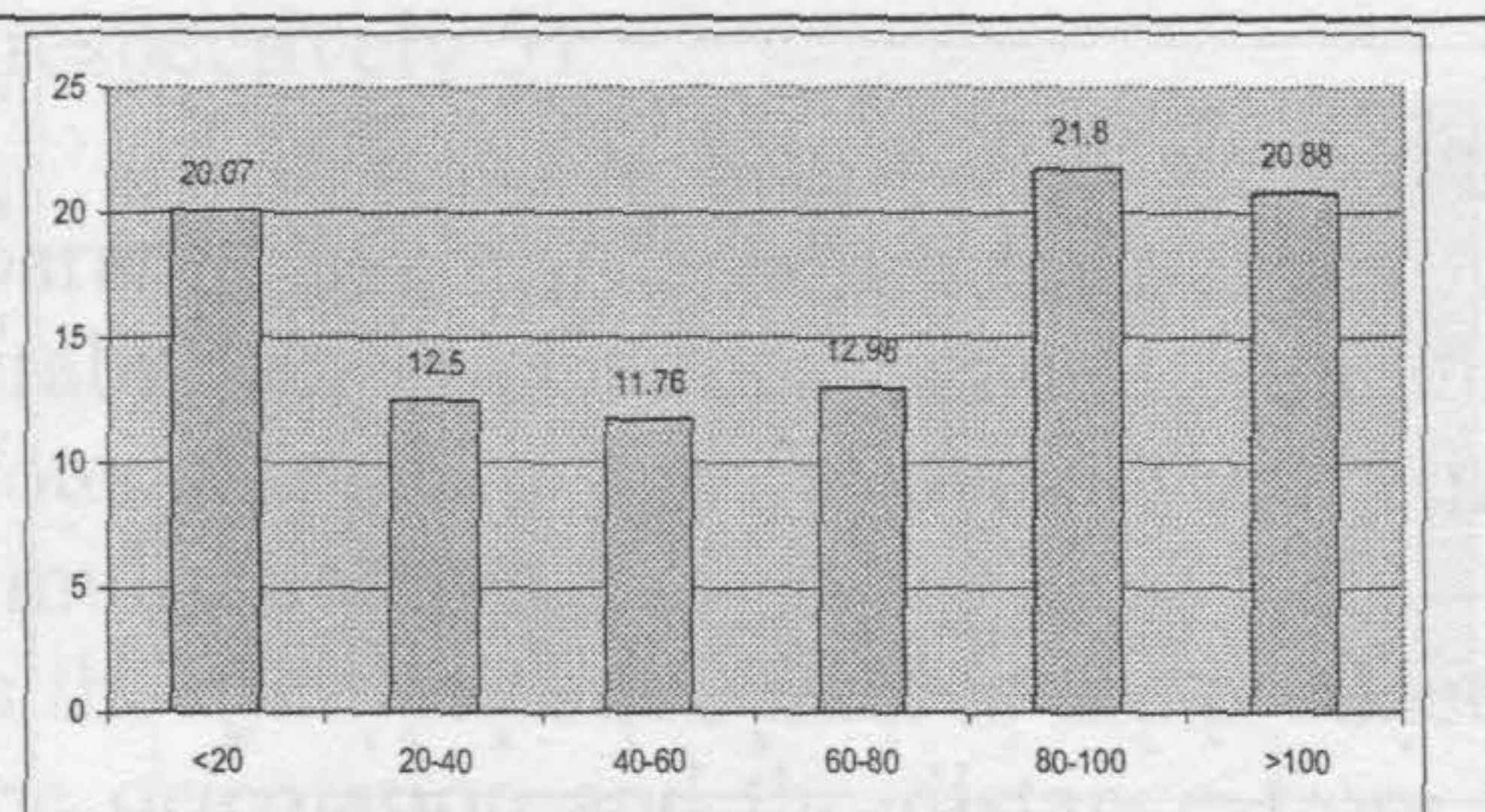


Fig.14 - (1983-2006)

From their analysis can be seen a similarity with the previous ones, only in the second the expansion of areas built-up on less favorable classes is highlighted better. If the first time most of the built area of the city was placed



on very favorable areas as Bistrita valley corridor, in the second period there was a proportional distribution in all classes of favorability of the extended areas. In this case, anthropogenic pressure has led to expansion of built even in the mountain area, on the slopes with less favorable orientation such as the north or a considerable distance from the main ways of communication.

#### 4. Conclusions

Evolution and current situation of the administrative territory of the city are the result of a complex natural and socio-economic factors, whose role and weight has changed over time and space. Natural conditions were favorable for human settlements, but these aspects of the landscape has been altered in a significant extent by human actions more or less conscious.

Regarding the recent changes occurring in land use are the most significant expansion of the perimeter of the city built. It has an extremely fast growth rate in only 23 years, which resulted in an environment very high anthropogenic pressure.

The analysis of favorability for construction observed that the city has grown especially in areas which are suitable for building such as those with a lower slopes value, with an exhibition of the slopes favorable, but also to the smallest distance from the main communication routes. The best example is the Bistrita valley corridor. However, after reaching the saturation of the building in the most favorable areas, there was need to extend to areas that are less favorable. Another factor that led this expansion stems from the desire of people to improve their lifestyle by growing demand for housing, reflected as an increased need for area.

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## ANALIZA SCHIMBĂRILOR ÎN UTILIZAREA TERENULUI DIN ARIA MUNICIPIULUI PIATRA NEAMȚ CU AJUTORUL TEHNICILOR GIS

(Rezumat)

Lucrarea reprezintă o analiză a schimbărilor în utilizarea terenurilor din aria municipiului Piatra-Neamț, vizând în special extinderea teritorială, fenomen care a cunoscut o dezvoltare accelerată în perioada postcomunistă. Pe lângă evaluarea pe teren s-a apelat la o serie de studii de specialitate și la unele materiale cartografice avute la dispoziție. Etapa de analiză a informațiilor coincide cu etapa de laborator reprezentată de utilizarea tehnicilor SIG, urmând interpretarea datelor și compararea rezultatelor.

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