A METHODOLOGY FOR INTEGRATION OF RURAL BUILDINGS IN THE LANDSCAPE: LOCALIZATION STUDY BY GEOGRAPHIC INFORMATION SYSTEMS

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Abstract

Geographic Information Systems provide an excellent tool for modeling the landscape and for its three-dimensional analysis.
This research used the system made up of ArcInfo and ArcView G.I.S. Used together they allow an easy digitalization of geographic information, its storage in coverages, its analysis and its clear representation.
In order to map out the landscape in 3D the network TIN (Triangulated Irregular Network) and the Digital Terrain Model (DTM) were calculated. Using these, a shed having a rectangular ground-plan measuring 10 m by 20 m and a total height of 8 m was subjected to a visibility study. This building was placed in different positions within the given territory. In each case the extension of the different layers of existent vegetation within building area was studied, particularly the woodland formed by white Poplars (*Populus alba*) along the edges of roads, rivers and streams.
The results obtained show how the amount of visible building varies according to where it has been positioned. Each position for the spatial location of the building was chosen according to its possible scenic composition on the perception of the landscape.
These are not only graphic results but also, when stored in the G.I.S., form a database that allows their statistical study and analysis in order to establish the relationship between the visibility area and the scenic composition. This relationship provides the basis for the analysis of the spatial location of the buildings in accordance to the level of its visual perception. This way, it can be constructed a useful tool for planners and designers when they are choosing optimum locations for rural buildings so that they improve their landscape integration.[1]

Keywords:Visual impact, G.I.S., D.E.M., visual elements

1. Introduction

In this work the landscape has been treated as the space that surrounds the observer or, to be more precise, the visual surroundings from the lookout point. A perceived scene comprises natural elements and anthropic interventions, of which buildings are the most important. The perceived scene is studied not only as a whole but as the relations between its components. The individual components can never be regarded as a landscape; a tree or a hillside does not form a landscape, which is the overall composition. Moreover, the application of the term to a reproduced image (in this case a photograph) demonstrates the ambivalence of a word that covers both a three-dimensional reality as well as a two-dimensional representation of it. This

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substitution process contains a solid psychological mechanism of assimilation of perceptual schemes, so that the observer can perceive as different landscapes the various views of the same scene when observed from different angles. In this mechanism the compositive concept acquires great importance because the composition obtained for each view is the result of the observer's position within the scene.
Buildings always entail the suppression of surfaces in their natural state and, at times, the introduction of extraneous elements in their place. This incorporation of "singular elements" requires planning in the execution and the study of building design criteria for their integration within the landscape. Consequently, an adequate study that anticipates environmental problems and avoids incompatibility between conservation and development is necessary.

2. Space as a Visual Element

Space, as a visual component of a scene, is defined as the three-dimensional layout of objects and areas of landscape that form the scenic composition, arranged by the relation between its components. Three characteristics of space will be studied: scenic composition, scenic background and sitting of units. The purpose of studying this element is to analyze the criteria that affect the choice of location of a specific project. A project's ubication has a considerable influence on its perception, meaning that it is possible to make it a greater or lesser center of attention within the scene.
In studies for the integration of projects within the environment, landscape visual analysis makes it possible to evaluate, with greater understanding, some of the essential effects that coincide on the medium. In addition, if the aim is to design the surroundings to be inhabited or contemplated, the spatial quality of the place is a crucial factor that needs to be maintained and taken care of.
The size of a building, its orientation and covering materials are elements that give it a precise definition, at the same time affording it an option of use and value. It is at this stage when a technical design option is converted into an aesthetic option and a creative hypothesis. The visibility study has been based on different theories and has been of interest to designers right from the beginning, insofar as it signifies a method of approximation to social determinations and their proposals, from Märtens and R. Arnheim to K. Lynch. As far as we are concerned, reference is made to a working hypothesis (Higouchi, 1983), based on the translation of the physical conditions of an area into permanent parameters that make up the image of the surroundings.
The principal assumption is that the value of the landscape constitutes a tangible asset, when treated as the application of human action on a natural support. This support varies physically from place to place, depending on the form or volume of the site, which give specific visual conditions to each place. Moreover, human action stamps a character on the setting which is visible in the elements that are built on it.
On the basis of this working hypothesis, in a first approach, space is recognized as an entity that is volumetrically defined by its relief, the preliminary condition on which all transformations will act, thus modifying its structure (Seguí, 1996). The separation of the formal components of a place into two groups, on the one hand those that refer to relief and on the other those that are related to the morphological description of the elements, allows the changing and permanent nature of the landscape to be studied. To do this, we have the relief, as the setting or starting point for all subsequent interventions which will modify its visual characteristics and general order, acting as a support for the intervention itself to which it will contribute visual resources, and then we have the morphological reading of the elements that form the scene, which allows a survey of the whole scenario to be made.

Thus the essential quality of the landscape is identified as something that is structural in form, where its relief and human intervention have their own character. The first acts as a support for the second, but the reading via visual perception does not make this differentiation, instead converting everything into a global setting or scenario.
Human activity when applied to the initial relief either highlights or contradicts features and geometry or repeatedly introduces an element to pinpoint a route; these are ways of appropriating a place and converting it into a human and consequently controlled place.
The study of these concepts as support and enclosure contributes basic arguments for the theories of intervention and is consequently an important foundation for the criteria that endeavor to safeguard the quality of landscapes.
In this element a study is made of the scenic composition of the visual enclosure, highlighting the location of the units that are contained inside it. But this is one plane of the morphological reading that has to be complemented with another that describes the relief as the base and architecture that frames and completes man's action.

3. Scenic Composition

Normally, the visualization of a building arises after a movement which draws the observer towards it. The three-dimensional layout of the objects making up the landscape is the key for defining this sequential perception of the construction. A gradual opening up of the view is always pleasanter to perception than a long and monotonous approach since, whilst interest in discovering or finding out something is maintained, attention continues to be active.
Some authors define indices for studying and analyzing this aspect that allow the visual structure of the space to be read on a topographical map. For example, Tadahiko Higuchi (1983) establishes six indices for this reading: the effect of distance, the angle of incidence, depth and invisibility, angle of depression, angle of elevation and depth of field. These indices allow the conditions for a visibility reading inside each limit and the relations between the various viewpoints to be studied. Moreover, they are a justification for the fact that the formation of visual images rests on elements that are objectively interpreted and help to establish the impact of an intervention. The study of topographical data provides information on the indices of a viewpoint pertaining to the watershed. Very generally, it can be said that when entering a landscape, one or other of the following options is discovered:

- There is no limit and the landscape stretches as far as the horizon.
- A series of planes acts as a limit in the middle distance, forming the immediate surroundings.
- These planes, forming the visual limit, are located between the middle distance and the horizon.

Also, depending on the layout of the relief planes in the intermediate distance, one or other of the following cases can be perceived:

- From a small obstruction in the space that surrounds us, allowing the definition of a landscape unit that is closed within an enclosure, such as in very steep valleys, or only partially closed such as in high plains where there are shadows of visibility.
- A spatially well-defined unit, like an enclosure, which is what most of the valleys and river banks known to us are, when there are no degrees of intermediate obstructions and all implantations are seen in the foreground.
- A completely open landscape unit, when we find ourselves on a plain, in the strict sense of the word, or on a point that sticks out above a plain, when there is no visual interference as far as the horizon and where any small element puts other elements that are behind it in the shade.

In other words, for each setting, landscape units can be classified that respond to spaces with a certain degree of interior complexity, each with its own characteristics, which summarize the conditions of interior and exterior visibility proposed by each elevation and depression. In addition, it must be taken into account that the perception of the project shall be executed by means of an approximation in which two concepts can be studied: one which is the process of information sampling within the scenario and the other that of visual exposure. The first is covered in the scenic composition and the second in the sitting of the units.
Each scene can be classified in such a way that the properties it offers to view are summarized. That is, the set of attributes that influence and shape the capacity to awaken the observer's attention. Thus the characteristic of the scene's composition shall define, according to certain values, the form of perception of the approximation to the project.

4. Integration of natural and social sciences

The location study of new rural buildings can be divided into two processes with different purposes:

- A complete planning analysis based on G.I.S. with the aim of determining optimal locations according to the planning criteria of the area. The first phase is the study of the territorial system. The aim of this is to make an initial selection of the possible sites where building is possible. In the analysis and diagnostic sequences necessary for processing the planning directives of a territory, the study area can be characterized by its physical-natural, socioeconomic, human establishment and institutional-legal subsystems (Gómez Orea, 1994).

- The evaluation of a building's spatial location by G.I.S. from the point of view of landscape integration. Spatial location is one of several landscape elements. The purpose of this process is to evaluate the impact a construction will have on the landscape, and to select the points where this impact will be least. This is the methodology proposed in the paper.

These two methodological procedures are successive. Optimal locations can then be determined from among those selected (according to planning criteria) from the point of view of visual impact.

5. Calculation of Scenic Composition by means of Geographic Information Systems

5.1. Visual calculation using the Territory Spatial Model.

The scenic composition of the location of a building on a given landscape can be calculated by means of a spatial analysis of the visual relationships. These relationships are calculated by means of the vision lines, outlined by the computer, from every single cell that constitutes the Digital Terrain Model (DTM) and from each of the vertices which are defined as being representative of the building.
The vision line is outlined by the computer by pressing the ArcInfo command VISIBILITY.

5.2. Building Spatial Modeling

For the three-dimensional analysis of spatial visibility it is necessary to create a 3D model of the building which is going to be studied. To do this, a three-dimensional vector field is created which hold the most significant parts of the building in their spatial position.
These key points are obtained by a process of disintegrating the building into basic masses defined by their vertices. Up to a maximum of 16 key points can be defined. In the event of the design being too complex to allow such a disintegration, it is defined by means of

individual points. These points are created by using the ArcEdit module of ArcInfo. The command CREATE is used to construct a vector field and the command CREATE FEATURE LABEL to define what will become a field of points. The z coordinate of these points is then introduced into the INFO module of ArcInfo.

5.3. Definition of the visibility area and altimetric study area

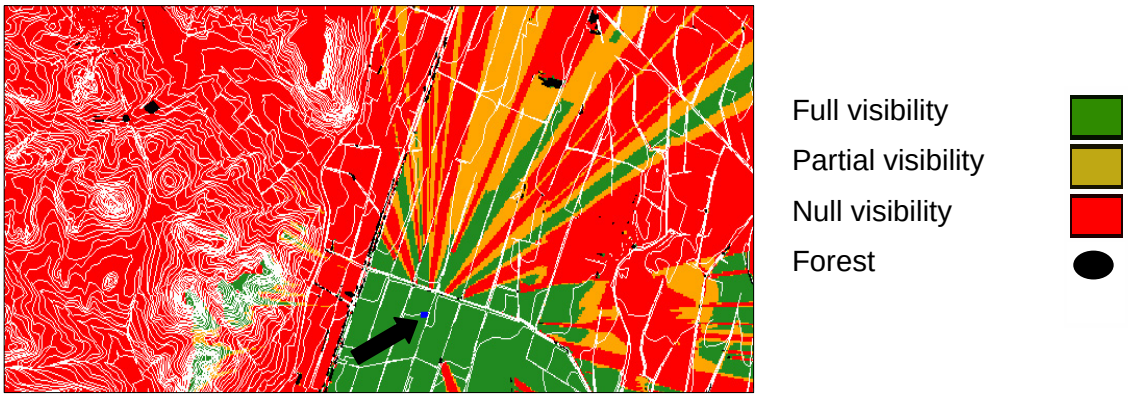
In order to obtain the scenic composition calculation one starts from the information stored in the vision file, which information is expressed in visual values (*VV*). This information is not analyzed in its totality but rather a square-shaped area of visibility is defined, in the center of which lies the possible location for a building.
The scenic composition is calculated by the computer using the visual information contained within this area. Various authors have estimated that human vision is capable of perceiving clearly for up to 3500 m. Following this opinion the diagonals of the square are 7.000 m long. This distance can vary in each investigation as it refers strictly to the conditions necessary to identify that which is observed with clarity. (Smardon, 1979, Español, 1996)
The computer defines the visibility area by creating a window for analysis in the GRID module of ArcInfo using the command SETWINDOW.
A square window, having at its center a possible site for the building, is also established. This is done in order to analyze the cells elevation degree that exist within the building. The dimensions were determined in accordance with the experimental analyses of numerous cases previously carried out.

5.4. Calculating the Scenic Composition

ArcInfo calculated the scenic composition by following the program previously stored in a procedure. This sub-routine imitates a small statistical study of the visual values that correspond to each of the cells included in the visibility area to be carried out. A similar statistical study is also made for the cells included in the elevation degree study. Following these statistical studies the computer makes a logical analysis of the results that have been obtained. These values are as follows:

1. Filtering: this is another way of gradually directing the onlooker's attention and in which it is during the movement of approximation itself that the building in its entirety is gradually revealed. This can be achieved with the presence of an open screen formed by trees that allows vision through it.

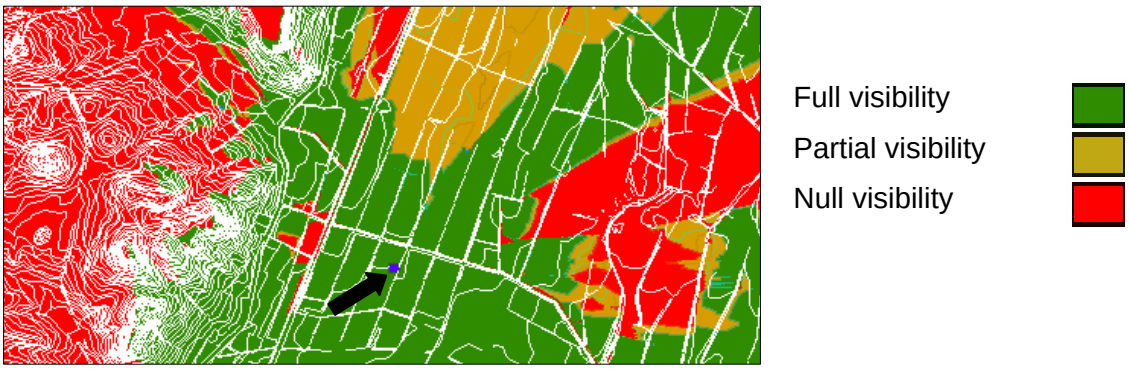
Fig. 1: Filtering scenic composition



2. Panoramic or open: there are no apparent limits on the field of vision, where horizontal elements predominate and the sky dominates the scene. In these spaces it is not possible to

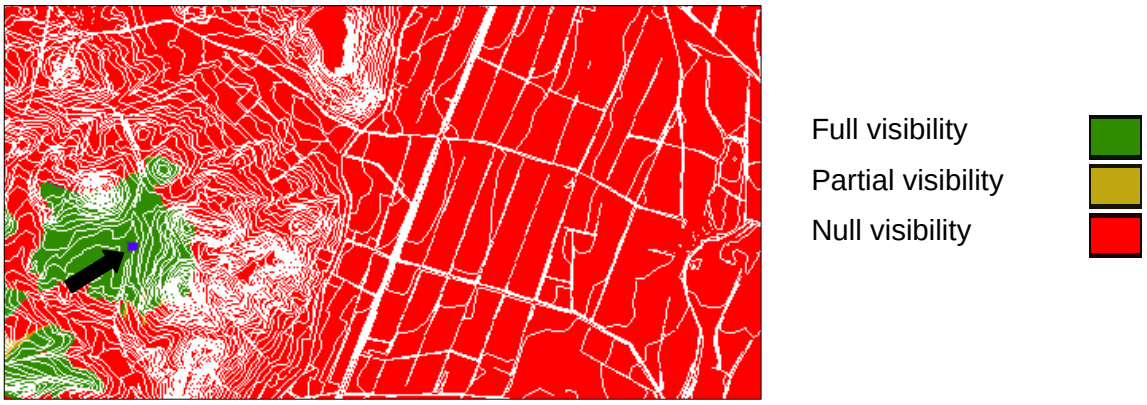
refer to a physical limit because the horizon is the limit. The building is perceived and the composite limits are not closed.

Fig. 2: Opened scenic composition



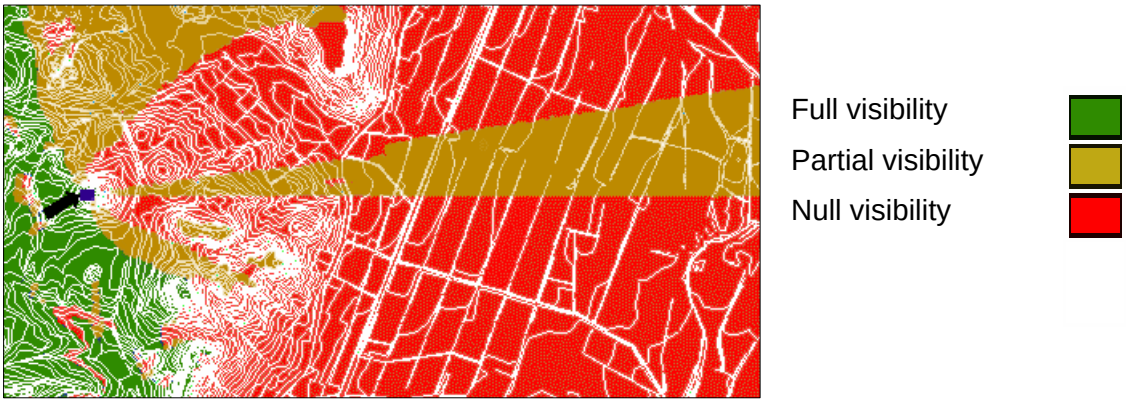
3. Closed: defined by the presence of visual barriers that establish a marked delimitation of the space. When the element under study shapes a composition of this type it is quickly perceived and moreover with well-defined spatial limits that attract attention due to the limited information provided.

Fig. 3: Closed scenic composition



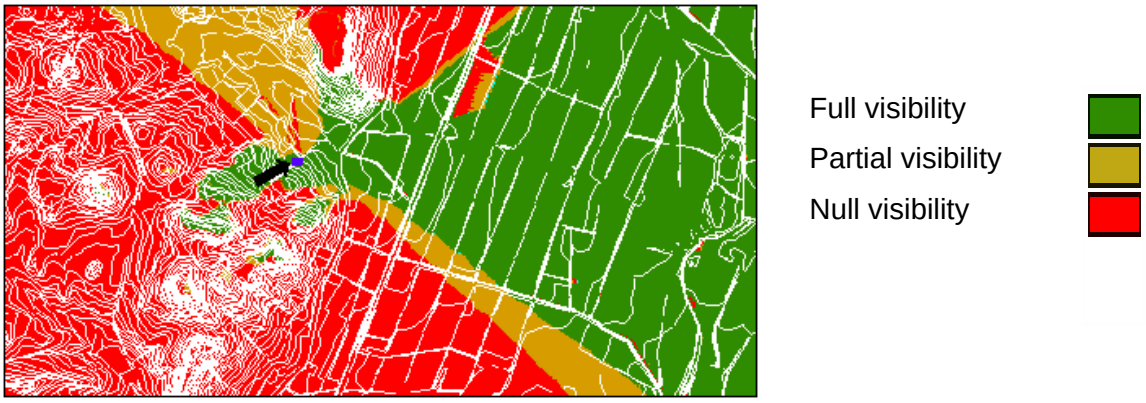
4. Singularity: dominated by a specific and differentiated element that dominates the scene (an isolated tree, etc.). This is frequently found in open compositions, in which the distinctive object becomes the dominant feature.

Fig. 4: Singularity scenic composition



5. Focussed: marked by the existence of parallel lines or lined up objects, focal spaces are created, due to a strong linearity (originated by linear infrastructures) which appear to converge towards a focal point that dominates the scene. Thus, elements of the landscape can be used to place a building in an outstanding position.

Fig. 5: Focussed scenic composition



6. Relations between scenic composition, perception and visual impact

The study made in previous sections allows calculating the scenic composition of the generated landscape, given a determined location of new building, and to define to that type belongs.

One of the previous assumptions in the present work is to consider that the interaction between the construction and the surroundings produces incompatible contrast (García, 1998) with respect to the visual integration of the same one. It is only possible to act, to mitigate those contrasts, in the spatial localization of the building. Nowadays, it is particular true in most of the projects that are being made in rural areas. They are very few that contemplates as a part of the project an evaluation of environmental impact that considers with objective and measurable parameters the visual impact.

The scenic composition is one of the characteristics of the space as visual element, in addition to the scenic background and the location of the units; and the level of visual perception of the project by the observer depends partly of it (Hernández, 2001). This perception level of the construction is in direct relation with the visual impact holed by the observer. So, if the visual perception of a construction is diminished, it is diminished the visual impact of the same one too. This will be one of the variables on which it is possible to be acted to reduce the visual impact: the scenic composition. One will look for that the scenic composition is filtered or opened, because they are those that are related to lower levels of visual perception.

7. Scenic Background and Sitting of Units

This refers to the relative topographical location of formal elements having their own identity. It is defined in relation to the altitude and characteristics of the composition. Consequently, it is a specific study of the sitting of the building, basically determined by its topographical position. Objects in more visible or strategic sites (focal centers) predominate over the others. In order to carry out the analysis of this characteristic, the scenic background is first going to be studied. The background is the “curtain” that exists behind a view. In open compositions it may be the sky; in sea-shore scenes it may be the water and in closed spaces the land itself. It is of great importance because it is a determining factor for the basic range of contrasts; it establishes the sharpness of the outlines and the continuity and amplitude of the space. An

object seen against the background of sky or water generally stands out far more than when seen against land, hence the importance of the interruption in the line of the horizon. The values it can adopt are:

1. Sky: It represents an interruption in the line of the horizon. The visual impact of a building varies enormously depending on its position in relation to the line of the horizon. Buildings that break the line of the horizon are seen from many different angles and also from a great distance. This is a way of highlighting a building but it can also break one of the most important lines that defines the landscape. This can result in incompatible contrasts in a composition.
2. Land and vegetation: When the land itself is used as the scenic background various alternatives are possible depending on the building's location:

8. Calculation of scenic background

For the calculation of the scenic background, the concept of visual line will be applied. The visual lines will draw up from ARCPLOT module of ARC/INFO. This allows calculating an objective point located to enough observed range, and who belongs to the visual straight line that leaves the eyes of the observer and happens through the construction. The program implemented in G.I.S. will allow to know if that objective point is visible from the observer, that is, if the background of the vision line who has calculated is earth (the objective point would not be visible by the observer) or sky (the objective point would be visible by the observer).

The scenic background depends, among other variables, the situation of each observer. It is associate with the relative position of the observed building. Therefore, for the determination of the scenic background like characteristic of the visual element space, is necessary to generate multiple visual lines from the points where a greater number of observers concur. These points are in the highways, roads and buildings.

One of the ARC/INFO commands is used to turn the linear covers corresponding to the highways and the buildings, in covers of points. And from those points, by means of the programming contained in FONDO.AML routine, they draw up multiple visual lines to the elevated place more of the building (building point). Once drawn up the lines of vision and calculated its scenic background, it will be obtained the number of times that the scenic background is earth and the number of times that the scenic background is sky. The highest value will be considered the scenic background of this building in the landscape.

9. Relation between scenic background and visual impact.

As the scenic composition, the scenic background constitutes a composite characteristic of the visual element space. In this methodological proposal, to simplify the calculation, it has only considered two possible scenic backgrounds: sky and earth.

When sky is the scenic background of the building, it breaks the line of horizon and the forms and lines of the same one are perceived with greater force by the observer (García, 1998). In this case, and with the assumption that the visual integration of modern constructions is negative and produces incompatible contrast, the scenic background sky originates high values of visual impact. This consideration is only possible knowing the previous hypothesis: the visual integration of most rural buildings originates incompatible contrast in the landscape. However, the buildings with scenic background earth do not break the line of the horizon, and their shapes and lines are cushioned by the own surrounding landscape. In this case, the perception is littler and the produced visual impact is lower.

Conclusions

Once analyzed the results obtained in the planning stage, one of the main reached conclusions turns out to be the establishment that the new rural buildings must be located preferably in the neighborhoods of transport ways (freeways, highways and roads); in the periphery of the urban nuclei; and in the proximity of other already existing buildings. It will be done in areas of low visibility with respect to the observation points of the landscape.

In relation to the obtained results of the study of visual impact, the new rural buildings must be located preferably in zones of little rough topography, in the points of smaller altitude. In places always opened, not limited, where the building is not a point of preferred attention from the observation points of the landscape.

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