ORGANIZATION AND ARRANGEMENT OF ANTI-EROSION GLACIER AREAS: NEUTRAL-INCLUSIVE ANTI-EROSION MANAGEMENT

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Abstract: *The article presents a method and applications for an anti-erosion management formula, based on the neutral-inclusive characteristics of the organization and management of glacial processes and phenomena. It is shown that the study of soil erosion under the influence of the glacial formations and the study of the glacial erosion itself have complexity. The organization and the anti-erosion arrangement for both cases implies the real procedural knowledge, the disposition in verifiable conceptual instruments and managerial actions / solutions of a neutral-inclusive nature. The general knowledge of the erosion phenomenon, invoked in the field, provides the premises for research regarding glacial-pedological erosion, specific to the continental areas, including for Romania, in the Carpathian Mountains area. By investigating the glacial relief in Romania and identifying sub-processes and glacial processes, a relational image could be elaborated expressing the occurrence / manifestation of glacial-pedological erosion. The concept and method presented in the article can be complemented by the extension of the research in the field regarding the specific aspects of the global erosion processess, but also with the local, mountain, intramontane ones from the geographical areas with continental and polar climate. An important step in this article is to devise a method of formalizing a geo-glacial "atlas" starting from "maps" of real-glacial sub- areas, demonstrating their conditions of injectivity and differentiability. Further, a qualitative performance indicator could be established for*

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comparing the movements of the glacial formations on the mountain / intramontal surface of Romania with the standard, measurable and controllable displacements, aiming at the zonal protection in front of the geo-glacial incidents.

Keywords: *anti-erosion glacier areas, neutral-inclusive anti-erosion management, differentiable variety, difeomorphism*

1. Introduction

The fight against erosion has been noticed since ancient times. The phenomenon of erosion has dominated and nowadays dominates scientific research for solutions, methods, processes and so on, to combatit. In comparative terms, for example, in the real world space, the legal regulations (law) are relatively proportionally configured in relation to the real facts (offenses), but we observe that in cyber-space (a new, equally real "space") the law cyber is always behind the facts, because the inventions / technological information innovation is much greater than the capacity of the contemporary society to impose appropriate lawsfor the virtual space.

Likewise, *the phenomenon of erosion,* which acts on the geophysical material / geomorphological territory, proves dominant, still above the capacity of the contemporary society to control, organize and lead by appropriate methods and tec hniques the diminution / eliminationof soil and subsoil deterioration. For example, on the Romanian territory,the wind erosion is manifested with different intensities in 18 lands with sandy soils, acting with increased intensity on the cultivated soils. (Parichi, M., 2000) [20]

Surface erosion remains predominant over *depth erosion.* Following the kinetic energy of the wind and the water that glides (moves) on the land (the glacial formations), particles of different sizes (particle size) are detached, moving at varying distances. The process is dependent on soil erosion / glacial erosion resistance.

At present, it is surprising the attitude of human collectives and families of specialists / researchers in the field of environment, geography and management, which manifests "peace and expectation" when it comes to the glacial formations that, under the influence of climate change, are suffering erosion, they break, they move, which means that they cause the imbalance (it is true, “slow”) of the classic glacial framework, perceived and known as being specific and strongly structured.

This context justifies and motivates the initiative to research the organization and anti-erosion planning of glacial areas. Ultimately, it is about identifying an anti-erosion management that, in this paper, will be formalized based on the neutral-inclusive characteristics of the organization and management of the specific processes and phenomenain the field.

2. Related Literature

About the glacial erosion itself of the glacial formations, there are not many approaches, studies, investigations, researches, etc. Global warming and the greenhouse effect, on the other hand, resulted in the elaboration of different reports on glaciers, polar caps, reflecting, in particular, the consequences of deterioration of glacial formations and less explaining the processes and phenomena of erosion / erosion of the quantity and quality of glaciers.

United Nations signals the effects of glacier melting, for example, through the disorder that is still prevalent in the global economy: “In order to restore the global economy to a healthy growth trajectory over the medium-term, as well as tackle poverty, inequality and climate change, policy measures need to target a wide range of objectives, including, for example, (...) green technology; and progressive reform of the regulatory environment.” (United Nations, New York, 2017) [33]

At the same time, the United Nations warns of the dangers facinghuman communities when disturbances, destructions, displacements and so on occur of the glacial formations: “With global glaciers – a vital water source for millions, or even billions, of people worldwide – melting at a record rate, the UN Environment Programme urged countries to agree on a new émissions réduction pact.” (UN News Centre, 2008) [34]

In the same frame of concern, it is shown, for example, that "Himalayan glaciers are expected to become smaller, and small glaciers will have disappeared, but by no means will all glaciers have melted by the end of the 21st Century." (Stoffel, M., Sehgal, R., 2015) [23]

Yuanjing Z. et al., (2013) [24] stresses that "Soil erosion, one of major disasters in the world, can damage land resources, cause disasters like deposit, drought and flood, exacerbate ecological environment, and threaten human survival and development, so it has been paid close attention to ail over the world".

On the other hand, Evans, G.S., (1992) [7] mention that "Natural processes associated with this loss of glacier ice pose hazards to people and the economic infrastructure in mountain areas. These processes include glacier avalanches, landslides and slope instability caused by debut tressing, catastrophic outburst floods from moraine-dammed lakes,and outburst floods from glacier-dammed lakes (jökulhlaups)".

Kääb A., et al. (1998) [14], says that "Beside their thermal and mechanical material properties, active rock glaciers are essentially defined by their kinematics. Surface topography and surface kinematics can be analysed in detail with photogrammetric methods. In conjunction with other studies, knowledge of surface kinematics substantially helps the understanding of the dynamic processes of creeping permafrost. To reach this goal, investigations using a combination of techniques, concentrated on some selected rock glaciers, seem to be most promising."

In Romania, Urdea P., (1998) [23] focuses attention on the fact that "Mapping of rock glaciers in the Southern Carpathians allowed a clear differentiation between talus rock glaciers and debris rock glaciers, and clarified their spaţial and morphological relationships with glacial deposits."

The soils, especially the mountain ones, in the vicinity of which glaciers are found (in winter or throughout the year) are affected by non-anthropic actions, the erosion phenomenon being observed almost unanimously. It could be the "movement of natural cycles of selfregulation of the environment", we – the people, considering that "negative conventional affectation" is happening, and the nature considering the cyclicality of the soil destructures, as "natural process".

National Snow & Ice Data Center (2017) [27] confirm that "Glaciers periodically retreat or advance, depending on the amount of snow accumulation or evaporation or melt that occurs."

The point of view of erosion in a single glacial area, however, is denied by the so-called natural self-organization of Ice Clusters. "Ice Cluster is a concentration of sea ice, covering 100's of square kilometers, which is found in the same región every summer." (Cryosphere Glossary, 2017) [25]

On the other hand, Rebecca Gillaspy, (2017) [9] mention that "Land and rock cannot move out of the path of a glacier, so they are subjected to *glacial erosion,* which is simply the carving and shaping of the land beneath a moving glacier."

In this context, Ondrej Scepita (2011) [22] looks like "Anti- erosion protection is understood as a set of measures serving as process management to prevent soil loss and degradation of its productive and environmental potential."

In 1960 Vishmaier H. [in 16] elaborated an empirical equation to explain the mechanism of slope erosion, the emphasis being on quantitative estimates:

$$E=(K*S*C*C_3*L^{0,3})(1,36+0,79i+0,138i) \qquad (1)$$

in which:

E = average annual erosion; [t/ha an] K = rainfall aggression coefficient; S = soil erosion coefficient; C = coefficient related to the influence of vegetation on the soil; C_3 = coefficient related to the influence of the culture system used; L = slope length; i = average slope of the slope; [%]

At the same time, the average slope of the slopes (of the surface), denoted P_m, is dependent on the length of the level curves (Lcv), equidistances („echih”) and on the slope surface (S_v):

$$P_m = (L_{cv})\frac{\text{"echih"}}{S_v} \tag{2}$$

In this framework, it follows that: 1) the study of soil erosionunder the influence of glacial formations and 2) the study of the glacial erosion itself is complex, and the organization and arrangement of the erosion (for both cases) implies a) the real procedural knowledge, b) the availability of tools verifiable concepts and c) management actions / solutions of a neutral-inclusive nature.

These aspects justify the extension of research for the identification of “maps / atlases” with glacial processes and phenomena (including erosion), the applications being found also for the glacial areas of the Romanian Carpathians.

3. Method and Methodology

3.1. Theoretical and practical prerequisites for conducting research

The movement of glaciers on water can also be associated with the movement of glaciers on the ground. The action of gravity is decisive, defeating the inner friction (of the rocks and glaciers), the cohesion (of the mass of the rocks, the soil materials and the glaciers), all manifested under two causal aspects: a) the temperature rising (T°C) and b) gravity correlated with the specific weight (total weight) of the formation started in motion, (G_{ge+gm}).

Slips, crashes, bumps, etc. are elements related to the causal factors from the water (freeze-thaw).

Vertical movement manifestation is rarer than indirect movement,in the direction of the local slope angle.

Freezing and thawing lead to the degradation of the physico-mechanical properties of the soil, respectively of their structure, when theglaciers are in direct contact with the dry surface.

Glacial slips can be: a) displacement, (Δ_a); b) detrusive, (Δ_d) and c) mixed, (Δ_m), which can confirm their sense of displacement.

The shapes of the sliding surfaces can be: a) consecvente, (ΔF_c); b) insecvente (ΔF_i); and / or c) asecvente (ΔF_a).

In any case, in the glacial areas of the global territory, there is a quasi-permanent potential and active evolution for the slip / displacement of the frozen formations on the depths, usually small, without significant underground amplitudes.

By pre-conceptualizing the glacial erosions, we advance the thesis of the existence of two procedural formulas in the field: 1) soil erosion under the action of glacial formations and 2) proper glacial erosion (erosion, deterioration of glacier masses, when the shapes and quantities can trigger their geophysical movement in the environment. proximity).In a generalized, systematic view, successions of erosions and their effects on the "glacier-dry" composition are encountered.

The general model of a generic erosion phenomenon can be formalized taking into account the binomial of glacier-dry formations. (*Figure 1*)

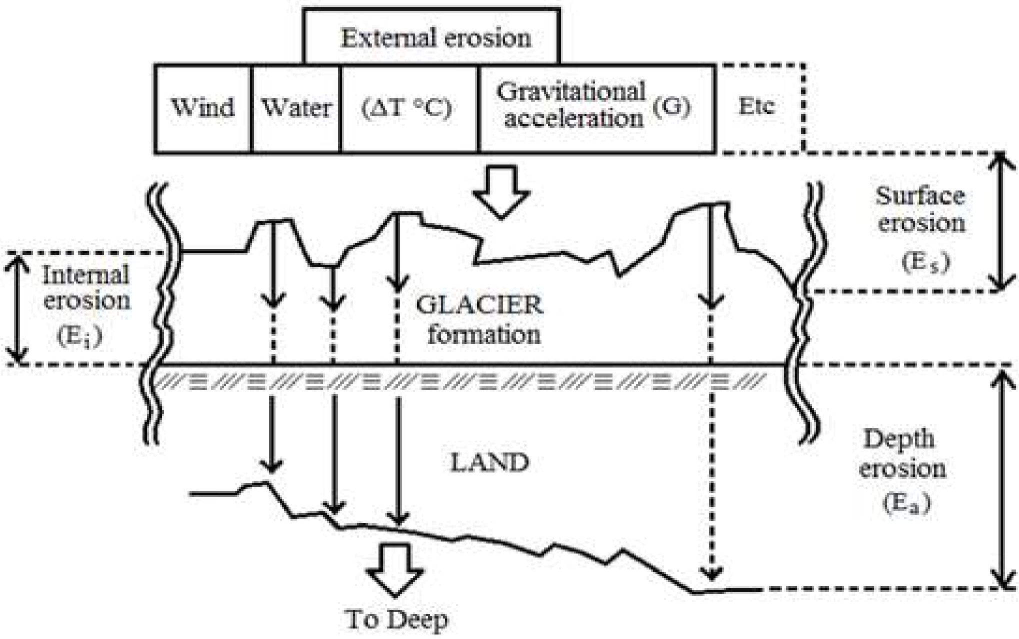

Fig.1 *Sequences of erosions and their effects on the glacier-dry binomialformations*

Source: Authors

In this context, the following composition is recorded:

$$\{E_t\} = \{(E_s) * (E_i) * (E_a)\} \quad (3)$$

in which $\{E_t\}$ = total erosion / compound in the "glacier-dry" dual zone.

The composition $\{E_c\}$ of surface erosion (E_s) with depth erosion (E_a) highlights consequences that need to be investigated, evaluated, upon them being necessary to apply a certain organization / leadership for combating or process development in the spirit of environmental sustainability. (*Figure 2*)

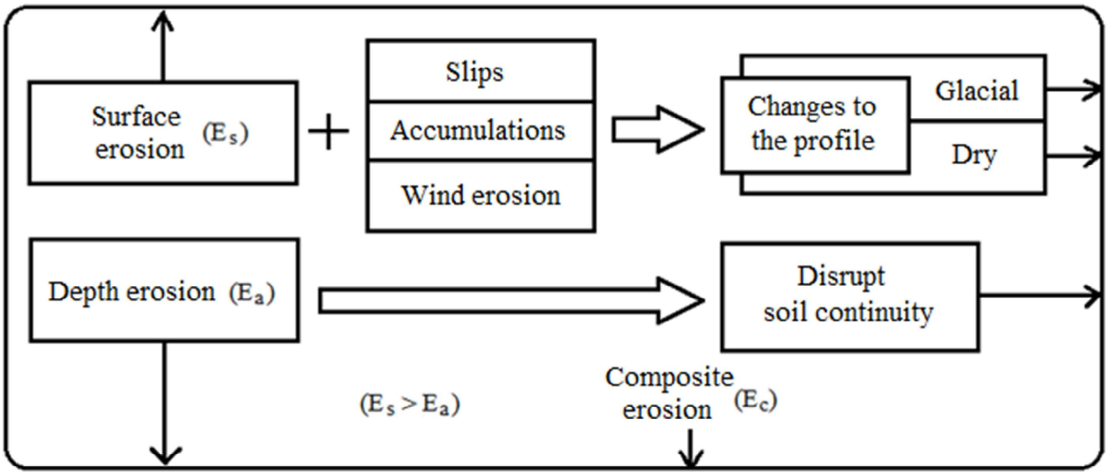

Fig.2 *Composition of surface erosion with depth erosion and itsconsequences*

Source: Authors

As such:

$$\{E_c\} = \{(E_s * E_a)\} \quad (4)$$

with the prevailing / objective condition: $E_s > E_a$

This picture of general knowledge of the erosion phenomenon provides the premises for research regarding glacial-pedological erosion, specific to the continental areas, including for Romania, in the Carpathian Mountains area. By investigating the glacial relief in Romania and identifying sub-processes and glacial processes, a relational image could be elaborated expressing the occurrence / manifestation of glacial-pedological erosion. (*Figure 3*)

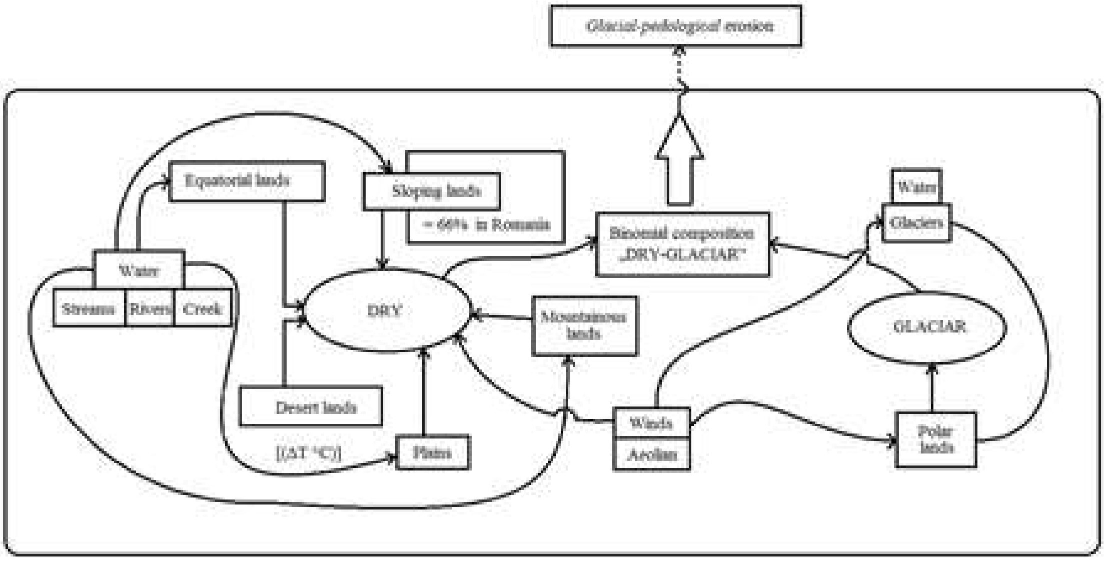

Fig. 3. *Occurrence / manifestation of glacial-pedological erosion*
Source: Authors

the general context presented above can be complemented by the extension of the research in the field regarding the specific aspects of the global erosion processess, but also with the local ones, intramontane mountains from the geographical areas with continental and polar climate.

3.2. Specific view of glacial erosion processess

Romania is located in the central-eastern European area with an area of 238,391 km^2, and the relief on its territory is: 28% mountains (maximum height is 2544 m in Fagaras Mountains), 42% hills and plateaus, 30% plain. The country has a rich hydrographic network and shoreline at the Black Sea (254 km), as well as 4 seasons, of which winter (-7^0C), on average, the temperature on the Carpathian coasts is – 2^0C (extreme temperatures reach -30^0C in winter).

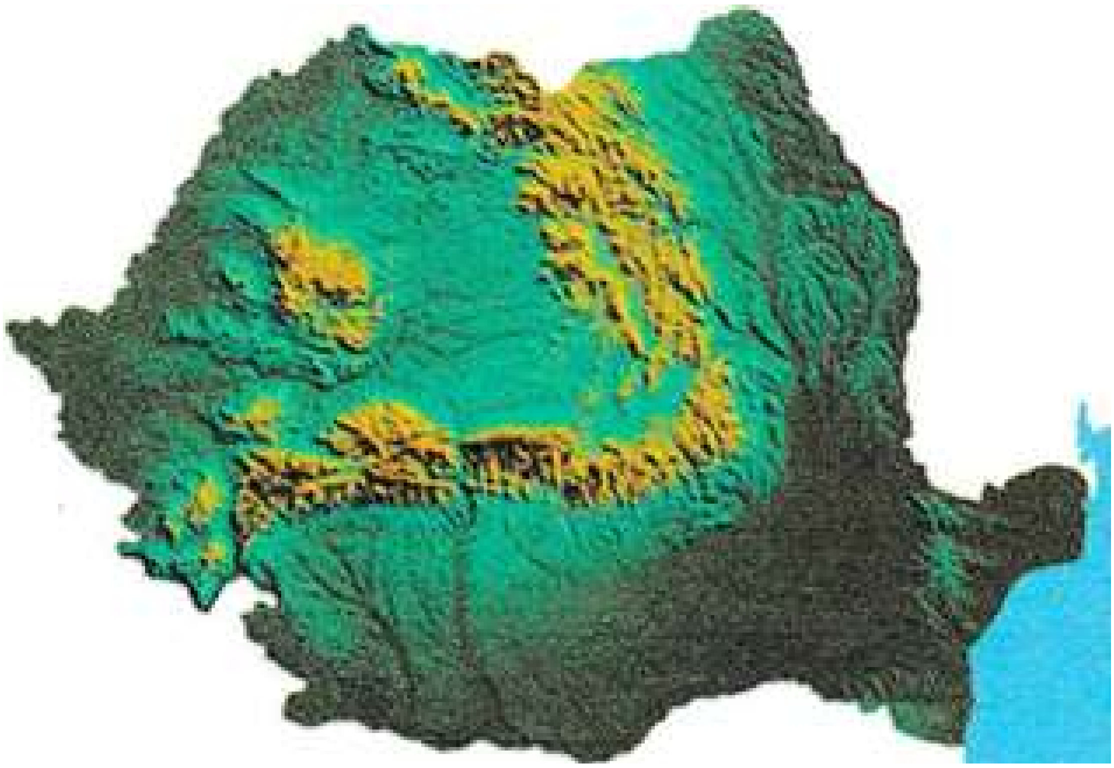

Fig. 4. *Carpathian Mountains, Romania*
Source: Encyclopedia of Romania,
www.http://enciclopediaromaniei.ro, May 2019[26]

In the intramontane areas and in the high lake areas, glaciers are formed, which are permanently subject to transformations under the incidence of glacial erosion. On this alignment of findings it is important to highlight successions of erosions on the "glacier-dry" binomial (S_g:S_u), and on the composition of surface erosion with that of depth.

According to the Azimut EcoTourism Association in Bucharest (Lambrinoc L., 2014) [15], the global land area occupied by glaciers is 16.24 million Km^2 (10% from the surface of the terrestrial land). Low average temperatures and rainfall are essential conditions for the formation, existence and maintenance of glaciers.

A systematization of the types of glaciers existing in Romania shows the preponderance of the alpine glaciers. *(Figure 5)*

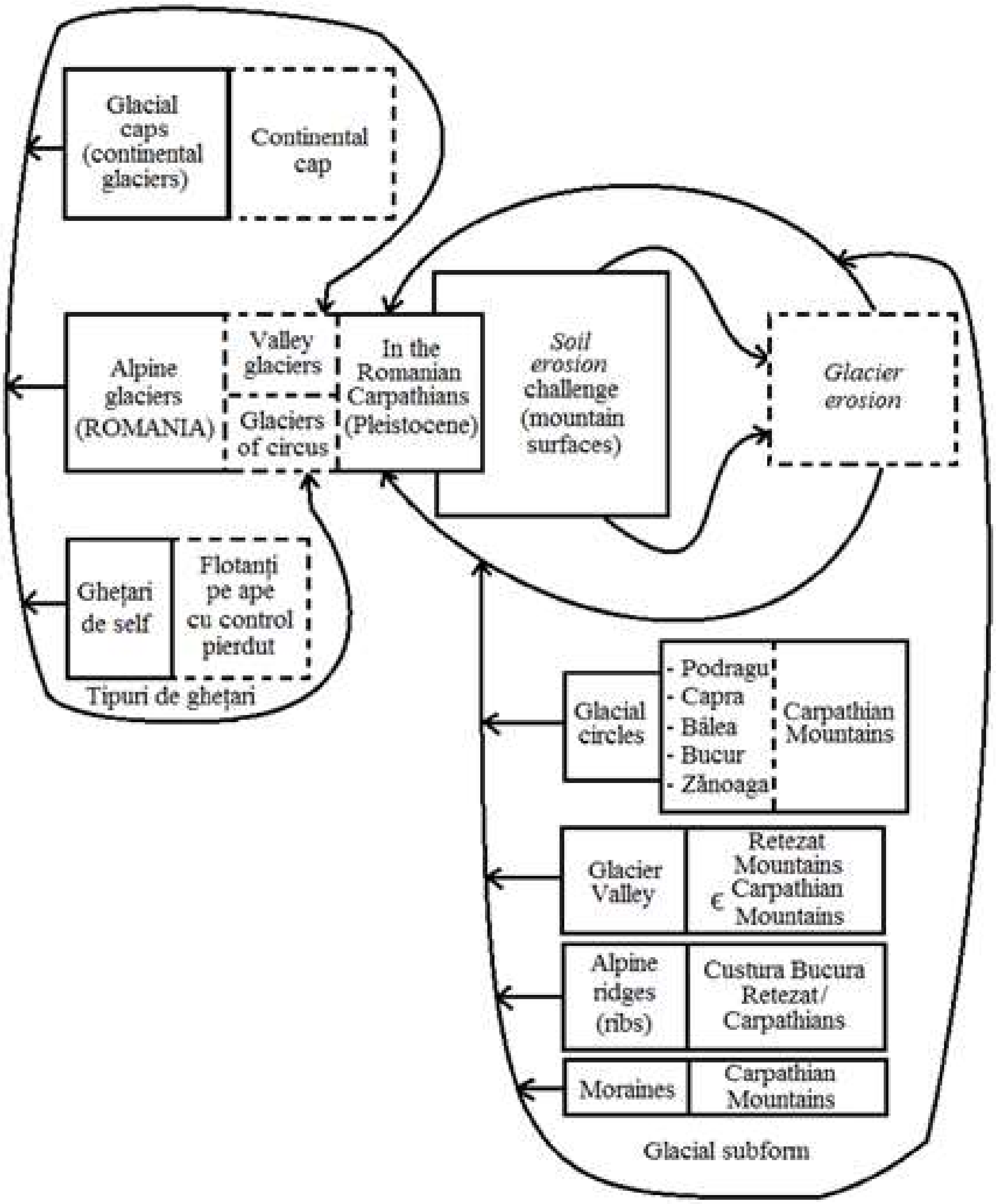

Fig. 5. *Types of glaciers existing in Romania*

Source: Authors

Glaciers of self

Floating on water with lost control

Types of glaciers

In the same context, the spread of alpine glaciers in Romania (*Table 1*) mainly shows their presence on a predominantly mountain glacier relief (Carpathian Mountains) and intramont.

Table 1.
Component forms of glacial relief in Romania and examples with their geographical locations

Glaciers of height / altitude	**Glacial circles**	**Glacier suspended circles**	**Glacial valleys**	**Glaciallakes**	**Moraines**
- Pietrosu, Farcău (1500-2000m), Maramureşului Mountains	- Bâlea (Făgăraș Mountains) - Bucura (Retezat Mountains) - Iezerul of Parâng - Zănoaga (Retezat Mountains) - Capra - Podragu - 30 glacial circles in Rodnei Mountains - Leaota Mountains - 175 glacial circles in Făgăraș Mountains - in Godeanu Mountains	- Iezer-Păpuşa (Iezer Mountains) - in Parâng Mountains - in Țarcău Mountains	- Lia, Florica, Ana, Viorica (Retezat Mountains) - 8 valleys in Bucegi Mountains (Cerbului, Țigăneşti, Mălăeşti)	- Bâlea (Făgăraş) = 4,65 ha - Bucura (Retezat) = 8,90 ha - Zănoaga (Retezat) = 6,00 ha	- 15 moraines cliche in Şureanu Mountains

Source: processed systematization by www.ecoazimut.ro, May 2017 [35]

In Romania glacial lakes are formed in the glacier circles of the Quaternary. in the old glacier boilers, by accumulating rainwater and snow / rain feed. (Pişota, I., 1971) [21]

Bucura Lake is the largest glacier lake in Romania (over 10 ha), and Zănoaga Mare Lake is the deepest (29 m), both located in the Retezat

Mountains (in the Retezat National Park in Hunedoara county with an area of 40,000 ha, where there are 40 other large and medium lakes and 18 small lakes, all permanent). Mioarelor Lake in Fagaras Mountains is located at the highest altitude in the country, 2282 m.

The Pleistocene Quaternary glaciation in the Carpathians has traces attributed to the last two general glaciers in this area, namely Riss and Wurm. [28]

In the Romanian Carpathians there are 531 deposits of the type of glacial circuses. (Badea L., -I-, et al, 2001) [1] and (Badea L" et al., – II-, 2006) [2]

3.3. Method for assembling the knowledge of the erosion and the mountain and intramontane glacial areas on the territory of Romania

The most important step in this article is to devise a method of formalizing a geo-glacial "atlas" starting from "maps" of real-glacial sub-zones, demonstrating their conditions of injectivity and differentiability.

Further, a qualitative performance indicator could be established for comparing the movements of the glacial formations on the mountain / intramontal surface of Romania with the standard, measurable and controllable displacements, aiming at the zone protection in front of the geo-glacial incidents.

An invisible set M is considered to be a real differentiable variety having size n and is found in a class C^k if:

$$A=\{(U_a, h_a) \mid a \in A\} \quad (5)$$

in which A = a lot of indices;$U_a \subset M$

In this situation it is found that $h_a: U_a \longrightarrow R^n$ is an *injection application*, whatever it is $a \in A$, so that:

$$\bigcup_{a \in A} U_a = M \quad (6)$$

At the same time, if a,bϵA, when $U_a \cup U_b \neq \phi$, then the crowd $h_a(U_a \cap U_b)$ *is open* in R^n.

As such, the application

$$h_b * h_a^{-1}: h_a(U_a \cup U_b) \longrightarrow R^n \quad (7)$$

is class differential C^k.

It can be appreciated that now A is an *atlas* if it satisfies the conditions of being *injectable,* respectively *differentiable.*

On this basis, the pair (U_a, h_a) can be called *a map* on M and the application $(h_b * h_a^{-1})$ signifies the change of map. (*Figure 6*)

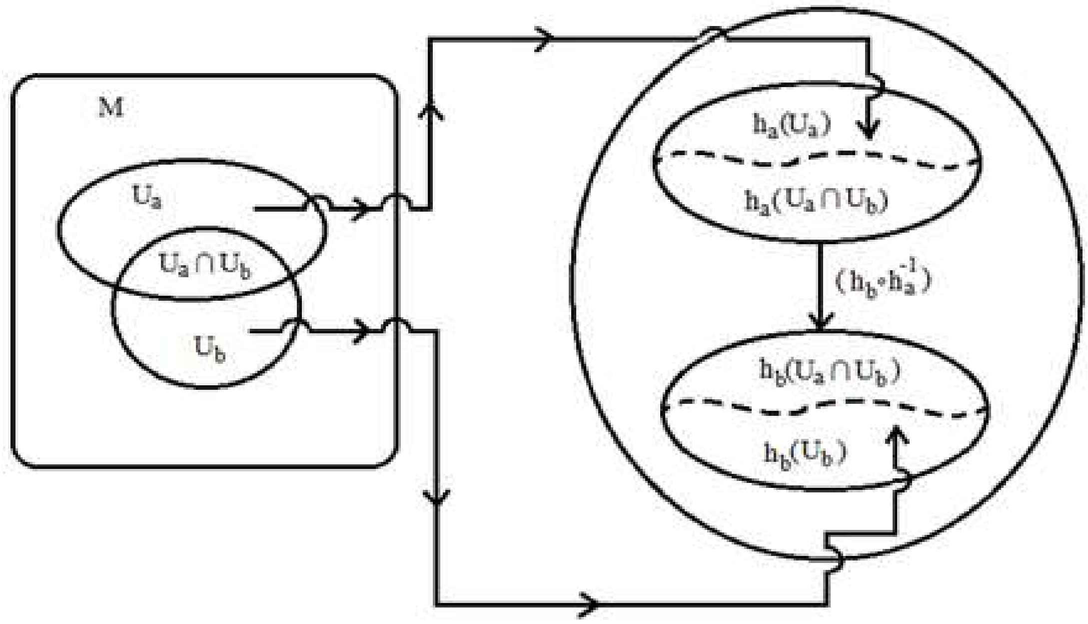

Fig. 6. *Formalization of the geo-glacial atlas starting from maps of sub-areas that fall within the real glacial area, respecting the conditions of injectivity and differentiability*

Source: Authors

The indices a and b belonging to the set A of indices related to theglacial formations characterize the differentiable variety of the invisible set M of glacial formations existing on a surface (on a territory), assumedto be from a / in a class C^k, highlighting the specificity (family) of these formations (glaciers) in a clarification assumed by the researcher.

When U_a is a map of glaciers from one sub-area, and U_b isanother map from another sub-area (adjacent, complementary, proximity,local, etc.), it can be seen that the intention of obtaining a at least quasi- global visions for the sub-area in which the two sub-areas are located leads to the thesis of the intersection tangency (mainly, in the present case), the meeting, the overlap, etc. of the two maps with glacial formations.

Of course, the superior tendency in this case is to "extend the meeting of map intersections" on an open and real area (R^n), in order to obtain the global vision in the field. On this basis, it is possible to study, further, the glacial erosion, the displacements, the landslides, the collapses, respectively it is reached the situation to formulate (at least conceptual) solutions for the management and the antierosional management in the glacial geo-climatic field.

If the satisfaction of the conditions of *injectivity* (2) and of the *differentiability* (3) is observed, a *geo-glacial atlas* can be obtained,based on the map changes in the sub-areas using the transforming condition ($h_b*h_a^{-1}$), all found in the open and real area (R^n).

4. Applications and Results

- Difeomorphism of the map-transforming condition of glacial sub-areas

In the researched territory it is possible to pre-delimit a sub-area of land ƛ, which is useful to find in the quasi-global / global mapping application.

If the differentiable variety is (M, ƛ) is class C^k and size n,respectively (M, ƛ) = $\{(U_a, h_a) \mid a \in A\}$, it is found that the application:

$$h_b*h_a^{-1}: h_a(U_a \cap U_b) \longrightarrow h_b(U_a \cap U_b) \qquad (8)$$

is in mathematical terms *class diffeomorphism* C^k, (Dif C^k),

whatever a, b $\in$ A.

The demonstration of this finding starts from the fact that $h_b(U_a \cap U_b)$ is a lot open in R^n and, as such, the term left (first compound term) ofthe relation (4), is an application in R^n assimilated to the class differentiable C^k.

Any composition between $h_b*h_a^{-1}$ şi $h_a*h_b^{-1}$ they represent *identical transformation*, respectively these terms are opposite applications to each other, so the application $h_b*h_a^{-1}$ is class diffeomorphism C^k.

In this context, diffeomorphism in the present situation (for glacial areas) is an invertible function, having the role of associating a differentiable set with another (one glacial sub-area with another), finally providing a so-called "*smooth function*" (geo-glacier map). (Banyaga A., 1997) [3]

- More open sets for mapping in real glacial areas

The same differentiable variety (M, ƛ) of class C^k, and dimension n if associated with a larger number of glacial sub-areas (1, 2, ..., n), considered "open" in R^n, then whatever it is a, b ϵ A there is the relationship:

$$h_a^{-1}(SZ1) \cap (SZ2), \dots, = h_a^{-1}(U) \quad (9)$$

wherein the new set (U) is opened in R^n for the sub-areas {(SZ1), (SZ2), …, (SZn).

The research of the glacial relief in Romania and the identification of the glacial sub-areas was performed on composite statistical bases, systematizing integrative assessments on the processes and phenomena of glacial erosion of the soil and of the glacial formations themselves. (*Table 2*).

Each variable, each parameter and each property was assigned a coefficient of importance / weight in the *min (*affecting), *balanced* (neutral-inclusive) ($\pm$), respectively *max* (non-affecting), the scale of the weight parameters being included in bounded range [0÷ 1]/[1-10].

The investigative logic in the field shows that the extreme weight values ("0"/"1", respectively "1"/"10") are ideal, they never meet in practice, in the field.

The purpose of such matrix formalization is to identify the delimited "maps" / "atlases" with tangible / intangible correlations, thus knowing and understanding the amplitude (understanding / all- encompassing) of the soil erosion / erosion / glacial formation.

On this basis, neutral-inclusive anti-erosion management programs can be formulated.

The documentation base [13], [17], [18], [19] and [29] provided the opportunity for data collection to legitimize the conversion of qualitative and quantitative assessments of the symbols of the columns in the matrix of analysis and scientific interpretation of the evolutions in *Table 2*.

Table 2.

Integrative assessments on the processes and phenomena of glacial erosion (soil and glacial formations) in the Carpathian Mountains of Romania (mountain / intramontane glacial relief)*

	Glacier relief units	Slips glacier			Sliding surfaces			T °C (winter)	(G_{gc+gm})	$(S_g \div S_u)$	Erosions			(U_m, h_m)	$h_a{*}h_a^{-1}$	A	$DifC^k$	(U)	Comments [calculations at 10^{-1}]
		Δ_a	Δ_d	Δ_m	ΔF_c	ΔF_i	ΔF_a				$\{E_t\}$	$\{E_c\}$	E**						
1	Erosion surfaces	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	>1100m
1.1	Southern Carpathians	5	-	-	2	-	-	<6	4	2	3	2	1	1	1	2	(±)	1	1800-2200m
1.2	Oriental Carpathian	2	2	1	2	-	-	<0	6	1	6	5	2	2	2	2	+	2	1800-2000m
1.3	Western Carpathians	6	3	2	3	-	-	<5	6	2	5	4	2	1	1	2	+	2	1100-1600m
2	Glacier relief	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	>2000m
2.1	Rodna Mountains	6	1	1	2	-	-	<0	5	2	4	4	1	1	1	2	(+)	2	1500-2000m
2.2	M. Maramureș	6	1	1	2	-	-	<0	5	2	4	3	1	1	1	2	(+)	2	1500-1700m
2.3	M. Căliman	2	1	-	1	-	-	<0	1	1	1	1	1	1	1	2	(-)	1	1800-1900m
2.4	M. Bucegi	3	1	-	1	-	-	<0	1	2	3	2	1	1	1	2	(-)	1	1900-2000m
2.5	M. Leaota	4	1	1	2	-	-	<0	4	3	4	3	2	2	2	2	(±)	1	1 glacier circus
2.6	M. Făgăraș	3	1	-	1	-	-	<0	3	2	3	2	1	1	1	2	(+)	2	1800-2100m
2.7	M. Iezer	5	2	1	2	-	-	<0	5	4	4	4	2	2	2	2	(+)	2	>1650m
2.8	M. Sureanu	5	2	1	2	-	-	<0	5	4	4	4	1	1	1	2	(+)	2	1700-1900m
2.9	M. Parâng	5	1	1	1	-	-	<2	4	2	3	2	1	1	1	2	(±)	1	glacial valleys
2.10	M. Retezat	5	2	1	2	-	-	<0	5	4	5	4	2	2	2	2	(+)	2	1300-1400m
2.11	M. Godeanu	5	2	1	2	-	-	<1	4	3	4	3	1	1	1	2	(±)	1	moraines/1600m
2.12	M. Țarcu	5	2	1	2	-	-	<0	5	4	4	4	2	1	1	2	(+)	2	1300-1400m
3	Glacial lakes	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	23 lakes
3.1 a.	Rodna Mountains - Iezer 0,34 ha	-	-	-	-	-	-	<6	-	-	1	1	1	1	1	2	(±)	1	0.34 ha
b.	- Lala Mare 0,56 ha	-	-	-	-	-	-	<6	-	-	2	1	1	1	1	2	(±)	1	2.56 ha

* Empirical analysis based on the method of assigning the coefficients of importance based on thesystematization of data from [5], [6], [30], [31] and [32]

** (E = Vischmaier Method)

The notations in *Table 2* are as follows:

Δ_a = sliding glacial slips;

Δ_d = detrimental/detrusive glacial slip;

Δ_m = mixed gliding;

ΔF_c = consistent/ consecvente gliding surface;

ΔF_i = glacial slip surface in sequence;

ΔF_a = glacial asecvente gliding surface;

(T°C) = temperature; [°C]

(G_{gc+gm}) = gravity correlated with the specific / total weight of the ice mass;

($S_g \div S_u$) = binomial of glacier-dry formations;

{E_t} = total erosion /composed in the dual zone "glacial-dry";

{E_c} = "glacier-dry" compound erosion (complex process);

E = Vischmaier average annual erosion [t/ha/year]

(U_a, h_a); (U_b, h_b),…, = maps with processes and glacialphenomena;

($h_b * h_a^{-1}$) = map changes with glacial processes and phenomena;

A = atlas (injectable and differentiable) with maps with glacial processes and phenomena;

($DifC^k$) = class k diffeomorphism;

(U) = open crowd in R^n for subareas {(SZ1), (SZ2),…, (SZn)}.

The statistical calculation of the coefficients of importance (weight) was used for the variables, parameters and properties of the mountain and intramontane glacial areas in Romania and, according to the data in *Table 3,* mainly, the following results are obtained:

- representative glacial formations in Romania are encountered in the Carpathian Mountains; The average annual temperature in this relief unit (at heights above 1600 m) is below 0°C-6°C.

erosion surfaces, glacial relief and glacial lakes are the infrastructural support that on average (cliché observation / static observation) erosion damages are 0.240% of the total erosion as a processand a geographic / geomorphological phenomenon.

Table 3.
Quantifications of glacial erosion levels in the Romanian Carpathians (sequential case study)

	(%) Average (10^{-1})	(%) Average (10^{-1})		
	(01-06)*(08-12)	(13-15)*(17)	Ranking	Remarks
1	-	-	-	Erosion surfaces
1.1	0.212	0,125	(3) (min)	Area with minimal erosion surface
1.2	0.300	0.200	(2)	
1.3	0.367	0.150	(1) (Max)	Area with maximum erosion surface
2	-	-	-	Glacier relief
2.1	0.289	0.150	(4)	
2.2	0.278	0.150	(5)	
2.3	0.100	0.125	(10) (min)	Area / relief with minimal erosion
2.4	0.156	0.125	(9)	
2.5	0.267	0.125	(6)	
2.6	0,178	0.150	(8)	
2.7	0.323	0.150	(2)	
2.8	0.312	0.150	(3)	
2.9	0.223	0.125	(7)	
2.10	0.334	0.150	(1) (Max)	Area / relief with maximum erosion
2.11	0.278	0.125	(5)	
2.12	0,323	0.150	(2)	
3	-	-	-	Glacial lakes
3.1	-	-	-	Mountain glacial lake erosion
a	0.034	0.150	(2) (min)	Minimal erosion
b	0.045	0.150	(1) (Max)	Maximum erosion
	0.240	0.140	-	(Composite assessments)

Source: Authors

This weight, even reduced, over time has a certain role of geophysical / geomorphological affectation of the territory.

- Correspondingly to this level of affectation, neutral mapping (including cumulative, non-markovian) map changes and meetings in atlases with erosion processes / phenomena is recorded, the essential property in this case being the defined class diffeomorphism (C^k) related to glacial sub-zones, found in an open crowd, hosting glacial formations on the national territory.
- Specifically, in the Carpathian Mountains of Romania, the most significant erosional effects occur in the relief units related to the Western Carpathians, respectively in the Retezat Mountains.

For example, from the research database, in *Figure 7*, there are presented erosion situations due to glacial causes recorded in the eastern area of the Retezat Mountains (Campul lui Neag / Valea de Brazi).

a)

b)

c)

d)

e)

f)

g)

Fig. 7. *Post-erosional glacial situations in the intramontane sub-areas Valea deBrazi (c, d, e, f, g) and Câmpul lui Neag (a, b) (Retezat Mountains, Romanian Carpathians)*

Source: Own research database, 2014-2019, Authors

An indicator of the qualitative performance of comparing themovements of the glacial formations with the observed (detected) measured and controlled standard-displacements can be expressed cumulatively, for the sub-polar / polar area (glacier), or for the continental areas (such as the glacial surfaces of the Carpathian Mountains, from Romania), where glaciers meet on land, as follows:

$$I^{d}_{pc} = \sum_{i=1}^{n} (c_i p_i) = \{c_1 p_1 + c_2 p_2 +, \dots, +c_n p_n\} \quad (10)$$

The average quality of the journeys can record a coefficient (C^d) of the harmless neutral-inclusive journeys:

$$\{\bar{C^d}\}_m = \frac{\Sigma^n_{i=1} k_i p_i}{\Sigma^n_{i=1} p_i} \quad (11)$$

in which:

k_i = coefficient for qualitative classes, by weighting the importance (k=0 = quality with very high neutral-inclusive performance; k=1 = non-quality, non- driving displacement disturbance);

I^d_{pc}= indicator of the qualitative performance of the trips;

c_i= characteristic qualitative values;

p_i= weights related to the value characteristics (from values).

This statistical-mathematical instrument is handy for use in neutral-inclusive erosion management, benefiting from previous identifications of glacial sub-areas where erosion is encountered at amplitudes, with intensities and effects that require interventions for the organization and management of the anti-erosion process territory.

5. Concluding Remarks

If the index k of the class (C^k), which shows the differentiable variety, is zero, then the unseen set of existing glacial formations is *topological.*

In the case where the index k=ω then the map change is analytical and the set M is *analytical variety.*

Of course, in the empirical investigation of glacial erosion it can be understood that if M belongs to class $C^{\circ\circ}$ then this set is always *differentiable variety*.

The design of a method of formalizing a geo-glacial "atlas" starting from "maps" of real-glacial sub-areas, demonstrating their conditions of injectivity and differentiability, is contributing to the establishment of a qualitative performance indicator for comparing the movements of the glacial formations with standard, measurable and controllable displacements, aiming at zonal protection in the face of geo-glacial incidents.

Currently, the attitude of "peace and expectation" for environmental, geography and management research is not conclusive when it comes to glacial formations that, under the influence of climate change, move, suffer erosion, break, move, what it means that it causes the imbalance of the classical natural framework, which was and is perceived and known as being specific and strongly structured.

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