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Using GIS in the Assessment of Landscape Visual Quality: a Methodological Approach Applied to Piatra Neamt, Romania

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Abstract

This study demonstrates the feasibility of using GIS in the assessment of landscape visual quality. Based on the digital elevation model achieved by processing the 1:5000 scale topographic plans, Viewshed analysis application was performed for 5 observation points of the territory, which were selected by objective criteria. We tried to quantify the landscape values of Piatra Neamt administrative territory through an objective analysis of the reality on the ground reflected from the observation points, taking into consideration also the human perception regarding these aspects (a hardly accepted domain by the scientific community). The analysis can lead to precise values of the landscape, yet the only element more difficult to quantify remains human perception.

The application was possible starting from the mathematical interpretation of the landscape proposed by Neuray G. in 1987, but a great importance in achieving the expected results is held by the specific GIS techniques mentioned above. The main purpose is to highlight the landscape potential of the area of study, noting that this analysis can be applied to any other area.

Keywords: *GIS, landscape assessment, Piatra Neamț*

Rezumat. Utilizarea tehnicilor GIS în evaluarea calității vizuale a peisajului: o abordare metodologică aplicată la Piatra Neamț, România

Studiul de față demonstrează fezabilitatea utilizării tehnicilor SIG în evaluarea calității vizuale a peisajului. Pe baza modelului digital al terenului realizat după planurile topografice la scara 1:5000 s-a efectuat aplicația Viewshed analysis pentru 5 puncte ale teritoriului, selectate după criterii obiective. S-a încercat o cuantificare a valorilor vizuale ale peisajului din aria municipiului Piatra Neamț în urma analizei obiective a realității din teren reflectate din punctele de observație, dar și prin prisma percepției umane (domeniu mai greu acceptat de comunitatea științifică). Astfel, se poate ajunge la valori precise ale peisajului, singurul element mai greu cuantificabil fiind percepția umană.

Aplicația a fost posibilă plecând de la interpretarea matematică a peisajului propusă de Neuray G. in 1987, urmând ca un rol deosebit de important în atingerea rezultatelor dorite să-l aibă tehnicile specifice SIG amintite anterior. Scopul principal este de a vedea potențialul peisagistic obiectiv al teritoriului studiat, însă această aplicație poate fi realizată pentru orice areal.

Cuvinte-cheie: *tehnici SIG, evaluare peisaj, Piatra Neamț*

Introduction

The landscape approach is widely recognised today as a powerful method of multidisciplinary environmental research. Integrating data both on natural geoecosystems and socio-economic impacts and their relationships, it offers an ideal frame of territorial sampling for evaluating, mapping and modelling environmental status and dynamics (Lioubimtseva et Defourny, 1999).

Frequently, the plurality of position regarding the meaning of the term geosystem replaces this very complex reality of the concept of landscape. At least for pressing practical reasons, its assessment (operation that involves rigorous quantification) should be based on scientifically validated methodology. In fact, the promoters of this

assessment have not yet established whether landscape values to be measured are economic, social, functional, ecological, economic, aesthetic etc. (Ungureanu I., 2005).

The landscape is an external manifestation, an indicator image or key reflecting the processes (natural and anthropic) that take place within a territory. As a source of information, the landscape requires interpretation. (...) The absence of a clear concept of landscape, plus the difficulty in reducing the amount of information it provides to manageable quantities, have led to the recent development of methods for its analysis. The large number of features that make up the landscape have given rise to many different approaches (some of which are complementary) to its study (Pastor et al., 2007).

Landscape assessment is a much requested direction in geography today. The high priority given to landscape states on European and global scale requires a thorough study of them, and the establishment of methodologies for assessing their status (Dumitrașcu M., 2006).

Techniques for assessing landscape attractiveness are becoming increasingly important in environmental planning. They are a manifestation of the growing need to monitor landscape deterioration, to help preserve natural beauty, to learn about our cultural perceptions, and to satisfy an ever-increasing body of environmental law. (Kane, 1981)

Geographical information systems (GIS) are excellent tools for landscape modelling and three-dimensional analysis. They allow easy digitalisation of geographical information and coverage structure, as well as facilitating graphical representation. (Hernandez et al., 2004)

THE AREA UNDER STUDY

Geographically, the Piatra Neamt town location is quite original, the initial built perimeter is sheltered by heights with steep slopes carved into flysch and it expanded to the Bistrita valley and its affluents (Fig. 1), especially on terraces, but also in meadows, areas that show optimal urbigene conditions.

The great diversity of natural conditions of Piatra Neamt have led to a great complexity of anthropogenic use, which gives a distinctive note to the landscape of the area (Apostol et Chelaru, 2011).

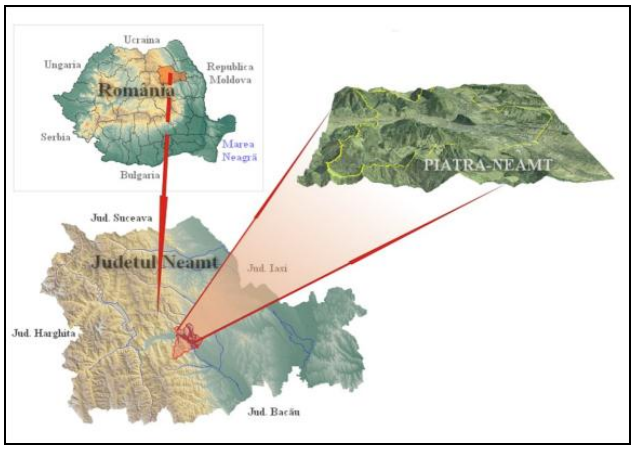

Fig. 1. Localization of area under study

Data and Methods

Based on the mathematical interpretation of the landscape proposed by Neuray G (1987) , there can be reach precise values of the landscape; the only more difficult to quantify element remains human perception. Thus, the application starts from expressing landscape value by:

V`` = L*R*S where L is the length or the visual distance calculated using the formula L= ½*10*log 10 l (l – maximum length of the distant plan visually perceived); the height of the visual area (R is an expression given by the formula R = 1 + sin $\alpha$ + sin $\beta$ + sin $\lambda$ + d/100, => V``= (L*R).; α, β, λ are the angles formed by horizontal line with elements located in the foreground and in the following existing plans in the area of predefined field of view , and d is the inclination or slope, T is the valorisation factor and represents the sum of all natural and anthropogenic components which are intercepted by the visual field coverage (180^o) and this factor is introduced in the formula S= 1 + T/100.

The last step consists in calculating the total value of the landscape, which is given by the objective landscape value summed up with the value of the visual elements (in other words - the perception of each person on the landscape observed).

Each constituent element of the visual field is rated on a scale from -10 to 10. Elements that could damage the value of a landscape from anthropogenic structures that are not integrated into the landscape to polluted areas receive the lowest notes. Of course spectacular scenery will receive the maximum grade (mixed vegetation, historical monuments).

To see the perception tendency on natural and anthropogenic potential that match most of the population, there was applied a questionnaire with seven questions on a sample of 50 people.

There results that Vt = V``+ Vv , where Vt – total landscape value, Vv – subjective visual value, based on perception.

Methodologically, for achieving landscape value analysis, we used the ANALYSIS VIEWSHED application from the Microimages TNT Mips software to see the visual area from a point of observation with an 180° angle.

The next step consists in quantitative and qualitative analysis of the landscape by applying the formula of Neurray G. explained above.

Because the application depends on the relief configuration, it was necessary to achieve a more detailed Digital Elevation Model (DEM) to capture as accurately areas taken into observation. DEM was realised through the same Microimages TNT Mips professional software. Based on the analysis and processing the achieved database, DEM represents the support of the following cartographic material. The main data source for achieving the DEM are vector layers represented by contour lines and altitude rates. Vectorisation operation of the contours was a time-consuming step, because we used 1:5.000 scale topographic maps. Finally, there were assigned "z" values, resulting 3D vector layers.

By using this method of interpolation, DEM accuracy is not maximum because the contour lines already represent interpolated values of elevation data extracted from the field, and for achieving DEM it is used a second interpolation (between contour lines). Thus, the data concentration along the contour lines and their absence between isolines result in a topographical uniformity between the contour lines.

We have chosen to use detailed topographic plans at 1:5.000 scale, so that the accuracy of DEM to be higher. The final product was conducted at a resolution of 10 m, which allows us to visualize correctly the overall configuration of the landscape and the morphometric parameters taken into account.

As far as we are concerned, the utilitiy of DEM is viewing the general relief configuration, which allows, by linking with other elements, to identify certain types of landscape; cartographic determining of morphometric elements with role in landscape structure, accurate measurements on different surfaces and drawing transversal profiles on different alignments to reflect geographical phenomena and processes.

Results and Discussion

The main goal is to see the landscape potential of the studied objective. Thus, we tried to quantify the landscape values reflected in Piatra Neamt municipality, through the analysis of the visual quality obtained by specific GIS techniques, using also the subjective component of the landscape, the aesthetical part that is every person's perception.

The visual quality is not the same as the aesthetic quality of the landscape, the latter depending on the perception of images. Even if a landscape has particular aesthetic qualities, it is useless if its image is not visible from certain points (Drăguț, 2000).

The visual expression of landscapes affects people in many ways: aesthetic appreciation, health and well being (Tveit M. S., 2009).

In order to achieve this study, there have been made five Viewshed observation points (view area), from different sites of the city, for an analysis as objective as possible, after which values were compared (Fig. 2, 3, 4, 5, 6). It should be noted that this application can be made for any point in the area.

For a more realistic analysis of the phenomenon we studied, reference points were selected according to several criteria: depending on the areas most often frequented by people looking for great scenery, or by the impact of public perception on the entrance to the town (by road or rail) as follows: at the southeast entrance to the town on DN15, linking Bacau and Piatra Neamt, at the eastern entrance DN15D (Calea Romanului), very common route which allows the access to Iasi.

Cross sections are intended to better illustrate the morphology of the area and are applied to the farthest distance plan.

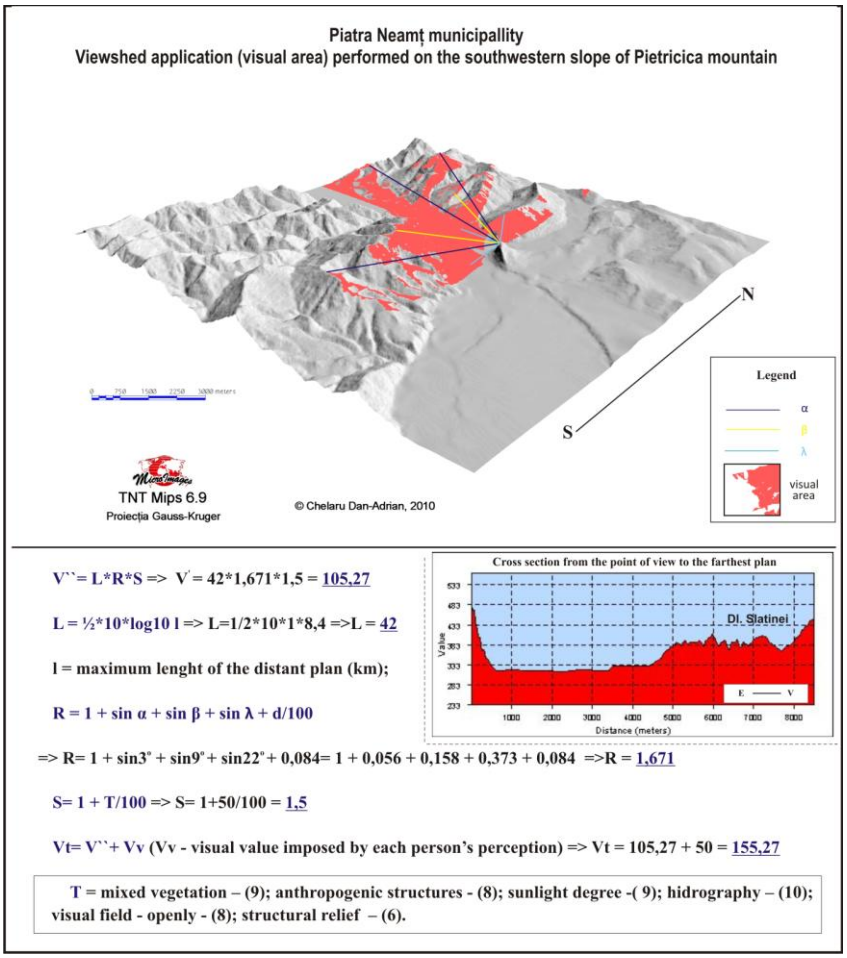

Fig. 2. Viewshed application realised on observation point 1 – SE slope of the Pietricica mountain

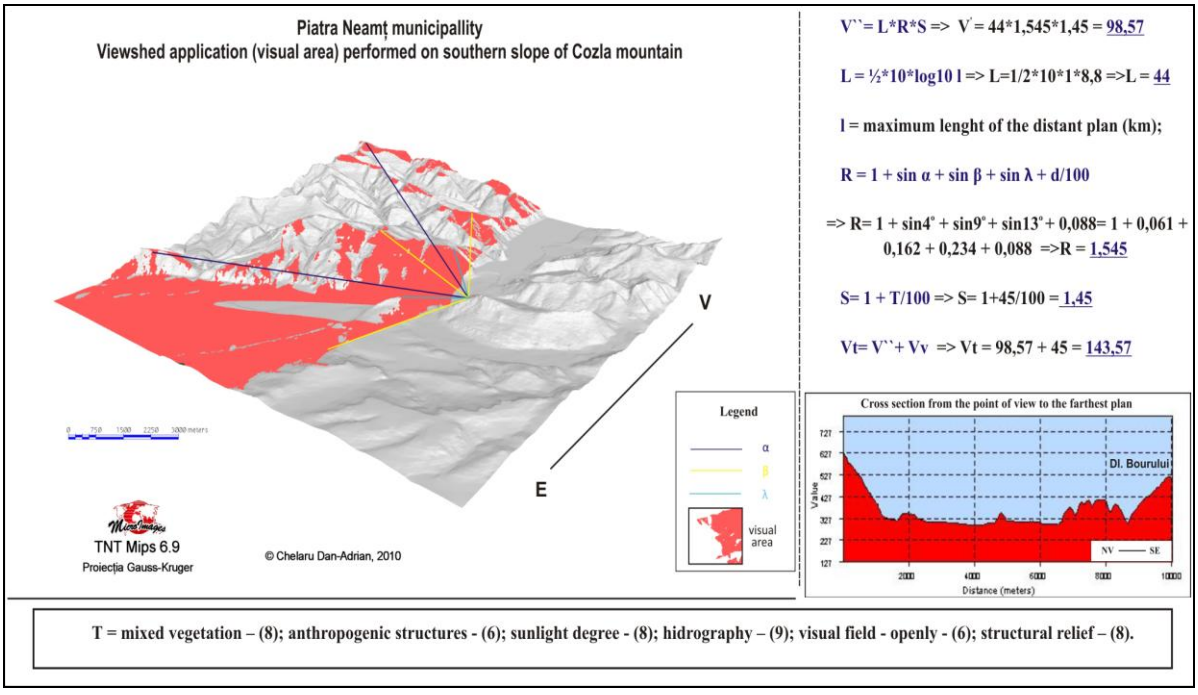

Fig. 3. Viewshed application realised on observation point 2 – southern slope of the Cozla mountain

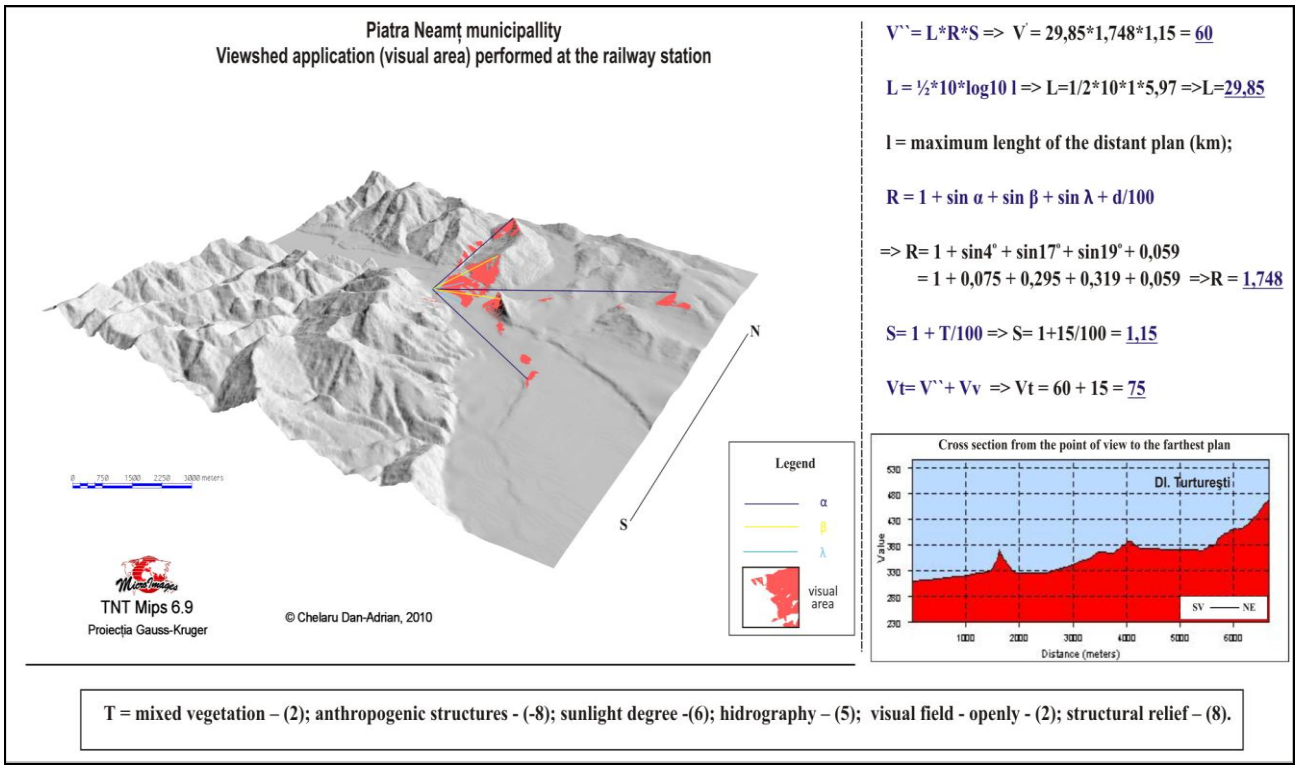

Fig. 4. Viewshed application realised on observation point 3 – The railway station

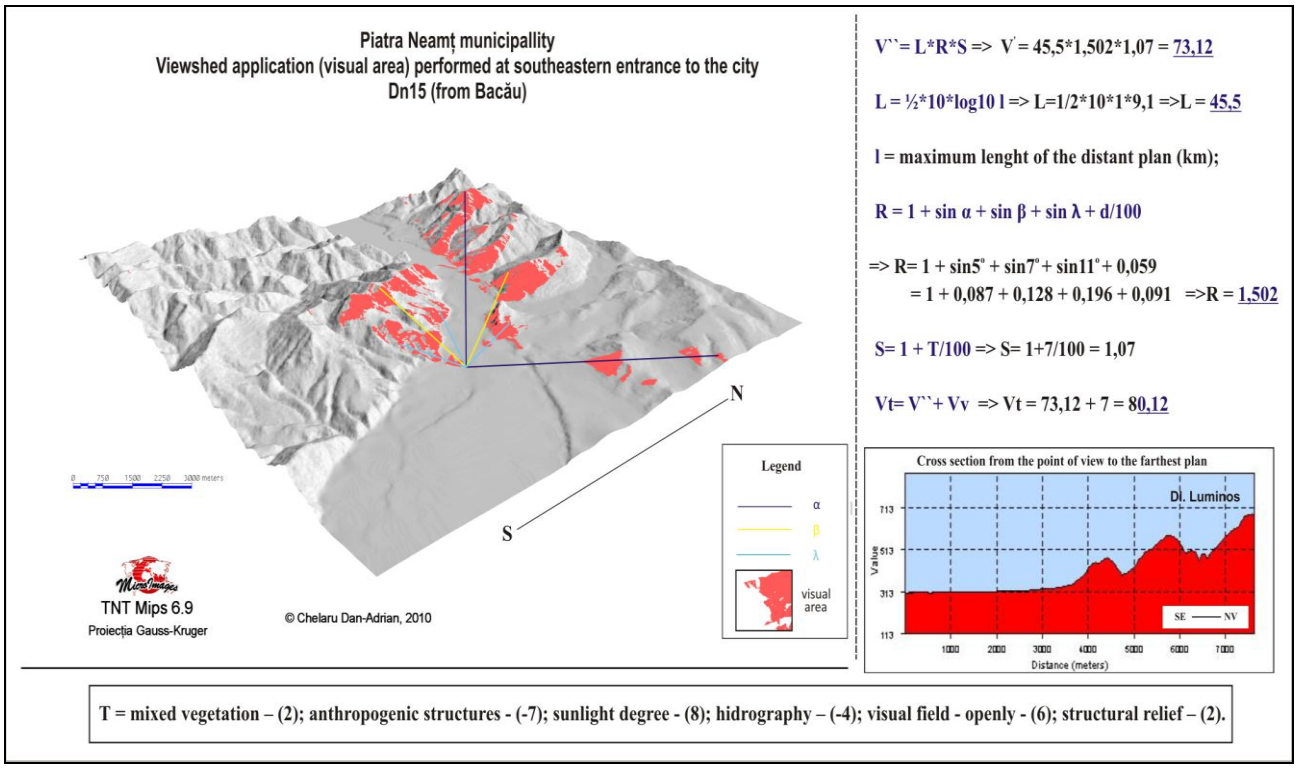

Fig. 5. Viewshed application realised on observation point 4 – DN15 road

(the southeastern town entrance from Bacau)

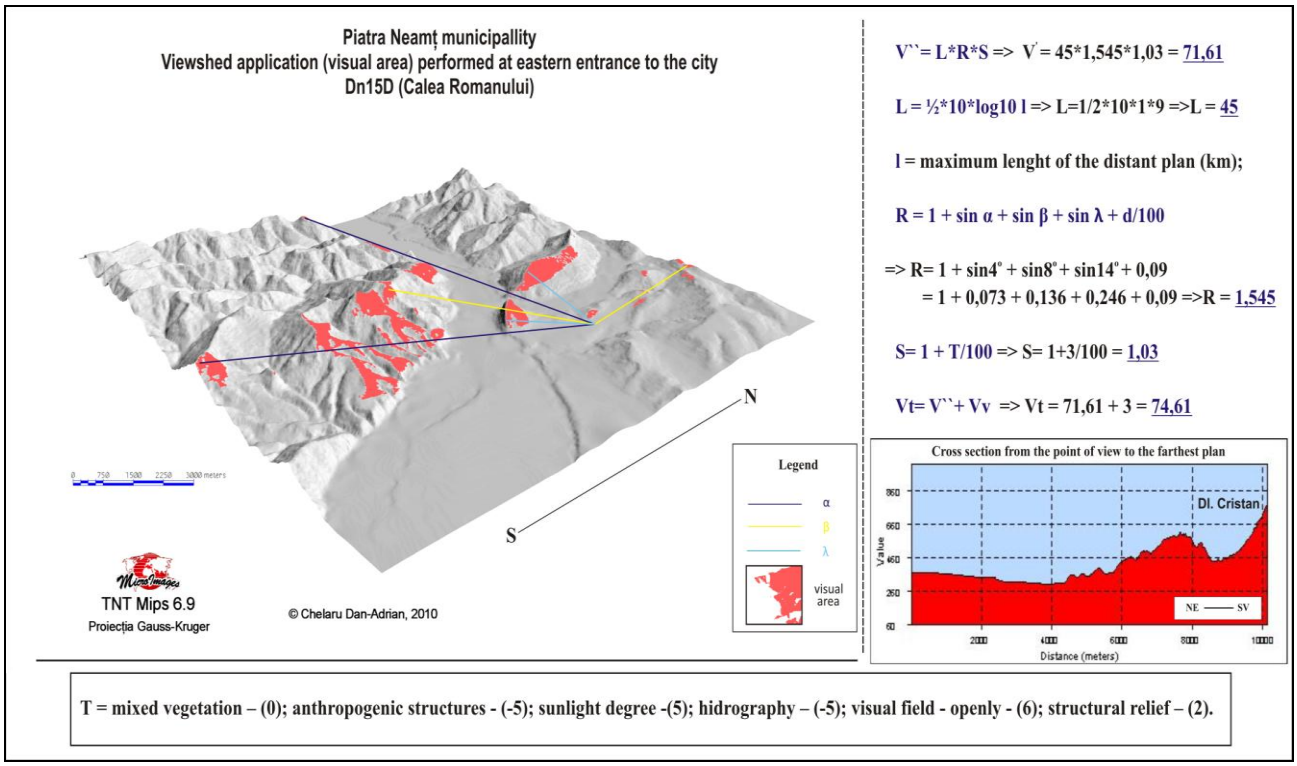

Fig. 6. Viewshed application realised on observation point 2 – DN15D road (eastern town entrance – Calea Romanului)

The results of the Viewshed analysis of the 5 sites are shown in Fig. 7, from which we can see that the highest landscape valuesare found in the high areas of the town, such as the Cozla and the Pietricica mountains, because of the remarkable view from these points. As expected, the other three points taken into account received lower landscape values, primarily due to lower overall image and thus the less visual impact stressed on the natural and anthropogenic components intercepted by the visual field coverage.

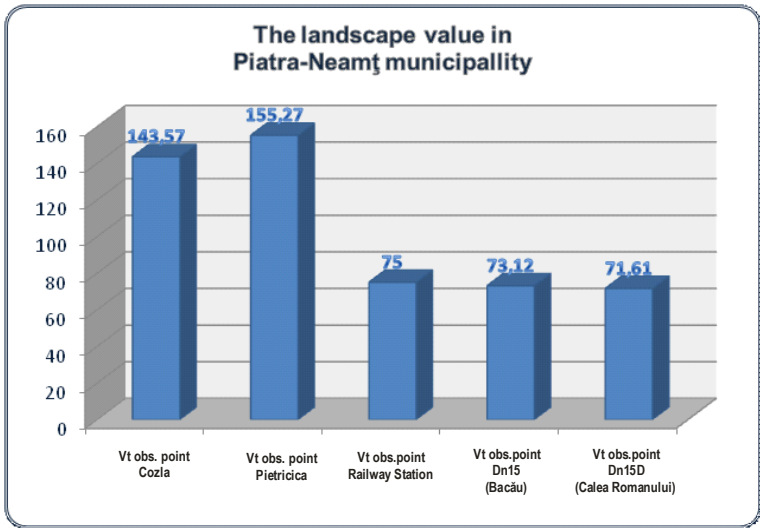

Fig. 7. The landscape values

We can highlight the observation point on Pietricica mountain (Fig. 8), its name being often asociated with the description of Piatra Neamt municipality. The landscape value in this point is maximal being situated in the town center, at a hight of 590 m, which gives it a privileged status, the

perception impact on natural (structural relief, mixed vegetation, hydrography - the Bistrita River, Bâtca Doamnei Lake etc.) and anthropogenic elements being high.

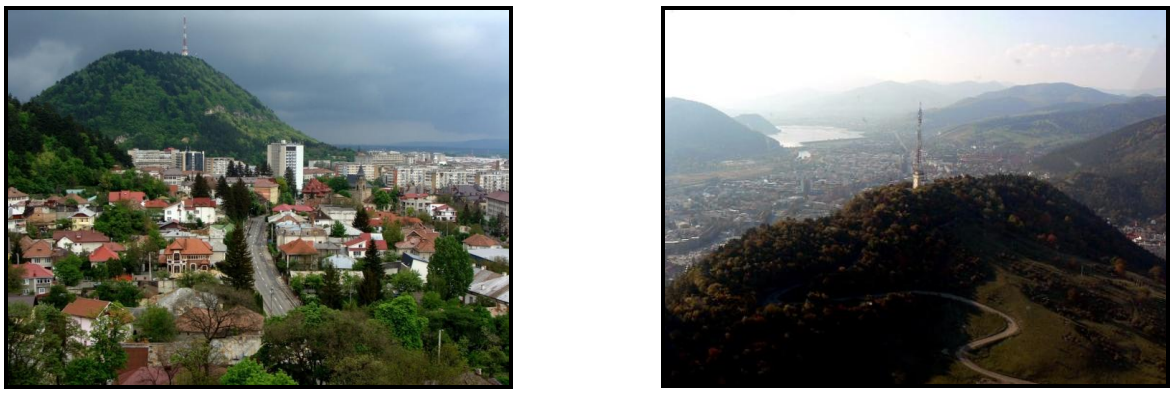

Fig. 8. Selective images of the Pietricica mountain

Conclusions

The framework aims at providing a repeatable and systematic approach in the assessment of landscape visual quality using GIS techniques, which should qualify it as a useful tool in landscape analysis and for the local authorities actions.

Acknowledgements

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