Chapter 8
Natural Heritage: Quantitative Evaluation of Landscape Scenic Values

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Abstract Landscape is part of the natural heritage and it has scenic, esthetic and economic values, both from the point of view of tourism and recreation, as well as in terms of the social access to the contemplation and use of such heritage. Scenic values are in fact, natural resources, and as such, high scenic values are scarce, and thus, valuable. In the case of scenic values, it is necessary to apply techniques of quantitative evaluation of such resources, which are closely related to the geomorphological characteristics of the studied region, to use these results in decision-making and priority ranking processes. This paper presents various techniques of quantitative evaluation which may be applied at the local and regional level. A case study in Tierra del Fuego is herein described.

Keywords Natural Heritage · Quantitative Evaluation · Geotourism · Landscape

8.1 Introduction

Landscape is part of our natural heritage. In ethical terms, it should be considered as much appropriate to save a species from extinction, or an eco-community from its degradation, as to preserve a certain type of landscape or landform, which may possess scenic values, from its destruction, its environmental pollution or its blockage from society access to it.

An almost infinite landscape variety exists, as a result of land modeling by a variety of endogenous agents (such as tectonics, volcanism, or the occurrence of lithological types of different behavior toward erosion) and exogenous processes (physical, chemical, and biological weathering, fluvial, marine, glacial, aeolian,

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cryogenic, and mass movement). The cited processes may act separately or simultaneously.

Quantitative evaluation of landscape esthetic values has been performed since many decades ago, and the classical papers by Linton (1968), Leopold (1969a, b), Coates (1971), Morisawa (1971), as well as the pioneer review by Cooke and Doornkamp (1974) should be cited. More recently, these topics have been widely developed by many authors, among whom Halstead (1984), Kent (1993), Willis and Garrod (1993), and Ellingston et al. (2010) must be quoted.

8.2 Geosites, Geoparks, and Geotourism

Migón (2015) pointed that "Geotourism" is frequently considered as a synonym of "geological tourism," thus implying a primary interest on those aspects typically associated with the Earth Sciences, such as rocks, minerals, paleontological findings, and primary matters and their exploitation. However, the occurrence of spectacular geomorphological landforms and landscapes has a significant influence upon the people decision about where they want to go and what they want to see. Thus, the geomorphological sites are naturally placed within the core of "Geotourism", which allows the construction of a plurality of initiatives.

According to Migón (2015), the meaning and the concept of Geotourism may be approached from two different perspectives. Firstly, and following the general explanation by Hose (2012), the focus may be found in the circumstances permitting the tourists to enhance their experiences beyond the simplest level of esthetic appreciation. Thus, the interpretation of scientific facts becomes essential and the interest sites need to be adequately explained. Secondly, it should be emphasized that a "geotourist" is somebody who is primarily motivated by the observation of the Earth's natural heritage and/or the physical exposure of the geological and geomorphological acting processes. These two viewpoints may suggest that better information may be of interest to the tourists, even though they may not fully understand at first hand the acting processes that modify the surface of the planet. However, the motivated geotourists will expect precise and more adequate information about the geology and geomorphology of the site. Nevertheless, this condition implies also the explanation offered is better adjusted to the needs and expectations of these groups of tourists, which may not be necessarily identical. It may also be suggested that it is more promising to focus on more specialized subjects such as the history of the rocks or the tectonic structures, using a physical landscape easy to understand as a starting point, and not the other way around. Thus, the explanations for the tourists may dodge the regular academic order of a presentation in geoscientific terms, which would be from geotectonic characteristics and early geological periods until reaching the present-day landscapes.

In a geomorphological context, Migón (2015) stated that the challenge is to move the static representation of landforms toward their evolution in time, with the

superposition of landform generations, of varied origin and age. The phrase "History behind the scene" is particularly appropriate. There may be different manners of telling this history, from printed materials with good illustrations to interpretation centers, information panels, virtual guiding, special talks, and guided tours. According that the geomorphological landscapes vary in nature and age, there is not a precise formula to tell a successful history. The goal may be easier to achieve in spectacular mountain scenarios or along high-cliff coasts, where the clear expression of the landforms and their spatial patterns allow it and favor it. It is much more difficult to share this message in lowland landscapes or when there are covered by forest or grassland, although they may be record a fascinating geomorphological history, such as volcanism, glaciations, or sea level changes. Finally, telling the history of landscape evolution may need to find appropriate locations for large scale, direct observation ("viewpoints") that should dominate the surrounding territory, so as to permit the understanding of the problem. Thus, besides the typical "geosites"focused on individual objects, good observation locations with regional vision must be identified, developed, and managed.

All landscapes, with no exclusion, even those of maximum geomorphological homogeneity and/or scarce relative relief (Halstead 1984; Beasley et al. 1986; Ready et al. 1997; Rosenberg and Loomis 1999) present particular scenic values and what really matters is that their social appreciation is what determines such values. The existence of values implies the need of defining their nature and to establish their magnitude in quantitative ways. In many cases, explicit numerical or hierarchical expressions may collaborate, have influence or limit the decision-makers in responsible authorities, establish priorities and determine strategies for landscape preservation.

8.3 Landscape as a Touristic Resource

The basic problem for the analysis of landscape as a touristic resource is who is in charge of establishing exactly what a scenic value is, and which methodology is used to do it so. The Geography of Tourism cannot be today discriminated from Economic Geography and the Geography of Natural Resources (Clark et al. 2000; Baumol and Blinder 2003). In economic terms, things value for what people is willing to pay for them. The value of scenic resources may be estimated only based on their demand. The risk that may occur when using an analysis exclusively oriented by geomorphological criteria is that the researcher settles a framework of what is actually valuable and what is not, based uniquely in his/her criteria or personal experiences. For instance, the Perito Moreno Glacier (Glaciers National Park, Province of Santa Cruz, Argentina) has an immense scenic value, which justifies that people is willing to pay much to be able to visit it. But it may happen that the situation could be the opposite, that because there are enough people willing to pay large amounts to get to the glacier, this is the actual cause that it effectively has a great scenic value. Cultural circumstances may be forcing this

situation. What can be observed is that undoubtedly tourists are eager to pay large sums to reach this glacier, because it is a site of very high "**exceptionality"** or "**uniqueness**" ($E_{xc,}$ U; Leopold 1969a, b). This parameter indicates, in this case, that there are not many glaciers in the world, at middle latitudes, and therefore, moderate climates, which occurs with such spectacular and accessibility conditions, that it is needed to walking down to the glacier, instead of climbing the mountain to it. That is, the Perito Moreno Glacier is a site with very few substitutes in the entire planet. This concept of "value" is not necessarily the same as that used by economists, but both concepts would most likely show high statistical correlation. Simply, it must be established which the people preferences are in terms of landscape and which the motivations for their elections are.

8.4 Quantitative Evaluation Techniques of Landscape Scenic Values

Several quantitative techniques for the evaluation of landscape scenic values exist. In this paper, a summary of these techniques will be presented. Moreover, criteria will be discussed for (a) individual site evaluation, (b) evaluation of scenic variables in surficial terms, with a regional vision, and (c) evaluation based upon the landscape perception by potential users of the scenic resources.

8.4.1 The Leopold Method: Individual Site Evaluation

Leopold (1969a, b) developed a very interesting technique based on site evaluation, to be able to quantitatively represent esthetic and scenic features of a certain site, and to objectively compare them with other alternative localities for a specific purpose. The basic principle in Leopold works is based upon the following hypotheses:

(a) the existence of unmodified, natural landscapes provide benefits to society;
(b) a unique or rare landscape has a greater value for society than another one, more common and frequent, and
(c) the unique qualities that enlarge the value of a landscape are those that exhibit conditions of esthetic, scenic, or social values.

Three types of factors were selected to represent the esthetic qualities of a certain site: physical, biological, and of human interest. Leopold (1969a) sustained his analysis on 46 selected factors in their descriptive categories. Such number of factors is neither absolutely necessary, nor exhaustive, and it can be reduced, expanded or modified, according to the personal criteria of the investigator.

The value of each of these factors may be determined in an appropriate numerical scale, for instance, from 1 to 5, where the higher values represent the most favorable conditions from a scenic point of view. In some factors, categories may be established by means of precise measurements, whereas in others, only qualitative appreciations are valid. It must be taken into consideration that the factors proposed by Leopold (1969a) do not necessarily include all those relevant to human perception, and of course, such perception varies with social, cultural, and economic circumstances. The other problem present is that the treatment of the factors may be not identical and thus, it implies a strong personal component from the observer point of view.

8.4.2 The Concept of Uniqueness of a Scenic Resource

A very important concept proposed by Leopold (1969a, b) is "the uniqueness ratio" (Ur) of a site, which is proposed as the reciprocal of a certain number of sites which share a particular evaluation number of a certain specific factor. Let us assume, as an example, that the following problem is being analyzed: a list of 20 different cities in Patagonia is considered in terms of the presence of glaciers and their accessibility in locations close to town. The researcher is willing to know which of them have such attribute and in which magnitude, for instance, because a certain public investment is needed for a chairlift for touristic purposes and the available funds are enough for only one city. Ushuaia, Tierra del Fuego, the southernmost city in the world, has a cirque glacier (the Martial Glacier) located in a position very close to downtown, and tourists may even walk to the glacier and return to their hotels in daytime, without major physical effort, or special equipment or transportation means. Thus, Ushuaia is assigned, in this case, a value of maximum hierarchy, that is, 5. There are no other Patagonian cities with such exceptional characteristics. For instance, San Carlos de Bariloche (province of Río Negro), Villa La Angostura (province of Neuquén), El Bolsón (province of Río Negro), Esquel (province of Chubut) and El Calafate (province of Santa Cruz) have glaciers in short distance, but in all cases it is necessary transportation services to get to them. The value assigned to these cities would be, for example, or a lower hierarchy, perhaps 3 or 4 in the chosen scale, depending upon the case. Contrarily, Comodoro Rivadavia, Trelew, Puerto Madryn (the three of them in the province of Chubut), Río Gallegos (province of Santa Cruz) and other 10 Patagonian cities included in this list are located hundreds of kilometers away from glaciers, thus making the accessibility of the tourists to these glaciers is almost impossible from these destinations, unless several days and large amounts of money are spent in transportation. These localities receive in our example a minimum hierarchy value, that is, = 1.

Applying the definition of "uniqueness ratio" (Ur; see above) to the city of Ushuaia, since this locality is the only one with the highest hierarchy value, the following equation is obtained:

Ur = 1/1 = 1 (maximum value)

Ushuaia, then, has a very high value for this factor (as stated above) and certainly it will be a locality preferred by those tourists that are willing to have such experience, that is, a simple access to a glacier, in a very short time, with additional cost close to zero.

The cities of the second group have a value of Ur = 1/5 = 0.2, whereas those of the third group are assigned a value Ur = 1/14 = 0.07. This last value is of course very low and it is then possible to objectively quantify that the cities of this list will have a very poor interest to those people who may be interested in visual perception of glaciers.

These criteria may be applied to great number of variables of touristic and/or environmental interest, particularly those related to natural heritage.

The Uniqueness Ratio may be presented also as the result of dividing the total number of localities (N), which are being analyzed and the number of times (n) that a certain physiographic characteristic occurs in the group of studied localities.

Thus:

Ur = N/n,

where N is the total number of sites or localities under study, that is, the analyzed universe, and n is the number of localities that actually display the selected attribute.

If the ratio Ur tends to 1, the attribute that is under revision will have a very low relative value, because in this case, there would be many localities sharing such attribute. Nobody is willing to pay greater amounts in transportation and residence expenses to go to a site where the selected feature is not accessible.

However, if the ratio Ur is a large number or, moreover, tends to infinite if the chosen universe is too big, this indicates that the selected feature is unique, or almost unique, depicting very few localities which share this feature in the given universe, that is, the analyzed region.

Although Ur is, by definition, a parameter focused on one single attribute, Leopold (1969a, b) suggested that it can be used as a parameter based upon multiple factors, thus obtaining average values for the physical, biological, and social interest factors, adding at a time all these three magnitudes and obtaining accordingly a summation of the Ur values of a certain number of sites in a given region. Thus, Leopold applied a complex parameter, which could be named as "Integrated multiple Uniqueness Ratio" (Urim), taking into consideration several attributes of physical characteristics at a time. This new index represents several components in a wider manner, but its nature carries the implicit problem of relative assessment of the cited attributes. It is obvious that not all considered factors have the same relative value according to social perception, and that it is neither acceptable that physical, biological, and social interest factors might be added in a direct or equivalent manner.

Nevertheless, when applied within limited criteria, this concept allows the determination if a certain locality has various, multiple scenic values, of diverse nature, which when added may provide a scenic value which is greater than any other locality studied, that could perhaps present only a unique scenic value, whereas the rest of the attributes may be too common in the studied region.

The other problem that appears in this case is that this methodology has been applied to sites, specific places within a larger landscape. However, it is not easy to assume that it may be used in more extended areas or in regional overviews.

Leopold methodology is attractive because it is based in parameters of easy identification and measurement and provides clear, understandable, quantitative and semi-quantitative results. It is also very important that the technique may be applied to any aspect of the landscape or the environment that the researcher may consider pertinent and useful.

8.4.3 The Linton Method: The Regional Overview

Linton (1968) proposed a methodology for the evaluation of the scenic resources of the landscape, based upon areal differentiation, which implied a regional vision, unlike the Leopold method, which is based upon the study of sites. The Lindon method is founded on:

(a) scenic elements that expose their influence to the spectator reactions;
(b) spatial variations of such elements which may be represented in maps, and
(c) various categories that may be exposed in a value hierarchy.

The method gives special attention to the landscape landforms and its use by humans.

One of the most important aspects of this proposal is the use of quantitative parameters and thus, of objective nature, being the most relevant the local relief (the difference of maximum and minimum elevations in a chosen cartographic grid). This is a parameter of very easy acquirement using the Digital Elevation Models (DEM) which were not available in times of the original Linton paper. In addition to local relief, and always using cartographic grids, the DEMs allow the acquisition of slope values, absolute relative elevation (elevation difference between contiguous quadrangles, slope orientation, presence of stream channels of varied magnitude, deepening of the valleys and hypsometric distribution of the landscape. For each one of these parameters, hierarchical values can be ascribed according to the criteria and judgment of the researcher, which necessarily implies some degree of subjectivity. These values being established, rating of the studied scenic values can be calculated and mapped.

Linton method has strong connections with the methodology of geomorphological mapping and the diverse techniques of Quantitative Geomorphology.

8.4.4 *Method of Personal Responses to the Natural Scenery: The Use of Polls and Surveys*

Although it is reasonable to consider that the determination of scenic values of the landscape may be in itself an objective of scientific nature, it is obvious that the utility of this methodology is directly related to its application to tourism industry. Thus, the reaction of the tourists when facing a certain landscape attribute is fundamental to establish its value in economic terms.

In this context, landscape itself or its specific history loose terrain in the objectives of the valuation process. What counts is the perception of the landscape user, which depends upon not only of the landscape nature, but mostly on the psychology, education, culture, economic position and sensorial and personal experiences of the consulted observer. Thus, the response of the actual tourist to the real landscape or the potential tourist to an image representation of it is necessarily quite complex and the result of a large number of variables. However, this methodology implies that different groups of consulted people will reply to these scenic stimulations in different manners.

This methodology is based upon the consultation to tourists, either real or potential by means of polls or surveys, which may be very different, depending upon the researcher decisions and his/her experiences and specific interests. The shape and contents of polls and surveys will not be considered in this paper, since they belong mostly to the field of sociology and not to geomorphology. A regular format in this kind of studies is the exhibition of series of photographs of the investigated landscapes to groups of potential social users, which may have similar or different characteristics. The responses of those who have been interviewed are based upon individual perception and the assignment of scenic values according to pre-prepared scales, following the researcher criteria.

It is clear that this methodology has the enormous advantage of the incorporation of the social appreciation of the landscape. However, the subjectivity that implies the selection of criteria and the images chosen by the researcher cannot be ignored.

8.5 A Case Study: "a Survey of Touristic Resources from the Point of View of Ecotourism in Tierra Del Fuego, Argentina"

María Laura Borla (1995) completed the inventory of touristic resources along the road system of Argentine Tierra del Fuego from the ecotourism point of view. Her analysis, as well as the results obtained in the polls to tourists, allowed the establishment of a hierarchy for these resources. Specific tools were designed, the ecotouristic resources were classified, including the landscape, and methodologies for their study, classification, and rating were defined. Borla (1995) presented a theoretical framework that sustains her work and the information was offered in

specific files designed with this purpose, preparing maps, sketches, and sections, including appropriate photographs for the topics in discussion. The surveying of ecotouristic resources was performed considering the natural landscape as the most important ecotouristic resource and dividing it into three component classes: abiotic, biotic and anthropic resources. This work did not include the urban landscape, since it was not taken into consideration in the original objectives.

The study area was divided in 48 sectors, which were included into a hierarchy by means of quantitative indicators. From the obtained values, 14 landscape units were defined and 3 categories of sectors were determined, concerning the development of ecotouristic activities: (1) sectors with optimal conditions; (2) sectors with poorly favorable conditions, and (3) sectors with unfavorable conditions. The sectors with optimal conditions are those that have already established regulations for its use, as theTierra del Fuego National Parkand the Harberton Estancia (= ranch). The work of Borla (1995) determined the need to extend the protection and management conditions of other areas to those under study, so as to prevent the touristic surcharge and preclude its degradation. Borla (1995) concluded that the alignments defining these parameters should be focused taking into account the spatial limitations of the resource and the scenic preferences of the ecotouristic demand.

8.6 Conclusions

The analysis of the available information presented in this paper shows that quantitative evaluation (and even, perhaps, the semi-quantitative one) of the landscape and the determination of its scenic values should be considered as a fundamental tool in the technical assistance of those people who are responsible for decision making which may be related to the protection of natural heritage, and particularly, the scenic values of the landscape. None of the herein presented techniques may cover by itself the ample universe of possible circumstances, but an adequate combination of some or most of them may facilitate the assignment of political and/or economic priorities to the preservation and development of scenic resources of the landscape. An objective and reliable evaluation of these resources would not be achievable if the specific studies do not contemplate in their design the characteristics of the site, the regional scope and the human perception of the landscape.

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