ASSESSMENT METHODS OF ANTHROPIC IMPACT ON THE TERRAIN FEATURES OF A REGION

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Assessment of human impact on the relief is a challenge, because the assessment methods are very rare, due to the priority of assessing the human impact on other environmental components (water, air, soil, human communities) which are often ineffective when the term "relief" is considered synonymous with the term "landscape."
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Introduction

By economic activities, human society has imposed on the territory the emergence of relations between anthropogenic and environmental elements based on exploiting natural resources, in order to satisfy the needs. The result of this relationship, most often, highlighted by the appearance of an anthropogenic landscape, characterized by forms of relief that has not any geological or geomorphological process, genetically speaking, with an unpredictable evolution.

Human process of redesigning the original land is a vital social and economic development of human society. Induced land transformations consist of disruption a significant volume of materials, relocation and storage them in anthropogenic various forms of relief. Thus, the initial land form suffers a change of shape and function, the final result is the generation of a complex with an increased sensitivity to anthropogenic hazards. As technological development and spatial extent of the anthropogenic areas, has been produced a contradictory relationship with the natural environment.

Anthropogenic shaping differs from the natural one by the rate of intensity during the event, complexity and shape of the products, offering irreversible changes to the land. Thus, areas with positive landforms, subject to human shaping, have been transformed from its original shape to a form almost horizontally and flat surfaces have been raised tens of meters. Following this feedback, morphological and structural changes are generated and the result would be a landform inversion and the appearance of critical environments.

Assessment of human impact on the morphology and structure of the relief

A component of the concept of "sustainable development" is the management of impacts of social and economical activities on the environment.

Impact management requires detailed knowledge of the phenomenon, which involves going through stages of identification and estimation.

It is well known that any human activity has a wide range of implications which can be seen in various areas. In general, we need to take into account the full range of implications for indirect effects in some cases exceeding those of direct importance.

In a brief definition, evaluation of human impact on the morphology and structure of the landforms follows the scientific investigation of complex geomorphological effects resulting from the impacts of human activities on the structure and morphology of the original land.

By estimating the effects induced by anthropogenic impact on the morphology of land means the quantitative and / or quality assessment of geomorphological processes and phenomena. Many times, the novelty of problems, lack of previous or similar data, highly diverse nature of the effects of uncertainty and multiplicity of interactions with other environmental factors, the qualitative estimation may be the only solution, and the quantitative estimation may require the use of mathematical and physical models to provide a basis for interpreting the results.

The proposed assessment methods

Assessment method of geomorphological quality depreciation

Geomorphological quality depreciation **(DC)** is calculated by summing the two parameters: ***geomorphologic type*** **(Rg)** and ***diversity of geomorphological features of interest*** **(D)** created from human activities, in order to highlight the severity of the impact on the terrain features from a region (table 1).

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$$DC = Rg + D$$

Geomorphological type may have the following values of interest: local (1), regional (2), national (3) and global (4).

The **diversity of geomorphological features of interest** is given by the number (subtypes) of elements with geomorphological significance (table 2).

Regarding the type of affected geomorphological resource, the matrix can be filled with the landforms and the type of modelling system that created it, depending on the specific region. Ex: glacier modelling system (landforms: fjord, moraine, fjard, etc), marine and oceanic modelling system (landforms: cliffs, headland, bay, delta), etc.

After mapping, it can be identified the number of significant items created by the human activity (forms of accumulation, hollows, accumulation of water) in the natural landform, noting in table 1.

It will total all the elements created by human activity and pass the result obtained in section D, thereby achieving the diversity of geomorphological features of interest.

The obtained parameter will be introduced in the above formula and filled in table 1 as well, and according to the relation, the depreciation of geomorphological quality will be obtained (DC).

Depending on the coefficient of geomorphologic quality depreciation obtained, it can be made the following classification:

- 0 unaffected geomorphological environment;
- 1-3 less affected geomorphological environment;
- 4-6 moderately affected geomorphological environment;
- 7-10 strongly affected geomorphological environment;
- ≥ 10 intense modified geomorphological environment.

Table 1 *Assessment matrix for geomorphologic quality depreciation*

Cons. no.	Name of affected geomorphological resource		Geomorphological type (Rg)	Diversity of geomorphological features of interest (D)	Quality depreciation (Dc)
	Modelling system	Name of landform			

Table 2 *Diversity of geomorphological features of interest*

Cons. no.	Name of geomorphological resource	Types of geomorphological elements			Diversity of geomorphological features (D)
		Accumulation forms	Hollows	Water accumulation	
Total					

Assessment method based on the relationship surface exhibition - solar radiation

This method takes into account the potential of climatic parameters to influence the vegetation growth on the surfaces of new landforms created by human activities.

Basis on the premise that areas with southern exhibition receive a larger amount of solar radiation, and the northern areas receive a lesser amount, it has been used a model for grades of creditworthiness, based on the use of values grouped into classes bounded by values - obtained through the threshold of Jenks optimization method (the method of optimal limits).

Thus, were awarded the following grades of creditworthiness (table 3):

Table 3 *Grades of creditworthiness for the exposure of surfaces*

	The range of values	Grade of creditworthiness	
		quantitative	qualitative
Exposure (versants orientation)	North	2	shaded
	North – East	3	shaded
	North – West	4	semi-shaded
	Horizontally	5	semi-shaded
	East	6	semi-shaded
	West	7	semi-sunny
	South –East	8	semi-sunny
	South – West	9	sunny
	South	10	sunny

As mentioned previously, the grades of creditworthiness were given according to the characteristics of areas in terms of quantity of solar radiation received (Filip S., 2008).

Thus, the orientation of the slopes is characterized as follows:

- 1 – 3 shaded slopes: North, North - East, is characterized by a lack of solar radiation, humidity and frequency of extra winds from a northerly direction;
- 4 – 6 semi-shaded slopes: East, North - West, horizontal surface is characterized by a significant contribution of solar radiation, especially in the early hours of the morning and a lack of moisture; are influenced by the general circulation of air masses from the east direction;
- 7 – 8 semi-sunny slopes: West, South - East, are sometimes considered to be similar to the eastern slopes, in terms of climate, but it has certain features, such as extra rain and heat in afternoon;
- 9 – 10 sunny slopes: South, South - West is characterized by an important contribution of solar radiation, humidity deficit and presents a specific climate, protected from cold winds.

Assessment method "alteration – reuse"

I designed this method as a product of three parameters namely: the strategic level of the affected area, type of human activities and the ability of affected geomorphological environment to recover (resilience).

$$MR = Ns \cdot Ta \cdot R$$

Strategic level (NS) indicates the importance of the area or landform under anthropic activity in terms of economic importance, accessibility, distance from the attractions, location (inside or outside the city), etc. (table 4).

This parameter can have the following values:

- 1 - low importance
- 2 - medium importance
- 3 - high importance

Table 4 *Strategic level of landform*

Landform or area potential	Strategic level Ns
Low economical potential, unincorporated area, open to natural processes (sloughing, landslides, concentrated erosion), poor accessibility, low productive land uninhabitable area.	**1**
Medium economical potential, within incorporated area or unincorporated area, not subject to active geomorphological processes, areas occupied by forests, grassland or meadow, approachable, temporary living area (seasonal or recreational activities).	**2**
High economical potential, within incorporated area, land for building, areas occupied by agricultural land, roads, the land is not subject to active geomorphological processes, high accessibility, continuously inhabited area (residential centers).	**3**

Type of human activities (Ta) is represented by how the anthropogenic factor involved in changes of geomorphological environment (table 5). It is classified as:

- **constructive and / or accumulation human activities** (anthropogenic accumulations like: waste dumps or landfills, local accumulations of water, concrete surfaces, buildings and yards, mud flows);
- **destructive and / or remodeling human activities** (surface excavations, underground holes, terracing the slopes, products of compaction processes, subsidence processes, concentrated erosion, landslides);

For the type of human activities (constructive or destructive) was given a score depending on the impact on the geomorphological environment.

I started from the premise that the resulting products like dumps, excavations and accumulation of water are those which affect the geomorphological environment the most, both in terms of the quantity of mass circulated material (excavation, relocation), processes and phenomena that arise due to the combined action of external agents and in terms of occupied area.

The other products can be considered as related products, some of them are part of a particular process (terracing the slopes or reshaping a versant for a coal pit or quarry) or the result of primary process (erosion products developed on dumps or the landslides; geomorphological processes caused by gravity, for coal pits or quarries, but also for dumps: declines, rolls, or landslides).

Recovery capacity (R), represent the ability of the geomorphological system to return by itself or man-induced through rehabilitation to the state it was before the commencement of human activity, or to a state similar to the original. Starting from this idea a value for each case will be given:

- R = 5, no possibility of recovery, 0%;
- R = 4, reduced capacity for recovery, <25%;
- R = 3, average capacity of recovery, 25-50%;
- R = 2, high capacity of recovery, 50-75%;
- R = 1, very high capacity for recovery, 75-100%;

Table 5 *Type of anthropogenic activity*

Products of anthropic activities	**Grade Ta**
h – anthropogenic accumulations (dumps, ash pit)	2,5
a – local water accumulations	2
sb – concrete surfaces	0,15
ci – buildings and yards	0,15
cn – mud flows	0,2
ex – excavations	2
gs – underground holes	0,2
tv – benches, platforms	1,5
pt – products of compaction processes	0,15
ps – products of subsidence processes	0,15
pec – products of concentrated erosion	0,2
dtm – landslides	0,8
Total	**10**

After applying the formula for assessing the impact on the morphology of a given area, the final outcome may fall, according to the scale, between 0 and 150, where:

- 0 – unaffected geomorphological environment, no human intervention, natural environment;
- 0-25 – less affected geomorphological environment;
- 25-50 – moderately affected geomorphological environment;
- 50-100 – strongly affected geomorphological environment;
- 100-150 – very strongly affected geomorphological environment due to overall change.

Using the table 4 and 5 in conjunction with the formula **M = Ns · Ta · R**, we obtain the coefficient of impact on landforms, later to be passed in the last column of the matrix of impact, table 6 (Nimară C., 2010).

Tab. 6 *Matrix for human impact assessment on the relief*

No.	**Name of the geomorphological resource**		**Products of human activity**	**Strategic level**	**Type of activity (total)**	**Recovery capacity**	**Value of the final rate**
	Natural modeling system	**Affected landform**		**(Ns)**	**(Ta)**	**(R)**	**(MR)**

Conclusions

The impacts on environmental components are part of the "price" that human society and the environment are forced to pay for the benefits of natural resource consumption. From this point of view it is unrealistic to say that the exploitation of such resources will be made without damaging the environment.

The papers refer to the assessment of human impact on the landforms are very rare and the conceptual and methodological base is diverse and sometimes remote.

It is curious that, an important element of the environment is unvalued when it comes to assess human impact, given that the relief represents the base of the other geospheres: biosphere, hydrosphere, pedosphere, atmosphere (troposphere), landscape and human society (social and economical activities).

The base character, the role of physical base for organizing the environment, that gives a certain spaciousness of the other environmental components, proved to be decisive in their mode of action.

I would like to mention that, by using these methods of anthropic impact assessment to the morphology and structure of a geographical region, I wanted to highlight the impact generated by human activities, specific to a landform, named "geomorphological resource" and not to the entire region.

Assessment method of geomorphological quality depreciation is a more simplified method and it can be used for anthropic impact assessment in regions where the anthropogenic pressure on the landforms is not so significant in terms of diversity of anthropic products. This method takes into account only the major interventions and the resulting products such as dumps, pits, ravines, considerable land subsidence and water accumulation (ponds or lakes).

Assessment method based on the relationship surface exhibition - solar radiation can be used in those cases where the affected area which will be reincorporated into the natural landscaping. The intent of creditworthiness grades is to support the decisions taken for the type of vegetation chosen. I mention that this method takes into account only the climate variability, created by the new exposure and not the type of soil.

The assessment method "alteration - reuse" is a complex method and can be used for regions which present a high anthropogenic pressure and a high geomorphological diversity, as well. This method is presented as a product of three parameters: the strategic level of the affected area, type of human activities that take into account both, human primary products, products that can be considered the "base" (dumps, quarries, coal pits and water reservoirs), but also secondary products, considered "related" (landslides, mud flows, products of subsidence, squeeze etc.) and recovery ability.

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