

Chapter 10

Geomorphosites Assessments of the Glacial and Periglacial Landforms from Southern Carpathians

Laura Comănescu and Alexandru Nedelea

Abstract Geomorphosites are landforms that in time have received a certain value due to human perception. This value can be scientific, ecological, aesthetic, cultural-historical and economic. *The Southern Carpathians* present numerous and various glacial and periglacial geomorphosites. In order to obtain an overall image of this area, the authors calculated indexes for glacial, periglacial and global geomorphic diversity. Geomorphic diversity is a dimensionless parameter that shows the number and diversity of geomorphosites within the study area. Global geomorphic diversity (glacial and periglacial) has a medium value of 0.365, with differences between glacial and periglacial. The values for glacial geomorphic diversity varied between 0 and 0.90 with a medium value of 0.30. The periglacial geomorphic diversity had higher values, ranging between 0.10 and 0.95 with a medium value of 0.43. In the *Southern Carpathians, The Viştea basin (Făgăraş Mts.) was chosen as study area* for an evaluation of geomorphosites. Several methods amongst the most widely used in the literature (Pralong in *Géomorphol Relief Processus Environ* 3:189–196, 2005; Coratza and Giusti in *Il Quaternario* 18(1):307–313, 2005; Bruschi and Cendrero in *Il Quaternario* 18(1):293–306, 2005; Serrano and Gonzalez-Trueba in *Géomorphol Relief Processus Environ* 3:197–208, 2005; Reynard et al. in *Geogr Helv* 62 3:148–158, 2007; Pereira et al. in *Geogr Helv* 62 (3):159–169, 2007; Zouros in *Geogr Helv* 62 3: 169–180, 2007; Comănescu et al. in *Forum Geografic. Studii și cercetări de geografie și protecția mediului* XI:54–61, 2012) were applied and their results were subsequently compared. Each of the above-mentioned methods has their strong and weak points and the resulted global values vary on a large scale. The hierarchy obtained for each method in particular shows much smaller differences. By adding all the resulted ranks, the authors can conclude that the Viştea Valley glacial geomorphosite is the most important one from the Viştea basin.

L. Comănescu (✉) · A. Nedelea
Faculty of Geography, University of Bucharest,
1st N. Bălcescu Blv., sector 1, 010041 Bucharest, Romania
e-mail: lauracomanescu@yahoo.com

Keywords Geomorphic diversity · Inventory · Glacial and periglacial geomorphosites · Southern Carpathians

Introduction

The current, unanimously accepted, definition considers geomorphosites to be landforms which, in time, have acquired a certain value due to human perception (Panizza 2001). Reynard (2005) argued that geomorphosites need to have several attributes and, as such, besides the scientific component (around which the focus should gravitate) additional values are also important (ecological, cultural, aesthetic and economic). Geomorphosites are multifunctional entities and a main component of the geomorphic landscape (Reynard 2005) . They can acquire different values, which may change over time depending on the way human society perceives and uses them.

Starting with this definition, Fig. 10.1 reveals the interconnection established between the human society and geomorphosites and the four fundamental attributes this relation relies on: knowledge, research, positive impact and use.

In time, the study of geomorphosites developed the following directions: defining, inventorying, establishing an assessment methodology and mapping.

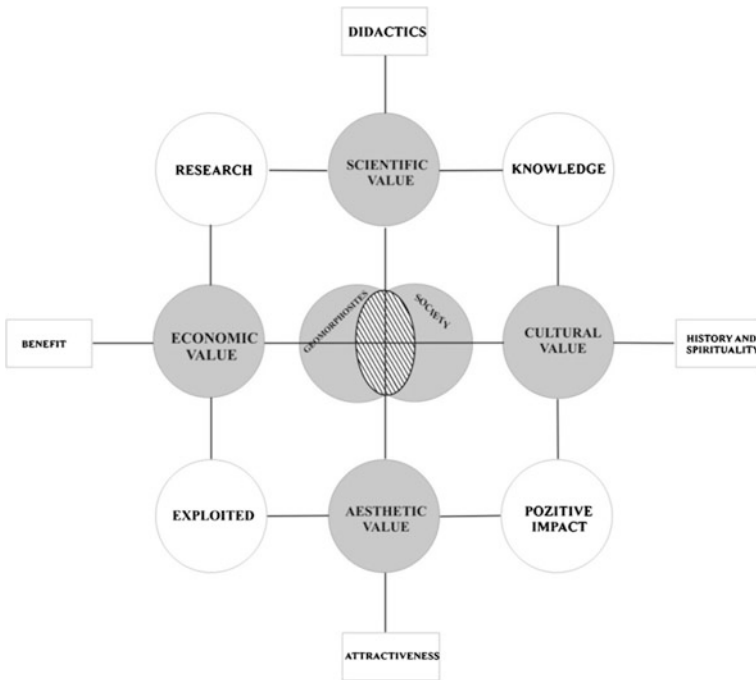


Fig. 10.1 Interrelations between geomorphosites and the human factor

Evaluating geomorphosites has been a constant concern for the scientific community, first in the larger framework of geosites and then in the individual class of geomorphosites. Though, at the level of the inventory methodologies there is no unitary methodology, due to the final purposes of the respective demarches, but also due to different regions of applying the methodologies.

Grandgirard (1999) formulates the first effective criteria of geomorphosites assessment, many of them residing directly or indirectly in the methods worldwide operating now (integrity, representativeness, rarity, paleogeographic value).

Wimbledon et al. (2000), within the Geosites project, establishes a set of criteria, which were embraced at that time by the international community, namely: representativeness, complexity, geodiversity and the site's potential for multidisciplinary studies. This method made it possible for the inventories realized within the project, but in different countries, to be more homogenous.

After the year 2000, the efforts for creating an evaluation method for geomorphosites become evident in the international geographical literature. As such, depending on the school that presented them and the areas they were used in, several methods have been developed.

A first synthesis of these methods was proposed by Reynard et al. (2009), as they tried to establish a series of common characteristics for these classifications (taking the scientific value as a central point of the assessment), and subsequently divided them into direct evaluations (subjective, done by researchers using their own grids) and indirect ones (objective, by clear quantifications). In the same paper (Reynard et al. 2009), the authors pay a particular attention to the purpose and the context in which some of the methods mentioned above were applied, as well as to the main criteria and sub-criteria employed for the assessment.

The study of geomorphosites in the Romanian literature started in 2004 at the University of Oradea (focusing mostly on the geomorphosites from the Apuseni Mountains) (Ilieş and Josan 2007, 2009; Ilieş et al. 2011; Ilieş 2014), continued in 2008 at the University of Bucharest (studying areas from the Southern Carpathians and the Dobrogea Plateau) (Comănescu and Dobre 2009; Comănescu and Nedelea 2010; Comănescu et al. 2009, 2011a, b, 2012, 2014) and after 2011 the Babeş-Bolyai University in Cluj (with studies on the Trascău Mountains, the Transylvania Depression and the western parts of the Northern Carpathians) (Cocean 2011; Cocean and Surdeanu 2011; Irimus et al. 2011; Irimia and Toma 2012; Gavrilă and Anghel 2013). All the resulted papers aimed for: inventorying geomorphosites from different areas, evaluating them using different methods existing in the specialized literature and constructing geotourism maps of areas representative for Romania.

The Inventory of the Geomorphosites

An inventory aims to review all geomorphosites located within specific boundaries, as a first step in their evaluation. In the specialized literature, there is no generally accepted methodology for inventorying geomorphosites because of the diverse

finality that the inventorying approaches had over time and the different areas with particular features where they were applied, each area requiring specific criteria (Cocean 2011). The most widely known and used inventorying fiche is the one elaborated by Pralong (2005) and by Reynard et al. (2007) which consider both the quantitative and the qualitative analysis, the same fiche that we used in this study. A very important step in the inventorying process is classifying the geomorphosites, and this can be done following several criteria. Here is an exemplification of these criteria using geomorphosites from the Southern Carpathians.

The Temporal–Functional Criterion

- *Active geomorphosites* represent geomorphosites with an important educational value because they help the understanding of the present-day morphology; are key-features in reconstructing the paleo-geographical conditions, and in turn cause the development of passive geomorphosites (Reynard et al. 2009) (e.g. the Stonerivers in the Retezat Mountains, the Rockglaciers in the Făgăraș Mountains).
- *Passive geomorphosites* constitute archives of the paleo-environmental conditions in which the respective landforms formed and developed, and enable the study of the genesis (inclusive the age) and evolution of the relief (Reynard et al. 2009) (e.g. glacial steps, the generations of moraines in the Făgăraș Mountains).

The Genetic Criterion

- *Glacial geomorphosites*—valleys, cirques, steps, thresholds, roche moutonnée, moraines, (e.g. Bâlea cirque, Bâlea Valley, the threshold on which the Bâlea Waterfall developed, the moraine from the Capra Chalet in the Făgăraș Mountains);
- *Periglacial geomorphosites*—nivation cirques, nivation hollows, nivation horseshoes, disaggregation ridge, escarpment slopes, needles, towers, slide rocks, rocks stream, rock glaciers, blockfields (present in the Făgăraș, Retezat, Parâng, Cindrel, Șureanu and other Mountains).

The Tourism Relevance Criterion

- *Local and regional interest geomorphosites*—Pleșcoaia, Setea Mare, Ieșu, Căldarea lui Murgoci cirques located in Parâng Mountains, Iezerul Podul Giurgiului cirque located in Făgăraș Mountains, the Tărtăraș nival cirque located in Parâng Mountains;

- *National interest geomorphosites*—Mălăești valley in Bucegi Mountains, Zănoaga, and Bucura cirques in Retezat Mountains, Câlcescu, Mija, Roșiile cirques in Parâng Mountains, the Judele, Râul Bărbat, Lăpușnicul Mare glacial complexes in Retezat Mountains;
- *International interest geomorphosites*—Bâlea Valley, Bâlea Cirque, Capra Valley, in Făgăraș Mountains.

The Surface Criterion

- *Punctual geomorphosites*: Cleopatra’s Needle in Făgăraș Mountains, Morarului Crags in Bucegi Mountains;
- *Linear geomorphosites*: the Arpaș, Viștea and Podragu glacial valleys in Făgăraș Mountains; the Mălăești, Cerbului and Morarului glacial valleys in Bucegi Mountains;
- *Areal geomorphosites*: Mioarele cirque in Făgăraș Mountains, Iezeru Șureanu cirque in Șureanu Mountains, the moraines in Parâng Mountains.

There are numerous glacial and periglacial geomorphosites within the study area and they vary in terms of functionality, genesis, tourism relevance and surface (Fig. 10.2). Table 10.1 shows a selection and inventory of different categories of geomorphosites located in the Southern Carpathians.

Because of the large extension of the study area, the authors propose a generalized approach with the specific aim to determine the geomorphic diversity for each massif according to the two types of landforms (glacial and periglacial) by only considering the geomorphosites in these categories (Table 10.2).

The concept of geomorphodiversity was introduced in the specialized literature in order to express the overall value of the geomorphosites for particular areas, usually large-sized, as well as the multitude/diversity and types of landforms (Panizza 2009; Demek et al. 2011; Kostrzewski 2011).

The coefficient of geomorphic diversity was calculated based on the formula

$$Gmd = \left(\sum EgXn + Gm \right) / s \quad (10.1)$$

where Gmd is the geomorphodiversity coefficient; Eg—the number of landforms; n —the number of genetic relief types; Gm—the number of geomorphosites, and S —surface (km²) (Comănescu et al. 2014).

“A special attention was given to geomorphosites, which are practically calculated twice, both in the first category and in the second category, in order to give a plus value to those” (Comănescu et al. 2014). The result is a total dimensionless value that indicates the quantity and degree of geomorphic diversity within the considered area. The disadvantage of this parameter lies in the fact that it does not convey the total, effective value of the geomorphosites (Comănescu et al. 2014).



Fig. 10.2 Representative glacial and periglacial geomorphosites from the Southern Carpathians: 1 Bălea glacial complex (Făgăraș Mts.), 2 Capra glacial complex (Făgăraș Mts.), 3 Podul Giurgiului glacial complex (Făgăraș Mts.), 4 Coștilei slope (Bucegi Mts.), 5 Capra waterfall (Făgăraș Mts.), 6 Ogres' window (Făgăraș Mts.), 7 Babe (Bucegi Mts.), 8 Pelegii Cliffs (Retezat Mts.), 9 Sphinx (Bucegi Mts.), 10 Galeșu glacial complex (Retezat Mts.), 11 Glacial Valley Mălăiești (Bucegi Mts.), 12 Câlcescu glacial complex (Parâng Mts.)

The global value of geomorphodiversity was computed as an average between the glacial and periglacial geomorphodiversity, since other genetic types of topography are not being considered by this scientific approach.

The global geomorphic diversity (glacial and periglacial) registers a mean value of 0.365 but presents marked differences between the glacial and the periglacial (Table 10.2; Fig. 10.3). For example, the periglacial geomorphosites are more numerous and varied while the glacial ones have a superior intrinsic value even if they cover a more reduced surface. The highest values register in the Făgăraș and Retezat massifs (0.925) and the lowest in Ghițu, Frunți, Cernei and Mehedinți massifs (0.05).

The values for geomorphic diversity of the glacial landforms vary from 0 (Ghițu, Frunți, Cozia, Vâlcan, Cernei and Mehedinți) to 0.9 (Făgăraș, Retezat). The median value of this parameter is the highest registered in all Romanian Carpathians (Table 10.2; Fig. 10.4).

The values reflecting the geomorphic diversity of the periglacial landforms are higher than those obtained for the glacial ones due to their stronger presence within the study area. The Southern Carpathians present many periglacial landforms some

Table 10.1 Synthesis of the glacial and periglacial geomorphosites from the Southern Carpathians

No	Name	Location (mountain)	Functionality	Genesis	Tourism relevance	Surface
1	Ialomița Valley	Bucegi	Passive	Glacial	National	Linear
2	Doamnei Valley	Bucegi	Passive	Glacial	Regional/local	Linear
3	Morarului Valley	Bucegi	Passive	Glacial	National	Linear
4	Cerbului Valley	Bucegi	Passive	Glacial	National	Linear
5	Mălăiești Valley	Bucegi	Passive	Glacial	National	Linear
6	Mălăiești! Cirque	Bucegi	Passive	Glacial	National	Areal
7	Țigănești Cirque	Bucegi	Passive	Glacial	Regional/local	Areal
8	Caraiman Scree	Bucegi	Active	Periglacial	Regional/local	Areal
9	Mitarca Cirque	Leaota	Passive	Glacial	Regional/local	Areal
10	afl. Mitarca Cirque	Leaota	Active	Periglacial	Regional/local	Areal
11	Great Scree	Piatra Craiului	Active	Periglacial	National	Areal
12	Hornul Găinii Scree	Piatra Craiului	Active	Periglacial	Regional/local	Areal
13	Iezerul Mare Cirque	Iezer	Passive	Glacial	National	Areal
14	Pișcanul nival Cirque	Iezer	Active	Periglacial	Regional/local	Areal
15	Bâlea Cirque	Făgăraș	Passive	Glacial	International	Areal
16	Buda Cirque	Făgăraș	Passive	Glacial	Regional/local	Areal
17	Capra Cirque	Făgăraș	Passive	Glacial	National	Areal
18	Capra Valley	Făgăraș	Passive	Glacial	International	Linear
19	Bâlea Valley	Făgăraș	Passive	Glacial	International	Linear
20	Morena Capra	Făgăraș	Passive	Glacial	Regional/local	Areal
21	Orzăneava erratic block	Făgăraș	Passive	Glacial	Regional/local	Punctual
22	Podragu Cirque	Făgăraș	Passive	Glacial	National	Areal
23	Turnu Steep	Cozia	Passive	Periglacial	Regional/local	Areal
24	Piatra Șoimului erosion outlier	Cozia	Passive	Periglacial	Regional/local	Punctual
25	Căldarea Dracului Cirque	Parâng	Passive	Glacial	Regional/local	Areal
26	Găuri Cirque	Parâng	Passive	Glacial	Regional/local	Areal
27	Mija Cirque	Parâng	Passive	Glacial	National	Areal
28	Mija Mare debris cone	Parâng	Active	Periglacial	Regional/local	Areal
29	Piciorul Tecanului Scree	Parâng	Active	Periglacial	Regional/local	Areal
30	Zănoaga Mare—Călcescu stone see	Parâng	Active	Periglacial	Regional/local	Areal

(continued)

Table 10.1 (continued)

No	Name	Location (mountain)	Functionality	Genesis	Tourism relevance	Surface
31	Stone pavements on the main ridge (west of Setea Mare)	Parâng	Active	Periglacial	Regional/local	Areal
32	Grassy mounds in the Mohoru—Setea Mare saddle	Parâng	Active	Periglacial	Regional/local	Areal
33	Iezerule Cindrelului Cirque	Cindrel	Passive	Glacial	National	Areal
34	Gropata Cirque	Cindrel	Passive	Glacial	Regional/local	Areal
35	Balindru Cirque	Lotru	Passive	Glacial	Regional/local	Areal
36	Șteflești Cirque	Lotru	Passive	Glacial	National	Areal
37	Negovanu Scree	Căpățâanii	Active	Periglacial	Regional/local	Areal
38	Coșana Scree	Căpățâanii	Active	Periglacial	Regional/local	Areal
39	Șureanu Cirque	Șureanu	Passive	Glacial	National	Areal
40	Cârpa Cirque	Șureanu	Passive	Glacial	Regional/local	Areal
41	Pătru Cirque	Șureanu	Passive	Glacial	Regional/local	Areal
42	Gropșoare Cirque	Șureanu	Passive	Glacial	Regional/local	Areal
43	Lăpușnicul Mare Valley	Retezat	Passive	Glacial	National	Linear
44	Nucșoara Valley	Retezat	Passive	Glacial	National	Linear
45	Judele Valley	Retezat	Passive	Glacial	National	Linear
46	Păpușii Stitch	Retezat	Passive	Glacial	Regional/local	Linear
47	Zănoaga Cirque	Retezat	Passive	Glacial	National	Areal
48	Bucura Cirque	Retezat	Passive	Glacial	National	Areal
49	Gemenele Cirque	Retezat	Passive	Glacial	Regional/local	Areal
50	Galeș Cirque	Retezat	Passive	Glacial	Regional/local	Areal
51	Cârnea Valley	Godeanu	Passive	Glacial	Regional/local	Linear
52	Mățulu Valley	Godeanu	Passive	Glacial	Regional/local	Linear
53	Bulzu Valley	Godeanu	Passive	Glacial	Regional/local	Linear
54	Groapa Balmoșului Valley	Godeanu	Passive	Glacial	Regional/local	Linear
55	Hidegului Valley	Țarcu	Passive	Glacial	National	Linear
56	Custurii Cirque	Țarcu	Passive	Glacial	Regional/local	Areal
57	Bloju Cirque	Țarcu	Passive	Glacial	Regional/local	Areal
58	Petreanu Cirque	Țarcu	Passive	Glacial	Regional/local	Areal

Table 10.2 Values for geomorphic diversity of the mountains in the Southern Carpathians

No	Mountain	Geomorphic diversity of the glacial relief	Geomorphic diversity of the periglacial relief	Global geomorphic diversity
1	Bucegi	0.20	0.50	0.35
2	Leaota	0.10	0.35	0.225
3	Piatra Craiului	0.05	0.35	0.20
4	Făgăraș	0.90	0.95	0.925
5	Iezer–Păpușa	0.25	0.45	0.35
6	Ghițu	0	0.10	0.05
7	Frunți	0	0.10	0.05
8	Cozia	0	0.15	0.075
9	Parâng	0.85	0.90	0.875
10	Șureanu	0.45	0.50	0.475
11	Cindrel	0.35	0.40	0.375
12	Lotru	0.30	0.40	0.35
13	Căpățâni	0.25	0.30	0.275
14	Retezat	0.90	0.95	0.925
15	Godeanu	0.45	0.60	0.525
16	Țarcu	0.65	0.80	0.725
17	Vâlcan	0	0.25	0.125
18	Cernei	0	0.10	0.05
19	Mehedinți	0	0.10	0.05
20	Global	0.30	0.43	0.365

actual other relict (e.g. dating from Pleistocene) and many of them are geomorphosites. The obtained values vary between 0.10 (Ghițu, Frunți, Cernei, Mehedinți) to 0.95 (Făgăraș, Retezat), and the medium value (0.43) is the highest registered in all Romanian Carpathians (Table 10.2; Fig. 10.5).

Evaluating Geomorphosites

The geomorphosites were evaluated using international literature's most known and utilized methods developed by: Pralong (2005), Coratza and Giusti (2005), Bruschi and Cendrero (2005), Serrano and Gonzales Trueba (2005), Reynard et al. (2007), Pereira et al. (2007), Zouros (2007), Comănescu et al. (2012).

The introductory part of each method, including geomorphosite identification and description, was removed consequently, only the qualitative, objective body of these methods was considered. All the evaluation processes, regardless their

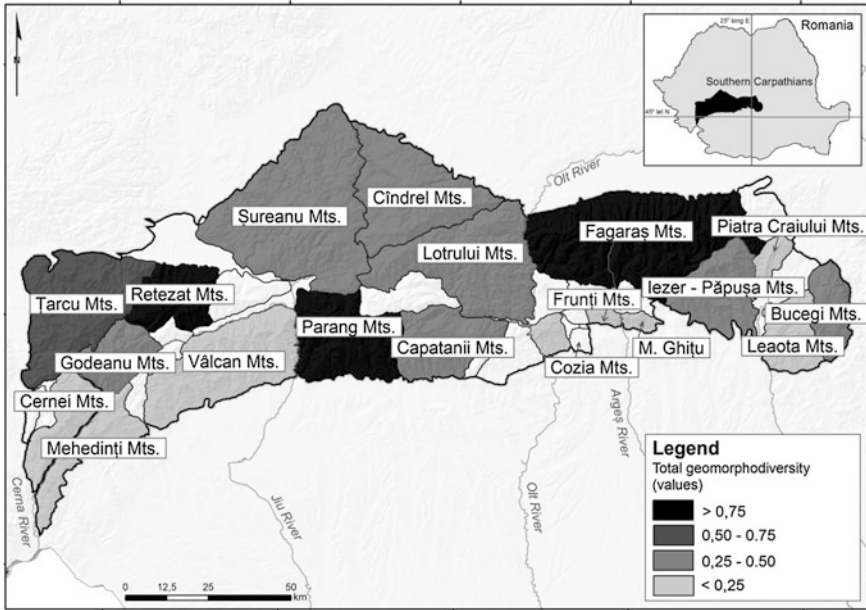


Fig. 10.3 Global geomorphodiversity in the Southern Carpathians

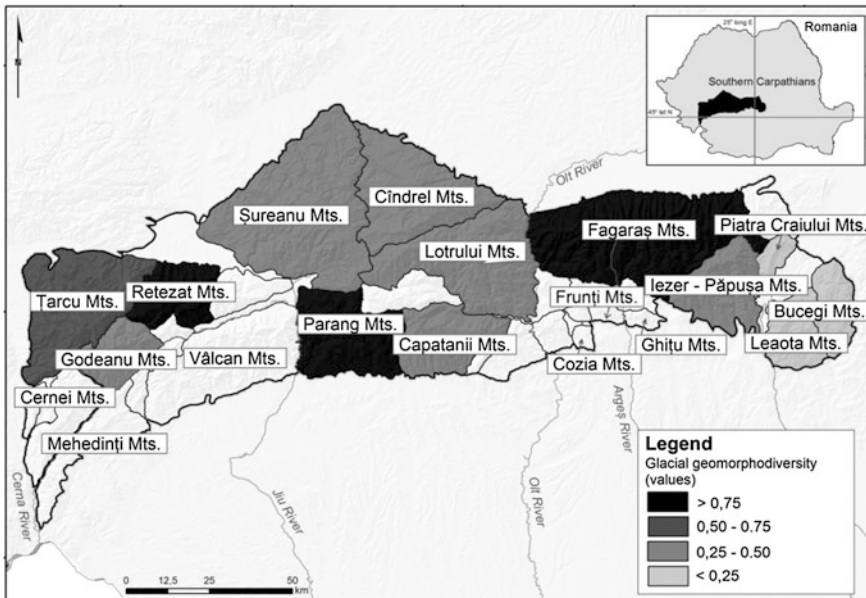


Fig. 10.4 Glacial geomorphodiversity in the Southern Carpathians

Table 10.3 Synthesis of the geomorphosites evaluation methods

No	Method	Scientific value	Additional values	Management	Use
1	Method developed by Pralong (A)	Yes	Yes	Yes	Implicit
2	Method developed by Coratza and Giusti (B)	Yes	No	No	No
3	Method developed by Bruschi and Cendrero (C)	Yes	Implicit	Yes	Yes
4	Method developed by Serrano and Gonzales Trueba (D)	Yes	Yes	Yes	Yes
5	Method developed by Reynard et al. (E)	Yes	Yes	No	No
6	Method developed by Pereira et al. (F)	Yes	Yes	Yes	Yes
7	Method developed by Zouros (G)	Yes	Yes	Yes	Yes
8	Method developed by the authors (H)	Yes	Yes	Yes	Yes

objective, focus on the scientific value, even if its weight is different for each of them and it takes a secondary role for the methods that aim to quantify the touristic value of that geomorphosite (Table 10.3).

For the evaluation of geomorphosites, the authors chose as case study the Viştea basin from the Făgăraş Mountains because this basin reproduces at a micro-scale the most important characteristics of the study area, where glacial and periglacial geomorphosites were inventoried (Table 10.4; Figs. 10.6 and 10.7). The results were compared, for each method the total value (reduction to a unit were made where necessary) and rank (place) that the respective geomorphosite has in each evaluation, were calculated.

Evaluation Using Pralong (2005) Method

This method was developed in 2005 by J.P. Pralong and covers two aspects: qualitative (geomorphosite's description spreadsheet) and quantitative evaluation. The purpose of this method is to establish tourism attraction value of geomorphosites also considering tourism infrastructure and the means and possibilities available to exploit them.

The tourism attraction value is calculated as an average of four distinct criteria according to the formula

Table 10.4 Geomorphosites in the Viștea basin

No	Name	Genesis	Type	Code
1	Galașea Mare–Viștea Mare Ridge	Periglacial	Linear	BVper01
2	Viștea Mare Ridge	Periglacial	Linear	BVper02
3	Zănoaga Glacial Saddle	Glacial	Areal	BVgla01
4	Drăgușului Ridge	Periglacial	Linear	BVper03
5	Hârtopu Mare Cirque	Glacial	Areal	BVgla02
6	Viștea Mare Waterfall	Glacial	Punctual	BVgla03
7	Viștișoara Cirque	Glacial	Areal	BVgla04
8	Viștea Mare Peak	Periglacial	Punctual	BVper04
9	Portița Viștei Saddle	Glacial	Areal	BVgla05
10	Viștea Needle	Periglacial	Punctual	BVper05
11	Viștea Valley	Glacial	Linear	BVgla06
12	Hârtopu Ursului Cirque	Glacial	Areal	BVgla07
13	Viștișoara Glacial Valley	Glacial	Linear	BVgla08
14	Saddle between Viștișoara and Iezerul Galben cirques	Glacial	Areal	BVgla09
15	Viștea Mare debris	Periglacial	Areal	BVper06

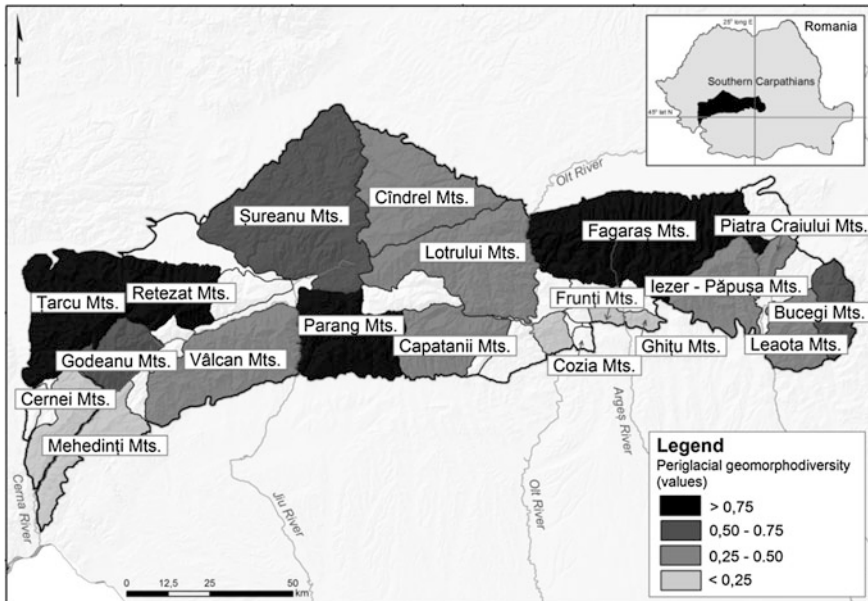


Fig. 10.5 Periglacial geomorphic diversity in the Southern Carpathians

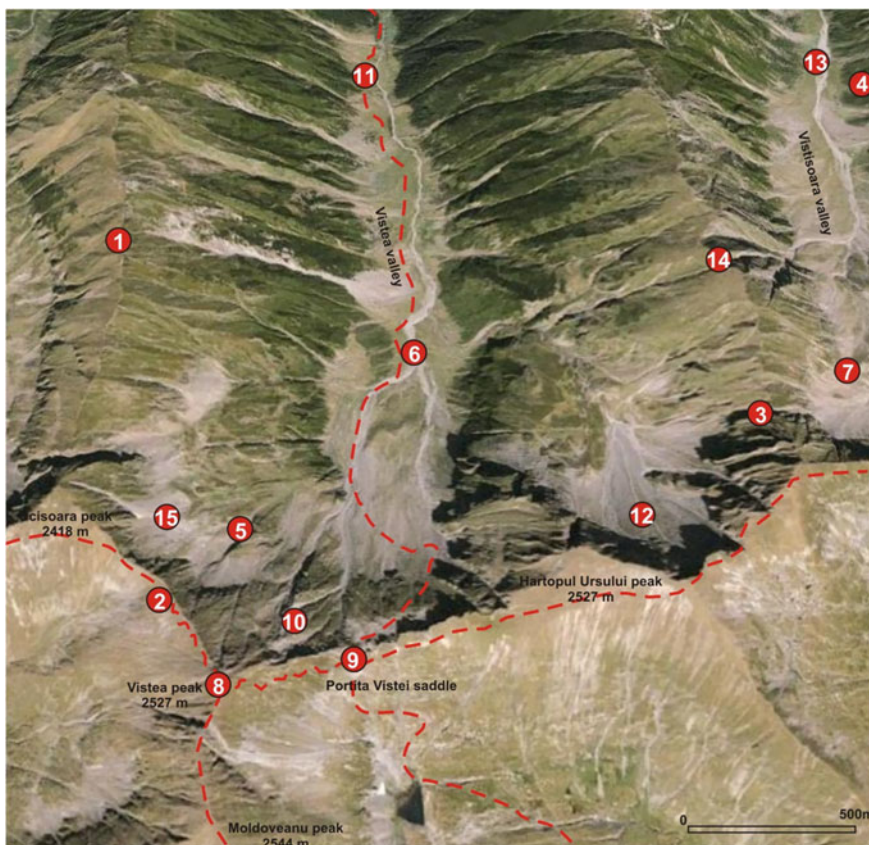


Fig. 10.6 Geographic location of the geomorphosites in the Viștea basin (modified after Comănescu et al. 2011b)

$$V_{tour} = (V_{sce} + V_{sci} + V_{cult} + V_{eco})/4 \tag{10.2}$$

where: V_{tour} stands for tourism attraction value, V_{sce} for aesthetic value, V_{sci} for scientific value, V_{cult} for cultural-historical value and V_{eco} for economic value.

The author of this formula considers all criteria equally important in assessing the tourism attraction value of geomorphosites, which explains why each criterion is given 100 % importance within the formula. The criteria considered were awarded scores ranging on a 0–1 scale (Pralong 2005) .

The considered criteria are: for the scientific value: paleogeographic interest, representativeness, surface (percentage), integrity and ecological interest; for the aesthetic value: number of lookout points, average distance between lookout points, slope, impact of colour against the surroundings; for the cultural-historical value: cultural and historical features presented in iconographic representations and/or in different writings, historical and archaeological relevance, religious and symbolic

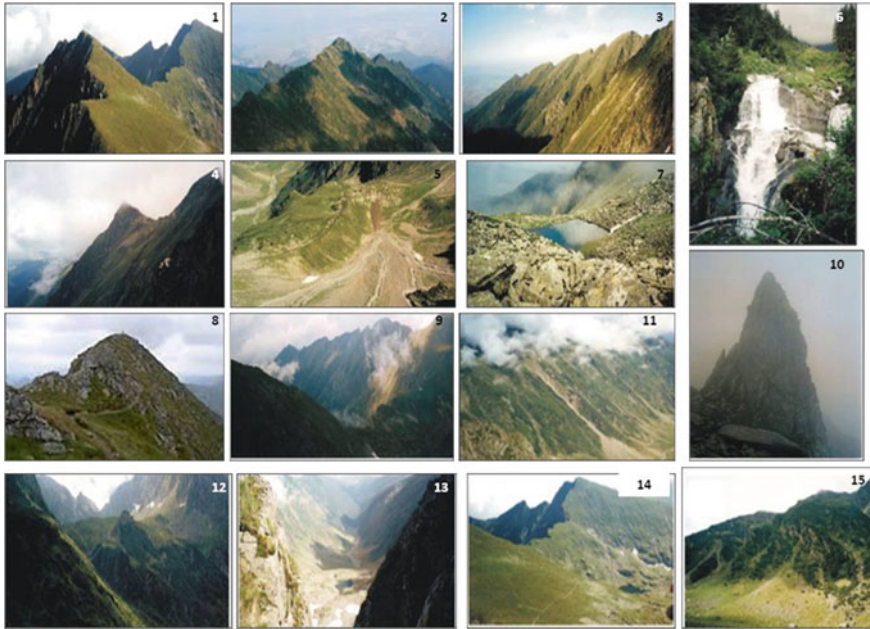


Fig. 10.7 The analyzed geomorphosites from the Viștea basin

relevance, art and cultural events; for the economic value: accessibility, natural hazards, annual number of visitors, official level of protection (Pralong 2005) .

“The *total (global) value* ranges from a low 0.187 for Zănoaga Glacial Saddle to scores as high as 0.375 for Viștișoara Cirque or 0.40 for Viștea Valley. This low amplitude indicates a similar genesis and low economic and cultural value” (Table 10.5) (Comănescu et al. 2011b).

“The *scientific value* scores well too as these geomorphosites are vital in understanding the genesis and evolution of the glacial relief in this area” (Comănescu et al. 2011b). The scores vary within a limited amplitude (0.5) with a maximum (0.75) for the Viștea Valley, Viștișoara Cirque and Portița Viștei Saddle and a minimum (0.25) for Drăgușului Ridge, Hârtopu Mare Cirque, Galașea Mare-Viștea Mare Ridge and Viștea Mare Ridge (Table 10.5).

“The *aesthetic value* definitely scores highest. The numerous lookout points, the good colour contrast and spectacular drop offs contribute greatly to these scores. The debris accumulations along Viștea Mare Valley score the lowest value (0.25) while Galașea Mare–Viștea Mare Ridge, Viștea Mare Peak, Viștea Needle and Viștea Valley score the highest (0.75). These geomorphosites are spectacular landforms and are included in their trekking itineraries by numerous tourists” (Comănescu et al. 2011b) (Table 10.5).

“The scores for the *cultural value* are very low as the region’s cultural component is little advertised; no dedicated promotional materials or any other iconographic

Table 10.5 Evaluating the Viştea basin geomorphosites using the method developed by Pralong (modified after Comănescu et al. 2011b)

No	Name	Scientific value	Aesthetic value	Cultural value	Economic value	Global value
1	Galaşea Mare–Viştea Mare Ridge	0.25	0.75	0	0.05	0.262
2	Viştea Mare Ridge	0.25	0.5	0	0.05	0.20
3	Zănoaga Glacial Saddle	0.5	0.20	0	0.05	0.187
4	Drăguşului Ridge	0.25	0.65	0	0.05	0.237
5	Hârtopu Mare Cirque	0.25	0.55	0	0.05	0.212
6	Viştea Mare Waterfall	0.5	0.55	0.05	0.05	0.287
7	Viştişoara Cirque	0.75	0.65	0.05	0.05	0.375
8	Viştea Mare Peak	0.5	0.75	0	0.05	0.325
9	Portiţa Viştei Saddle	0.75	0.65	0	0.05	0.362
10	Viştea Needle	0.5	0.75	0	0.05	0.325
11	Viştea Valley	0.75	0.75	0.05	0.05	0.40
12	Hârtopu Ursului Cirque	0.5	0.65	0	0.05	0.30
13	Viştişoara Glacial Valley	0.5	0.5	0	0.05	0.262
14	Saddle between Viştişoara and Iezerul Galben Cirques	0.5	0.5	0	0.05	0.262
15	Viştea Mare debris	0.5	0.25	0	0.05	0.20

representations were edited. The region under study is not awarded with any particular historical, religious or mythological importance as a matter of fact, there are only three geomorphosites that do align to this criterion (Viştea Mare Waterfall, Viştişoara Cirque, Viştea Valley)” (Comănescu et al. 2011b) (Table 10.5).

“The scores for the *economic value* are low and homogeneous (0.05) given that the region’s economic life and tourism infrastructure (except for hiking trails) are almost inexistent” (Comănescu et al. 2011b) (Table 10.5).

This is the most used evaluation method for geomorphosites and was applied in different areas, including the Alps. When comparing the geomorphosites located in the study area with those found in the Alps for example, it is clear that those in the Alps are better known scientifically and as tourism assets, and the differences result from their cultural and economic value. The comparison shows where differences come from, namely: for the scenic value, all geomorphosites have the same value

(0.4–0.75); for the scientific value, there are no significant differences (0.45–0.85); the cultural value has got significant differences (between 0 and 0.42), and the economic value registers most differences (0.05–0.85).

The main cause for the Carpathians' geomorphosites scoring so low in comparison with the Alps is related to the deficient infrastructure, the reduced number of tourists (geomorphosites under study in Făgăraș are located in areas accessible only to fit experienced trekkers) and the lack of defining elements in terms of cultural value (there are no iconographic representations of symbolic, mystical or religious relevance).

The strengths of the method are the following: the method covers the most important points of a geomorphosite assessment (both in what concerns the scientific value and the additional values). The weaknesses are as follows: elements regarding the management, promotion or natural and anthropic risks which could affect such an element are present. The method is also somehow subjective by the use of some attributes which are unclearly defined, as: large scale, medium scale, small scale (for representativeness) which leaves space to multiple interpretations depending on the expertise of the person who makes the evaluation.

Coratza and Giusti (2005) Method

This method was used for obtaining an inventory of the geomorphosites in the Emilia—Romagna Province and is applied for determining environmental impact and for territorial planning purposes. Only the scientific value of geomorphosites is calculated based on the following formula:

$$Q = sS + dD + aA + rR + eE + zZ \quad (10.3)$$

where Q is the scientific value; s, d, a, r, c, e, z —are multiplication factors depending on different assessment purposes; S, D, A, R, C, E, Z —considered values: scientific value (S) and didactical value (D) of the geomorphosite, A —surface (% of the total surface), rarity— R , state of preservation— C , exposure— E , added value(s)— Z . By introducing the professional experience of the expert (scientific and didactical value) the subjectivity is increased according to each person that constructs the evaluation (Coratza and Giusti 2005).

This method introduces a uniformity in the obtained values (that vary between 0.19 and 0.64 with 80.00 % varying between 0.4 and 0.6) because of its parameters (additional values are brought to a common denominator with the sub-criteria included in the scientific value), because the values of the *professional experience of the expert (CE)* includes the *scientific research (S)* and the *didactical value (D)* and because no multiplication factors are used.

The Viștea Valley registers the highest score (0.64) thanks to additional value elements (for tourism importance, as it is the marked trail leading up in a few minutes to the Moldoveanu Peak—2544 m, the highest in the Romanian Carpathians).

Table 10.6 Evaluating the Viştea basin geomorphosites using the method developed by Coratza and Giusti

No	Name	Global value	No	Name	Global value	No	Name	Global value
1	Galăşea Mare–Viştea Mare Ridge	0.58	6	Viştea Mare Waterfall	0.58	11	Viştea Valley	0.64
2	Viştea Mare Ridge	0.58	7	Viştişoara Cirque	0.42	12	Hârtopu Ursului Cirque	0.42
3	Zănoaga Glacial Saddle	0.58	8	Viştea Mare Peak	0.50	13	Viştişoara Glacial Valley	0.50
4	Drăguşului Ridge	0.33	9	Portiţa Viştei Saddle	0.50	14	Saddle between Viştişoara and Iezerul Galben Cirques	0.50
5	Hârtopu Mare Cirque	0.42	10	Viştea Needle	0.58	15	Viştea Mare debris	0.19

The same additional value elements (for tourism use) are present for the Viştea Waterfall (0.58) and Viştea Needle (0.58). The Galăşea Mare—Viştea Mare Ridge, Viştea Mare Ridge and Zănoaga Gacial Saddle geomorphosites have the same value (0.58) with criteria such as professional experience of the expert, visibility and additional value, standing out (Table 10.6). The lowest value (0.19) was calculated for the debris located at the base of the Viştea Mare ridge which does not score for criteria such as rarity (uniqueness), visibility or added value (Table 10.6).

The method can be used for evaluating the scientific value, but it cannot be applied in case of a demarche which would regard the touristic exploitation of geomorphosites due to the reduced weight which is given to additional values. This is the main drawback of the method. Besides, it is rather difficult to apply, because it requires strong expertise and experience, as some of the quality parameters employed for the assessment are subjective. For the scientific value, which is the central value of the geomorphosites, this is the most comprehensive and complex method.

Bruschi and Cendrero (2005) Method

This method was developed at the University of Cantabria (Spain) (Bruschi and Cendrero 2005; Bruschi and Cendrero 2009; Bruschi et al. 2011) and it aims to be an assessment method for the evaluation of geosites but can also be used in the case

of geomorphosites and it is useful both for the inventory and evaluation of environmental impact, which makes it very practical.

It is so far the most complex method in use, as the formula for weighting of the final value considers the following: the intrinsic quality (rarity, importance for scientific research, use in didactic purposes, diversity, age, significance as part of the historical, artistic, archaeological heritage, relation to other items of the natural heritage, state of preservation), the potential risks and protection measures (number of inhabitants in the areas, active natural hazards, possibility of collecting samples, the interrelation with planning policies, existing interests in mineral extraction, ownership status) and the potential use (activities, preservation measures, accessibility, surface, proximity of infrastructure, socio-economic features of the region). The final value is calculated with the help of a series of formulas used to determine the intrinsic value of geomorphosites, the state of preservation and potential use (Bruschi and Cendrero 2005).

However, a series of weak points can be noticed, namely: the degree of knowledge is introduced at intrinsic values, recreational activities at possible threatening and not at the potential of use of the site (Reynard et al. 2009). Also, we can notice that additional values have got a quite reduced importance in the final evaluation, decreasing from the immediate practical usability. The strength of the method consists in its practical applicability (the method holds clear practicality and it has been used for a number of coastal geomorphosites in Cantabria and The Basque Country and also for carrying out environmental impact assessments for building a new motorway) (Reynard et al. 2009)

The values obtained for the geomorphosites in the Viștea basin range within a low set of values (0.19) due to the high number of parameters considered and the homogeneity of the values these parameters register (which frequently revolve around 0). This is also supported by the presence of only three classes of values that hold the following percentages: 0.30–0.40 (13.33 %), 0.40–0.50 (66.66 %), and above 0.50 (20.00 %).

The maximum value of 0.56 is held by Viștea Valley (Table 10.7), a complex linear geomorphosite that integrates a series of smaller more simple geomorphosites, and which scores highly in terms of: degree of scientific knowledge, use in didactical purposes, diversity of elements, degree of preservation, possibility of sample collection, relation with planning policies, manners in which observation is possible, accessibility. The lowest value (0.37) was calculated for debris located at the base of the Viștea Mare ridge (Table 10.7), because this geomorphosite is vulnerable to subjective hazards for tourism activities due to its mobility and for Drăgușului Ridge.

Table 10.7 Evaluating the Viştea basin geomorphosites using the method developed by Bruschi and Cendrero

No	Name	Global value	No	Name	Global value	No	Name	Global value
1	Galaşea Mare–Viştea Mare Ridge	0.45	6	Viştea Mare Waterfall	0.49	11	Viştea Valley	0.56
2	Viştea Mare Ridge	0.48	7	Viştişoara Cirque	0.47	12	Hârtopu Ursului Cirque	0.47
3	Zănoaga Glacial Saddle	0.43	8	Viştea Mare Peak	0.48	13	Viştişoara Glacial Valley	0.53
4	Drăguşului Ridge	0.37	9	Portiţa Viştei Saddle	0.42	14	Saddle between Viştişoara and Iezerul Galben Cirques	0.42
5	Hârtopu Mare Cirque	0.52	10	Viştea Needle	0.50	15	Viştea Mare debris	0.37

Serrano and Gonzalez-Trueba (2005) Method

The method was applied for 22 geomorphosites located in a Natural Protected Area (Picos de Europa). It approaches geomorphosites as multifunctional elements that can act as cultural, economic, tourism and educational resources therefore require a complex, multi-purpose evaluation. The following are considered: scientific value (genesis, morphology, dynamics, chronology, lithology, geologic structure), additional value (aesthetic, cultural, educational value and representativeness, tourism attraction), geomorphosite use and management (accessibility, fragility, vulnerability, intensity of use, degradation risks, state of preservation, impact, visibility, limits of acceptable changes). The evaluation is objective (as it only includes a quantitative analysis) and is fairly easy to do. Scores range between 0 and 100 points but, in order to facilitate comparison with other methods these were reduced by a factor of 100 (Serrano and Gonzales-Trueba 2005).

A weak point of this method is the lack of some clearly quantified criteria, especially in the case of scientific value, a fact which favours the subjectivity of the person who accomplishes the evaluation. The final result is not general, but only a qualitative transposing, this way groups on classes with similar value being accomplished and not a clear classification. The entire method is led to establishing some priorities in preserving the heritage of a region and less for a scientific inventory or for touristic use (Cocean 2011).

This method considers a high number of parameters and many of the geomorphosites scored values close to zero which explains the small differences (amplitude

Table 10.8 Evaluating the Viștea basin geomorphosites using the method developed by Serrano and Gonzales-Trueba

No	Name	Global value	No	Name	Global value	No	Name	Global value
1	Galașea Mare–Viștea Mare Ridge	0.36	6	Viștea Mare Waterfall	0.42	11	Viștea Valley	0.51
2	Viștea Mare Ridge	0.39	7	Viștișoara Cirque	0.44	12	Hârtopu Ursului Cirque	0.44
3	Zănoaga Glacial Saddle	0.38	8	Viștea Mare Peak	0.44	13	Viștișoara Glacial Valley	0.47
4	Drăgușului Ridge	0.34	9	Portița Viștei Saddle	0.38	14	Saddle between Viștișoara and Iezerul Galben Cirques	0.40
5	Hârtopu Mare Cirque	0.45	10	Viștea Needle	0.44	15	Viștea Mare debris	0.29

of 0.22) between the maximum value (Viștea Valley –0.51) and the minimum (debris field located at the base of the Viștea Mare ridge –0.29).

This is also supported by the fact that the method grants an increased importance to additional values; more than 50 % of calculated values range between 0.40 and 0.50, because the studied geomorphosites share a relatively common genesis, morphology, dynamics and geology. Also, when considering the parameters related to additional values, the use and management, no significant differences are present. A relative homogeneity can be observed in terms of genetic categories (Galașea Mare—Viștea Mare ridge, Viștea Mare Ridge, Zănoaga Glacial Saddle, Drăgușului Ridge score values between 0.34 and 0.39; Hârtopu Mare Cirque, Viștișoara Cirque, Hârtopu Ursului Cirque between 0.44 and 0.45; Portița Viștei Saddle and the Saddle between Viștișoara and Iezerul Galben cirques between 0.38 and 0.40) (Table 10.8).

Reynard et al. (2007) Method

It was developed by Reynard et al. (2007) and focuses on quantifying the scientific value and the additional (cultural, economic, aesthetic, ecological) of geomorphosites. It focuses on quantifying the (main) scientific value (rarity, integrity, representativeness, paleogeographic importance) and the additional ones: cultural (religious, historical and artistic importance, geohistorical), economic (economic profit), aesthetic (lookout points, altitudinal distribution and spatial structure) and

ecological (ecological impact, protected sites). The qualitative aspects deals with general data, description and morphogenesis, as well as with the synthesis (global and educational value, risks and threats, management measures) (Reynard et al. 2007).

The method is intended to inventory local geomorphosites and its main purpose is to correlate human perception of these to their scientific value. Further, we left out all qualitative aspects related to general data, description, morphogenesis or synthesis (global value, educational value, risks, threats and management measures).

The author considers that a geomorphosite is impossible to comprise all the values; this is the reason why in accomplishing the final calculation, the highest value is considered (for cultural value) and the average between these values (for other values). The method is interdisciplinary and it seeks to assess the geomorphosites at various scales for the management of protected areas and the conservation of natural heritage. This is relatively easy to apply, being designed for students.

The total value varies between 0.71 (Viştea Valley) and 0.27 (Viştea Mare waterfall). The Viştea Mare Waterfall geomorphosite as well as Viştea Needle score 0 for ecological value because they cannot constitute themselves a support platform for valuable ecosystems for the alpine and subalpine area. Although the studied area is not included in the Făgăraş Mountains Alpine Gap National Park, it scores due to the presence of protected species of flora and fauna, as some of the evaluated geomorphosites constitute their natural habitat (Table 10.9).

Both the *cultural component* and the *economic* one scored 0 for all the studied geomorphosites (Table 10.9). In terms of *economic value*, activities such as grazing and tourism are present, but this method strictly quantifies only directly obtained profit.

The scientific value, which for this method has an important percentage, scores values between 0.85 (Viştea Valley, Portiţa Viştei Saddle, Viştea Mare Peak) and 0.25 (Viştea Mare Ridge), reflecting the importance these geomorphosites have for determining the stages and phases of glacial and periglacial sculpting.

The aesthetic component is the most subjective one, and it scores value ranging between 0.75 for Viştea Needle and Viştea Mare Peak that stands out with its level difference, space structure, sightseeing possibilities, and 0.10 for the debris field located at the base of the Viştea Mare ridge for which these parameters register low values (Table 10.9).

Table 10.9 Evaluating the Viștea basin geomorphosites using the method developed by Reynard et al. (2007)

No	Name	Scientific value	Scenic value	Cultural value	Economic value	Ecological value	Global value
1	Galașea Mare–Viștea Mare Ridge	0.47	0.66	0	0	0.5	0.38
2	Viștea Mare Ridge	0.25	0.50	0	0	0.5	0.37
3	Zănoaga Glacial Saddle	0.65	0.66	0	0	0.5	0.47
4	Drăgușului Ridge	0.45	0.33	0	0	0.5	0.33
5	Hârtopu Mare Cirque	0.65	0.66	0	0	0.5	0.47
6	Viștea Mare Waterfall	0.38	0.66	0	0	0	0.27
7	Viștișoara Cirque	0.65	0.66	0	0	0.5	0.47
8	Viștea Mare Peak	0.85	0.75	0	0	0.5	0.58
9	Portița Viștei Saddle	0.85	0.58	0	0	0.5	0.58
10	Viștea Needle	0.75	0.75	0	0	0	0.47
11	Viștea Valley	0.85	0.66	0	0	0.5	0.71
12	Hârtopu Ursului Cirque	0.65	0.66	0	0	0.5	0.47
13	Viștișoara Glacial Valley	0.75	0.50	0	0	0.5	0.58
14	Saddle between Viștișoara and Iezerul Galben Cirques	0.75	0.50	0	0	0.5	0.58
15	Viștea Mare debris	0.59	0.10	0	0	0.5	0.37

Pereira et al. (2007) Method

The method was initially developed in the Natural Protected Area—Montesinho Natural Park in Portugal (Pereira et al. 2007). This method is part of the studies meant to assess the natural heritage on a regional scale.

The study follows a *series of steps*: geomorphosite inventory (identifying potential geomorphosites, qualitative analysis, selection and description), quantification and hierarchy. In order to obtain this evaluation, the following are considered: scientific value (rarity within the area, integrity, representativeness, pedagogic

importance, diversity, other geological features with patrimony value, importance for scientific research, national coverage), additional values (cultural value, aesthetic value, ecologic value) and management values (accessibility, visibility, current use of any geomorphologic interests, current use of any other natural and cultural features, protection measures and limitations in use, the presence of improvements to the trails, integrity, vulnerability to being used as geomorphosite). The total value is calculated as sum of the scores achieved for each criterion, and for the purpose of classification the corresponding rank is also calculated (the sum of all ranks occupied per criterion) (Pereira et al. 2007).

The main advantage of this method is the early use of a quantitative evaluation, as early as the selection phase which, before, relied exclusively on a qualitative, therefore subjective, evaluation. Among the weak points of this method we mention: the inclusion of integrity (as criterion) both at scientific and protection value.

In the selection stage the intrinsic value, potential use and level of protection are established. Generally, geomorphosites scoring high in terms of scientific value are selected regardless of the scores they get for other criteria, the same goes for geomorphosites-awarded great scores in terms of potential use.

The values obtained for Viştea basin show that the geomorphosites within this area score high for scientific value and some of them for management elements (legal status, usage limitations, integrity and vulnerability to being used as geomorphosite) and low for additional (cultural) value and some for the aesthetic value as well (debris field allocated at the base of the Viştea Mare ridge) (Table 10.10).

The highest value (0.553) was registered by the Viştea Valley scoring for integrity, representativeness, pedagogic importance, diversity, other geological

Table 10.10 Evaluating the Viştea basin geomorphosites using the method developed by Pereira et al. (2007)

No	Name	Global value	No	Name	Global value	No	Name	Global value
1	Galăşea Mare–Viştea Mare Ridge	0.412	6	Viştea Mare Waterfall	0.443	11	Viştea Valley	0.553
2	Viştea Mare Ridge	0.408	7	Viştişoara Cirque	0.495	12	Hârtopu Ursului Cirque	0.487
3	Zănoaga Glacial Saddle	0.309	8	Viştea Mare Peak	0.487	13	Viştişoara Glacial Valley	0.491
4	Drăguşului Ridge	0.295	9	Portiţa Viştei Saddle	0.444	14	Saddle between Viştişoara and Iezerul Galben Cirques	0.436
5	Hârtopu Mare Cirque	0.471	10	Viştea Needle	0.527	15	Viştea Mare debris	0.387

features with patrimony value, importance for scientific research, aesthetic value, ecologic value, accessibility, visibility, current use of any geomorphologic interests, protection measures and limitations in use, integrity, vulnerability to being used as geomorphosite.

The lowest value (0.295) was registered by Drăguşului Ridge, which unlike other similar geomorphosites has a reduced accessibility and visibility, lacks any kind of improvements and has no cultural value (Table 10.10).

Zouros (2007) Method

The method was applied in 2007 for the evaluation of geomorphosites located in various geoparks from the Aegean area (Zouros 2007). The method considers: scientific and educational value: integrity, rarity, representativeness, exemplarity; geodiversity; aesthetic and ecologic value; cultural value; potential risk and prevention: legal protection; vulnerability; potential use: recognisability; geographic distribution; accessibility; economic potential. For each criterion, sub-criteria were defined and the established score range varies between 0 and 5 or 10, respectively. The final total per criteria can be as high as 100 (Zouros 2007). This method can also be used to make a comparison between attribute distribution and their contribution to the resulting geomorphosite value. The strength of the assessment is its immediate practical applicability in the management of the natural heritage of the geoparks, while its weakness refers to the existence of subjective assessment criteria.

The method proposed by Zouros for evaluating geomorphosites offered values ranging between 0.58 (Viştea Valley) and 0.35 (the debris field located at the base of the Viştea Mare ridge). Viştea Valley scored for integrity, representativeness, geodiversity, aesthetic and ecologic value, vulnerability, potential use, recognisability, accessibility, economic potential (in terms of tourism). The debris field located at the base of the Viştea Mare Ridge scored low for rarity, representativeness, exemplarity, geodiversity, aesthetic and ecologic value, cultural value, legal protection, vulnerability, accessibility, economic potential (Table 10.11).

The introduction of geodiversity as an evaluation parameter favours geomorphosites with a complex morphology, genesis and dynamic (Viştea Valley, Viştea Needle, Viştea Mare Waterfall, Viştişoara Cirque, Viştişoara Valley, Viştea Mare Peak) that stand out as important components even when calculating geodiversity and geomorphic diversity for large areas. They represent interest points for a large scale of geographers, geomorphologists, geologists, ecologists, pedologists, etc. Because the territories evaluated by this method are not a part of a protected natural area, the values obtained are uniform and the class distribution is as it follows: 0.30–0.40–20.00 %; 0.40–0.50–46.66 %; above 0.50–33.33 % (Table 10.11).

Table 10.11 Evaluating the Viştea basin geomorphosites using the method developed by Zouros

No	Name	Global value	No	Name	Global value	No	Name	Global value
1	Galăşea Mare–Viştea Mare Ridge	0.42	6	Viştea Mare Waterfall	0.51	11	Viştea Valley	0.58
2	Viştea Mare Ridge	0.41	7	Viştişoara Cirque	0.51	12	Hârtopu Ursului Cirque	0.48
3	Zănoaga Glacial Saddle	0.39	8	Viştea Mare Peak	0.56	13	Viştişoara Glacial Valley	0.49
4	Drăguşului Ridge	0.38	9	Portiţa Viştei Saddle	0.44	14	Saddle between Viştişoara and Iezerul Galben Cirques	0.44
5	Hârtopu Mare Cirque	0.48	10	Viştea Needle	0.54	15	Viştea Mare debris	0.35

Comănescu et al. (2012) Method

The proposed method gives equal importance to all values when evaluating geomorphosites: scientific (includes the ecological value), aesthetic, cultural and economic as well as management and use of the geomorphosites (Comănescu et al. 2012). The method was applied for some protected areas, its purpose is to achieve an inventory of geomorphosites, their superior capitalization and establishing the most appropriate management system.

The total value is calculated based on the formula

$$V_{tot} = (V_{sci} + V_{sce} + V_{cult} + V_{eco} + M_g) / 100 \quad (10.4)$$

where, V_{sci} —scientific value (paleogeographic interest; representativeness; rarity; integrity; degree of scientific knowledge; use in educational purposes; ecologic value; diversity), V_{sce} —aesthetic value (visibility; spatial structuring; colour contrast; level difference; landscape framing), V_{cult} —cultural value (cultural features; historic features; religious features; iconographic/literary representations; festivals or cultural manifestations; symbolic value), V_{eco} —economic value (accessibility; infrastructure; yearly visitors; number of types and forms of usage (including tourism); economic potential—incomes), M_g —management and use (preservation degree; protected sites; vulnerability/natural risks; intensity of use, the use of aesthetic, cultural and economic value, relations with planning policies) (Comănescu et al. 2012).

The results presented in Table 10.12 prove that any correlation between the scientific value and the additional ones is not possible. A high scientific value

Table 10.12 Evaluating the Viştea basin geomorphosites using the method developed by Comănescu et al. (2012)

No	Name	Global value	No	Name	Global value	No	Name	Global value
1	Galaşea Mare–Viştea Mare Ridge	0.33	6	Viştea Mare Waterfall	0.43	11	Viştea Valley	0.50
2	Viştea Mare Ridge	0.36	7	Viştişoara Cirque	0.39	12	Hârtopu Ursului Cirque	0.40
3	Zănoaga Glacial Saddle	0.31	8	Viştea Mare Peak	0.46	13	Viştişoara Glacial Valley	0.42
4	Drăguşului Ridge	0.34	9	Portiţa Viştei Saddle	0.31	14	Saddle between Viştişoara and Iezerul Galben Cirques	0.30
5	Hârtopu Mare Cirque	0.39	10	Viştea Needle	0.42	15	Viştea Mare debris	0.19

usually means similar values for management and use. The amplitude between the obtained values is 0.31, with most geomorphosites scoring values between 0.3 and 0.4 (53.33 %). The relatively low values compared with other evaluation methods result from the high score (20 p) of the cultural value, given that the main elements used for this value are not represented in the study area (Table 10.12).

The highest total value is registered by the Viştea Valley (0.50) that scores for all criteria except the cultural value, and the lowest total value is registered by the debris field located at the base of the Viştea Mare Ridge (0.19), that has no cultural value, and almost zero aesthetic value, management and use value. It is clear that geomorphosites with similar genesis (ridges, cirques, saddles, glacial valleys) score relatively similar values, with the differences resulting most of the times from the aesthetic criterion or accessibility and the different types in which it (the geomorphosite) is used for tourism activities (Table 10.12).

Discussions

Although the above-mentioned methods target different objectives, they all consider the following criteria: rarity, representativeness and entirety (Comănescu et al. 2012). Some methods emphasize on the environmental impact (Coratza and Giusti 2005), while for the others the main objective is establishing an inventory of geomorphosites (Serrano and Gonzales-Trueba 2005), to promote geomorphosites for tourism (Pralong 2005); the method developed Zourous (2007) as the one

proposed by Pereira et al. (2007) focuses on evaluating geomorphosites for the management of natural parks (Comănescu et al. 2012). An increased importance is given to potential hazards and use of geomorphosites for touristic purposes, which explains taking into account for the first time a criterion referring to the geomorphosite prestige.

The additional values of geomorphosites are evaluated explicitly in the methods proposed by Pralong (2005), Reynard et al. (2007) and Pereira et al. (2007), while the method proposed by Serrano and Gonzales-Trueba (2005) only considers the cultural value. These methods include the economic value in the evaluation process (the first two directly, and the third implicitly as it is more restrictive and only scores those geomorphosites that produce revenues) (Erhartic 2010).

Pralong (2005) analyzes in clear the economic value of geomorphosites whereas the other methods only present it as default information deriving from the type of use (Serrano and Gonzales Truebo 2005 and Pereira et al. 2007). Except the approach taken by Reynard et al. (2007), all the others concern with management and use of geomorphosites. As we will see, the listed methods share a few features and differ in some others as they were developed to meet different objectives and means of assessment (Grandgirard 1999). The criteria considered in determining geomorphosite value depend very much on the purpose and objectives of the evaluation (Reynard et al. 2007).

Although all of these methods rely on a quantitative system, a certain level of subjectivity cannot be prevented, as all of these parameters are rated by an evaluator based on his perception and experience; objectivity is particularly difficult to achieve in the case of the aesthetic value. Therefore, the method proposed by Pralong (2005) is the most complex and the most accurate one—some of the elements introduced in his method are descriptive (didactic value, risks, use) instead of quantifiable as such, comparison of similar geomorphosites is not possible (Erhartic 2010).

Also, most methods have a major scientific component whereas, in the case of Reynard's method, the scientific assessment only serves as grounds for carrying out a geomorphosite inventory and establishing environmental impact. This method does not place particular importance on the utilization of a particular geomorphosite, but takes into account especially the scientific value, which makes it more transparent and accessible.

The method proposed by Zouros (2007), describes geodiversity in detail, a quite different approach, considering the format of all other methods, yet understandable given that this method was first used within geoparks. Potential risks and use of geomorphosites are given much importance and, for the first time, the recognisability criterion was included in such an assessment, an extremely important factor in analyzing large-scale tourism activities.

Table 10.13 presents a synthesis of the scores obtained with the eight evaluation methods presented above (Fig. 10.8). The total rank results from the sum for each evaluation method and offers a general image of the value of each geomorphosite. Because the subjectivity of each author cannot be eliminated, we consider the rank hierarchy as very important for minimizing it (Comănescu et al. 2012).

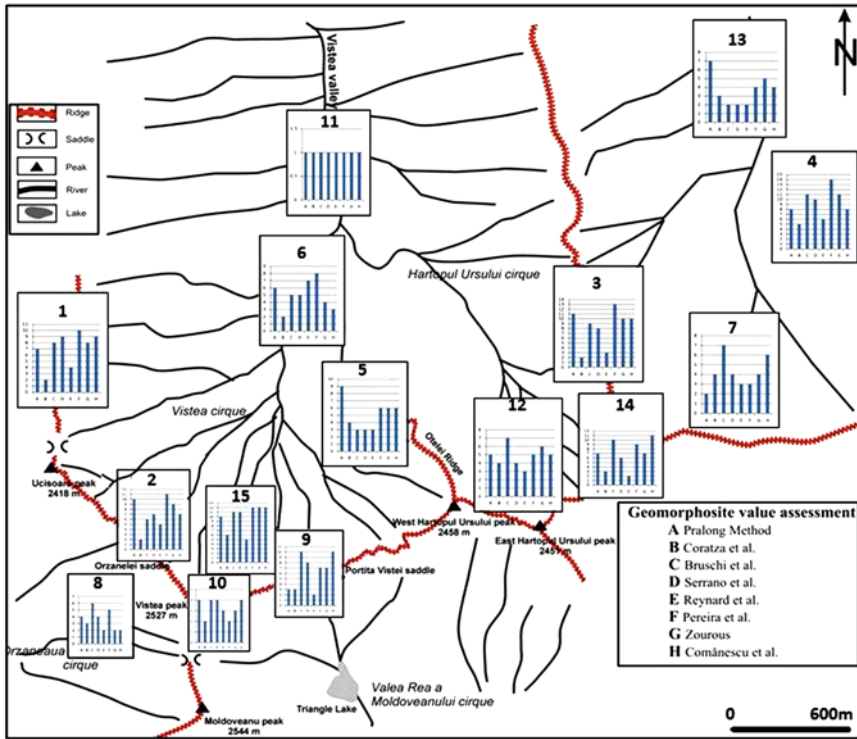


Fig. 10.8 Geomorphosite assessment methods—comparative summary

We computed the average value rank, which is inversely related to the effective value of the investigated geomorphosites.

The values obtained by the different evaluation methods differ according to the variables analyzed, but the upper part of the hierarchy remains mostly the same. Viștea Valley occupies the first position in all evaluations due to its outstanding scientific features, aesthetic and use value, relatively good accessibility and the fact that this geomorphosite includes additional smaller ones. It has the smallest added rank (8).

On the second place with an added rank of 26 (at a remarkable distance from the first place) stands the Viștea Needle that occupies places between second and fourth for all the evaluation methods. The Viștea Needle as well as other residual landforms from the Făgăraș Mountains attracts through its uniqueness, level difference, special structure and geologic and geomorphologic scientific value mainly for specialists.

The third place in terms of value (with an added rank of 28) is occupied by the Viștea Mare Peak, and with the exception of the Bruschi et al. method it stands between second and fifth.

The highest added rank (79) (translated into the lowest values) was achieved by the debris field located at the base of the Viștea Mare Ridge which, with the

Table 10.13 Evaluating the Viştea basin geomorphosites with different methods—rank hierarchy synthesis table

No	Name	Prolong (A)	Coratza et al. (B)	Bruschi et al. (C)	Serrano et al. (D)	Reynard et al. (E)	Pereira et al. (F)	Zourous (G)	Comanescu et al. (H)	Rank	Mean of rank
1	Viştea Valley	1	1	1	1	1	1	1	1	8	1.000
2	Viştea Needle	4	2	4	4	3	2	3	4	26	3.250
3	Viştea Mare Peak	4	3	6	4	2	5	2	2	28	3.500
4	Vişţoara Glacial Valley	7	3	2	2	2	4	5	4	29	3.625
5	Vişţoara Cirque	2	4	7	4	3	3	4	6	33	4.125
6	Hârtopu Ursului Cirque	5	4	7	4	3	5	6	5	39	4.875
7	Hârtopu Mare Cirque	9	4	3	3	3	6	6	6	40	5.000
8	Viştea Mare Waterfall	6	2	5	5	7	8	4	3	40	5.000
9	Portiţa Viştei Saddle	3	3	10	8	2	7	7	10	50	6.250
10	Saddle between Vişţoara and Iezerul Galben Cirques	7	3	10	6	2	9	7	11	55	6.875
11	Galăşea Mare–Viştea Mare Ridge	7	2	8	9	4	10	8	9	57	7.125
12	Viştea Mare Ridge	10	2	6	7	5	11	9	7	57	7.125
13	Zănoaga Glacial Saddle	11	2	9	8	3	13	10	10	66	8.250
14	Drăguşului Ridge	8	5	11	10	6	14	11	8	73	9.125
15	Viştea Mare debris	10	6	11	11	5	12	12	12	79	9.875

exception of the methods that emphasize the scientific value (Coratza et al. and Reynard et al.) where it placed 5–6th, has ranked between 10 and 13 due to its low additional values.

The added ranks of geomorphosites with the same genesis, morphology and similar dynamic have comparable values (all ridge type geomorphosites have values between 57 and 73; cirques between 33 and 40; and saddles between 50 and 55). This proves that even though the ranks of similar type geomorphosites are different from one method to another (according to the specific criteria and multitude of objectives) a sum of these ranks will provide a reliable hierarchy.

Conclusions

Geomorphosite assessment is an instrument that allows understanding of the role these could play in the development of regions, as well as in the evolution of tourist activities of different types. Reynard et al. (2009) remarks about the analyzed methods (with the exception of the Zouros method) that they have an inevitable degree of subjectivism, as the real value of these components of environment cannot be measured. The scientific value is evaluated in absolutely all methods, this being the main characteristic of geomorphosites, its lack determining the absence of the quality of geomorphosite. Additional values are differently exemplified, depending on the purpose of evaluation (in most cases protection or promotion of geomorphosites), the potential of use and the measures which impose for superior protection.

With all the clear differences which appear between the methods analyzed as regards numerical values, it must be underlined that the ranks of geomorphosites remain generally the same, which proves that in order to accomplish their classification, all methods are viable.

The area analyzed in detail, namely the Viștea watershed in the Făgăraș Mountains, displays a wide range of glacial and periglacial geomorphosites, with a high degree of representativeness both at the massif scale and at the level of the Southern Carpathians. These landscapes have a high scientific value, as they can offer important information concerning the genesis, evolution and dynamics of the glacial and periglacial topography. The other specific features (ecological, economic, cultural and aesthetic) have different values from method to method, but they are generally lower in comparison with other areas belonging to the Southern Carpathians.

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