

Geographic Information Systems (GIS) analysis on the Ariușd occupation at Păuleni-Ciuc "Dâmbul Cetății", Harghita County

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Analiza GIS (Sisteme de Informații Geografice) a așezării Ariușd de la Păuleni-Ciuc "Dâmbul Cetății", județul Harghita

REZUMAT

Așezarea preistorică de la Păuleni-Ciuc "Dâmbul Cetății" este poziționată într-o locație unică, din perspectiva ambelor scări, cea locală și cea regională. Sistemul de georeferențiere este unul care cuprinde o serie de unelte folosite la crearea, depozitarea și reprezentarea unor date spațiale necesare documentării unor aspecte ale amplasării sitului preistoric.

Utilizarea Sistemului de Informații Geografice (GIS) ca metodă de analiză a vizibilității și peisajului de la Păuleni-Ciuc, se referă la "reprezentarea spațială a oricărei proprietăți vizuale generate sau asociate cu o configurație spațială". Două caracteristici ale vizibilității sitului furnizează informații pentru analiza vizibilității așezării de la Păuleni-Ciuc: *poziția dominantă vizuală și importanța vizuală*.

Pentru a examina aceste caracteristici ale zonei din jurul sitului Păuleni-Ciuc, ne-am construit un model de date precise, combinate cu datele existente, și s-au efectuat analize de vizibilitate ale zonei.

The prehistoric settlement at Păuleni-Ciuc "Dâmbul Cetății" is positioned in a unique location, from the perspective of both local and regional scales. The following paragraphs will draw upon Geographic Information Systems (GIS) analyses to document some aspects of the settlement's location¹.

Although located at a high elevation, Păuleni-Ciuc was not a prominent settlement. Prominence is a measure of the elevation of a location or landform relative to the area around it, measured using a Topographic Position Index (TPI)², and may be used to determine if an archaeological settlement is a central feature within its surroundings³. A settlement is said to be topographically prominent if it is located at an elevation greater than the mean of all other locations within a pre-defined area. Păuleni Ciuc's topography prominence score was measured within three areas: a large, 1 km buffer around the site; a medium-size 625 m buffer; and a 125 m buffer, which represents the area in the immediate vicinity of the settlement. The site is not topographically prominent within the 1 km buffer; that is to say,

within a one kilometer radius of the site, there is a greater amount of land that is at a higher elevation than the site.

However, the site is prominent within the smaller 625 m- and 125 m- buffers (Figure 1). In other words, the settlement would not appear prominent, relative to the landforms around it, to anyone who was more than a kilometer distant from the site. As they approached, though, the particular ridgeline on which Păuleni-Ciuc rests would appear more dominant, with the site taking on an increasingly central position within the landscape. Such a situation is not surprising, given the rugged nature of the Ciuc foothills, and is in line with other Ariușd sites such as Ariușd - Dealul Cisc and Malnaș Băi - Culme Nisipoasă. However, the site's location shares little similarity with settlements like Cucuteni "Cetățuia" or Poduri "Dealul Ghindaru", which are prominently located in all of the measured areas⁴.

The settlement's low prominence would have had an effect on the inhabitants' visibility. Two types of visibility models were constructed for the settlement: a dominance

viewshed, which measures the area that can be seen from the site⁵, and a Cumulative Viewshed Analysis (CVA), which measures the total area visible from multiple points around the site⁶. In GIS, the viewshed tool calculates the total visible area from a single point by drawing a Line of Sight (LoS) to all points within a surrounding area. If the LoS is interrupted, that point is considered hidden; otherwise it is considered visible. The result is a map of the total area visible from a single point. The CVA builds upon the viewshed analysis by generating and then combining viewsheds from multiple viewpoints. The result is an image of visual accumulation; the value at each location represents the total visibility from that location.

Visibility from Păuleni-Ciuc is severely restricted (Figure 2). The settlement's inhabitants would have had the greatest view directly to the south, where they would be able to see the valley below them and the northern slopes of the neighboring hills. However, their view to the north, east, and west would have been hindered by the ridge-line and surrounding hill peaks. Even some areas in close proximity to the site were not easily visible; while the villagers could have easily seen the valley to the south, the valley leading from the Ciuc basin directly to the site is largely obscured by a hill to the west. As with topographic prominence, this restricted visibility is characteristic of Ariuşd settlements, but distinct from that of the Cucuteni settlements located in the Moldovan Plateau⁷.

While the settlement's location does not command an expansive view, the villagers would have had access to three nearby locations with much greater vistas (Figure 3). These are determined by the cumulative viewshed map, which measures the total visible area for every location. The cumulative viewshed can be seen in Figure 3; the brown areas represent low visibility, while the light and dark blue areas represent high visibility. The same hill that blocks Păuleni Ciuc's view to the west provides some locations of high visibility, as does the ridgeline to the north/northeast of the site. As the cumulative viewshed map demonstrates, areas of high

visibility are scarce in the immediate vicinity of Păuleni-Ciuc. While the settlement was not located directly on an area of high visibility, it was positioned close to some of the greatest viewpoints within a 2km area; only Mt. Şumuleu, to the southwest and visible from the site, could provide a greater vista. If the results of the settlement's viewshed and the area's cumulative viewshed are considered together, it is possible to suggest that the inhabitants may have established their settlement in order to maximize their view of the surrounding landscape, by using viewpoints nearby the settlement, while minimizing the visibility of the settlement itself. The possibility of a hidden settlement may indicate some concerns regarding protection or defense on the part of the inhabitants.

If the inhabitants were concerned with the settlement's defense, another important consideration is its accessibility. Movement is simulated within a GIS by using path distance and cost distance algorithms⁸. One variant of the movement models is the accessibility model, based the "*focal point model*"⁹, which generates the least-cost — or, easiest to traverse — paths from a settlement. To determine a site's accessibility, a number of origin points are placed an equal distance from the site. Then, the least-cost path, which represents the path to the site that is easiest to walk, is calculated from each of the origin points to the site. The result is a network map that models the accessibility of the settlement.

Păuleni-Ciuc's accessibility is presented in Figure 4. The steep slope directly south of the site had the biggest impact on accessibility, limiting the majority of southern routes to only two approaches from the south. From the Ciuc Basin, the settlement could be approached from three directions: from the aforementioned southern route, from the west via an approach leading straight up the valley leading to the site, and a third northern approach cresting the ridgeline to the north. All of the paths to the site from deeper in the Ciuc foothills, from the northeast, collapse into a single route approximately 0,5 km from the site.

Notes / References

1. Although the examples given here pertain to the Ariuşd occupation at Păuleni-Ciuc, the GIS analysis is relevant for all stages of the site's occupation, as its location in the landscape does not change.

2. **Weiss 2001, Jenness 2006.**

3. e.g., **De Reu et alli 2011.**

4. **Whitlow 2014**, p. 193-194, 200-202.

5. For the use of viewsheds in archaeology, see **Llobera 2007**; and **Trick 2008.**

6. **Lake et al 1998; Gillings 2009.**

7. **Whitlow 2014**, p. 219-221, 237-242.

8. **Conolly and Lake 2006**, p. 252-257.

9. **Llobera et alli 2011.**

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Figures / Figuri

Figure 1. Topographic Prominence of Păuleni-Ciuc

Topographic prominence is a measure of the elevation of a settlement relative to the elevation of all other landforms within certain vicinity, in this case the area with a 625m radius. Red areas indicate very prominent features, such as ridgelines and hill peaks, while blue areas indicate very recessed features, such as valleys.

Figura 1. Topografia altitudinilor de la Păuleni-Ciuc

Topografierea altitudinilor reprezintă măsurarea cotelor unei așezări, în raport cu cotele celorlalte forme de relief aflate într-o anumită vecinătate, în acest caz zona are o rază 625m. Zonele roșii indică elemente foarte proeminente, precum crestele și vârfurile de deal, în timp ce zonele albastre indică elemente foarte joase, cum ar fi văile.

Figure 2. Visibility from Păuleni-Ciuc

Visibility is calculated by using a Line of Sight to identify areas that are visible from a single point, in this case the settlement at Pauleni-Ciuc. In this figure, the blue area indicates the area visible from the site, while the shade of blue indicates how visible that area is, determined by measuring the distance from the viewpoint and the slope of the land. Highly visible areas are colored dark blue.

Figura 2. Vizibilitatea de la Păuleni-Ciuc

Vizibilitatea este calculată folosind o linie a orizontului pentru a identifica zonele care sunt vizibile dintr-un singur punct, în acest caz, aşezarea de la Păuleni-Ciuc. În această figură, zona albastră indică zona vizibilă de pe situl arheologic, în timp ce umbra albastră indică cât de vizibilă este zona, determinată prin măsurarea distanţei din punctul de vedere de pe sit şi panta terenului. Zonele extrem de vizibile sunt cele de culoare albastru-închis.

Figure 3. Cumulative Viewshed Analysis for the Păuleni-Ciuc area

The Cumulative Viewshed Analysis measures the total visible area for every point on the map. In other words, the CVA measures which areas have the greatest visibility. With blue indicating an area of high visibility and brown indicating an area of low visibility. Păuleni-Ciuc is located in an area of low overall visibility, but the inhabitants could easily access areas of high visibility to the north and east.

Figura 3. Analiza cumulativă a vizibilităţii pentru zona Păuleni-Ciuc

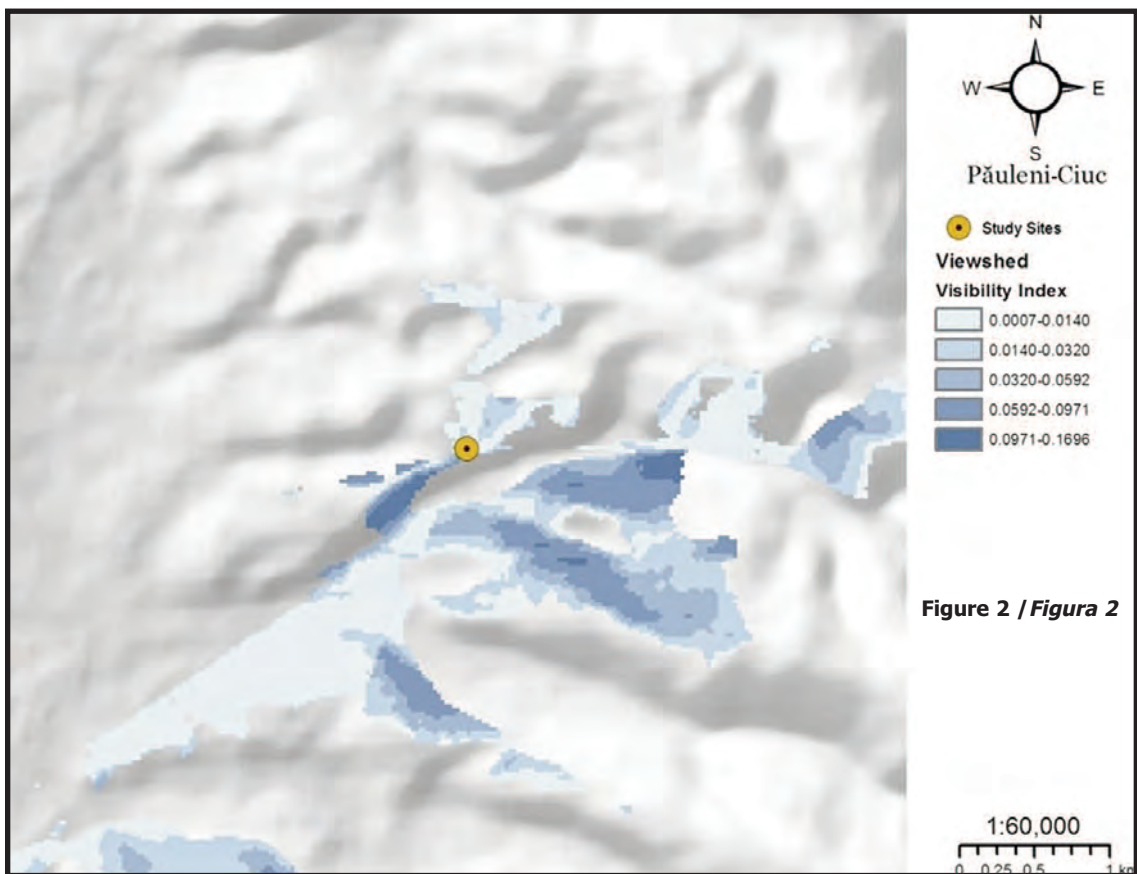
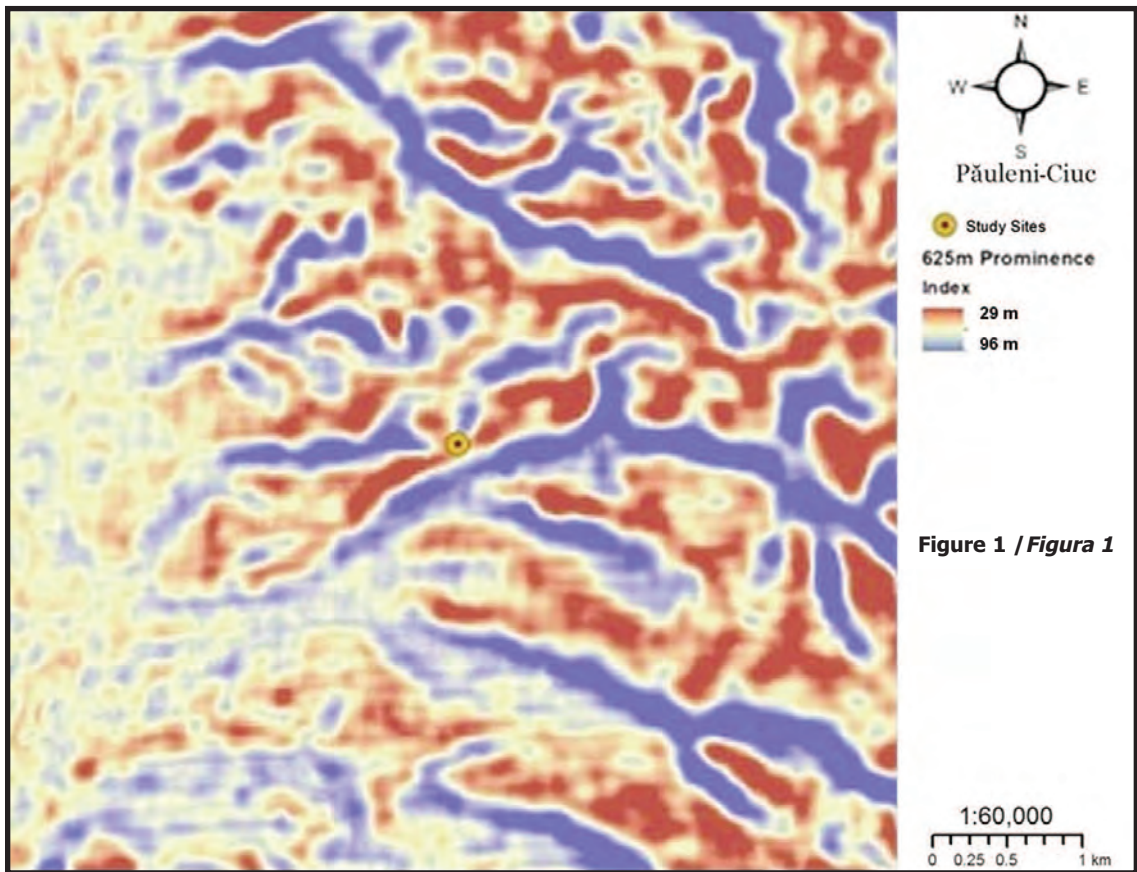
Analiza cumulativă a vizibilităţii măsoară suprafaţa totală vizibilă pentru fiecare punct de pe hartă. Cu alte cuvinte, analiza cumulativă a vizibilităţii măsoară zonele cu cea mai mare vizibilitate. Cu albastru este indicată o zonă de vizibilitate mare şi cu maro o zonă de vizibilitate redusă. Situl Păuleni-Ciuc este situat într-o zonă de vizibilitate în general scăzută, dar locuitorii sitului puteau să aibă acces uşor la zone de mare vizibilitate spre nord şi est.

Figure 4. Accessibility of Păuleni-Ciuc

An accessibility model calculates the least cost path (the path that is easiest for a person to travel when walking) between two locations. This accessibility models calculates the least cost path from a number of locations around Păuleni-Ciuc to the settlement. Taken together, these paths represent a model of the settlement's accessibility, indicating from which directions and which approaches the settlement could most easily be reached.

Figura 4. Accesibilitatea sitului Păuleni-Ciuc

Un model de accesibilitate calculează calea cea mai uşoară (calea cea mai accesibilă pentru o persoană să călătorească pe jos), între două locaţii. Acest model de accesibilitate calculează calea cea mai uşoară către o serie de locaţii din jurul sitului Păuleni-Ciuc. În general, aceste căi reprezintă un model de accesibilitate a aşezării, indicând din ce direcţii şi care sunt traseele cel mai uşor de parcurs.



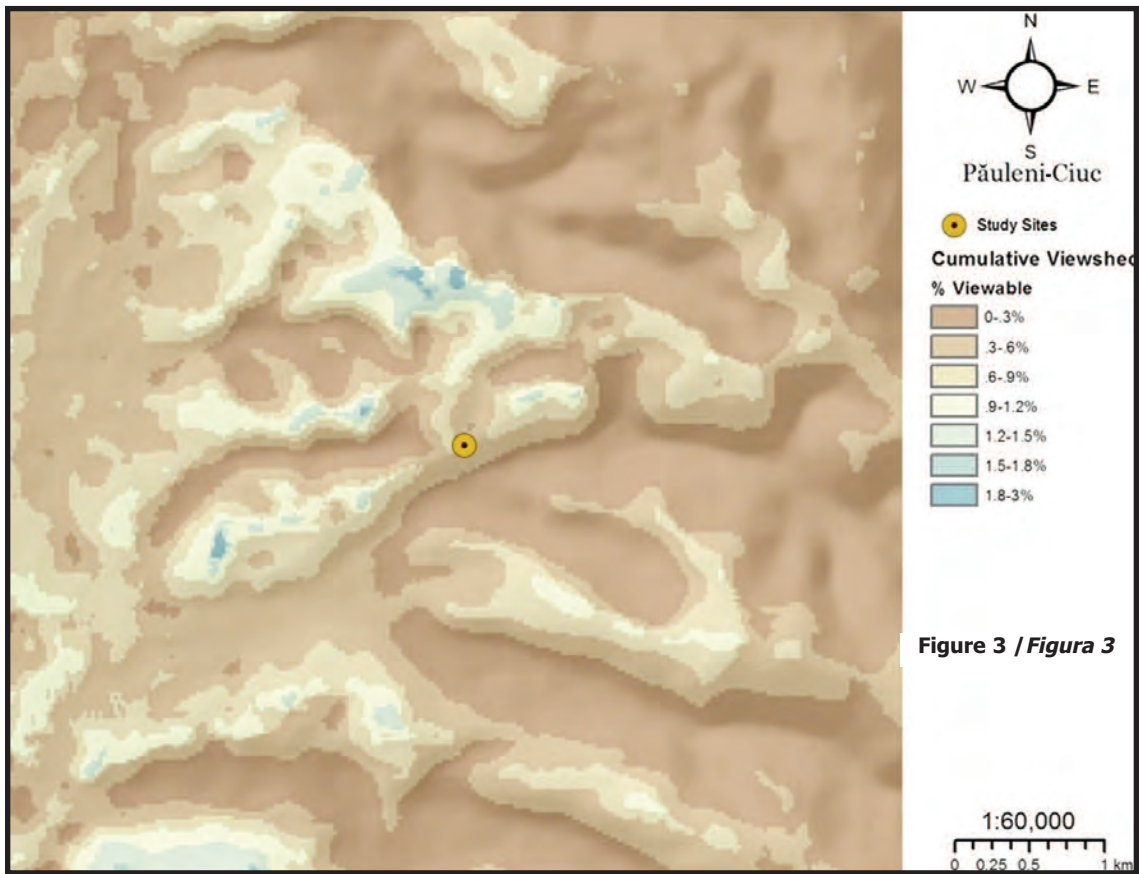


Figure 3 / Figura 3

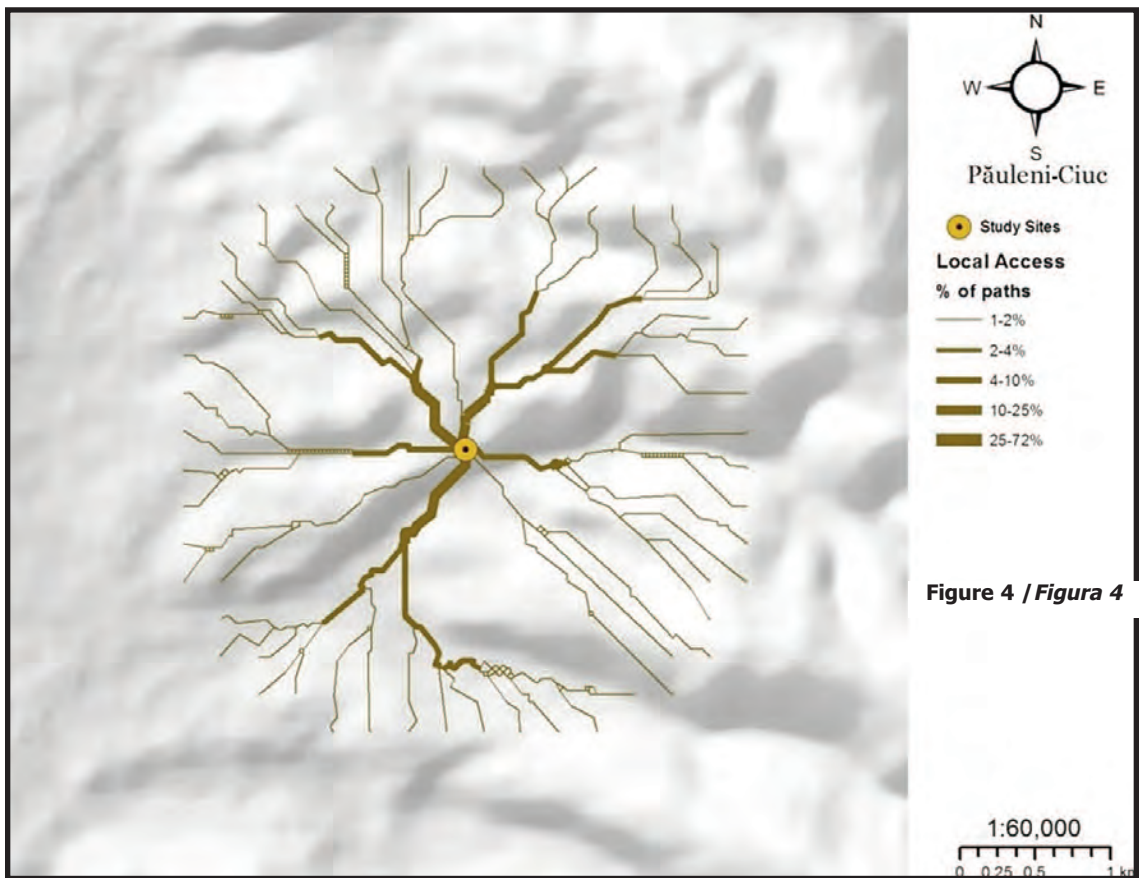


Figure 4 / Figura 4