PEOPLE: International Journal of Social Sciences
ISSN 2454-5899

Pandolfi et al., 2017

Volume 3 Issue 1, pp. 629 - 643

Date of Publication: 23rd March, 2017

DOI-https://dx.doi.org/10.20319/pijss.2017.s31.629643

This paper can be cited as: Pandolfi, A., Campi, P., & Terlizzi, L. (2017). GIS and Landscape Analysis. PEOPLE: International Journal of Social Sciences, 3(1), 629-643.

GIS AND LANDSCAPE ANALYSIS

Alessandra Pandolfi
Department of Architecture and urban research, Politecnico di Milano, Italy
alessandramaria.pandolfi@polimi.it

Paola Campi
Department of Architecture and urban research, Politecnico di Milano, Italy
paola.campi@mail.polimi.it

Luca Terlizzi
Department of Architecture and urban research, Politecnico di Milano, Italy
luca.terlizzi@mail.polimi.it

Abstract

Landscape is "an area, as perceived by people, whose character is the result of the action and interaction of natural and/or human factors" (Council of Europe, European Landscape Convention, 2000). The changing conditions of this complex factor, that determines the variability of our local and national contexts in Europe, can be effectively measured thanks to quantitative and qualitative indicators. These values could be calculated through procedures implemented thanks to Geographical information systems (GIS), using elements of geostatistics and numeric cartography. The speculative basics of the need of using GIS for the landscape analysis is strongly connected to the necessity of finding a steadier definition of its variability in time and space, mainly in a context like the European Union, that is in constant demand for procedures that could be standardized as best practices.

Keywords
Geographical Information Systems, Quantitative and Qualitative Analysis, Landscape Analysis

1. Landscape as concept

The modern form of the word "*landscape*", with its connotations of scenery, emerged in the late sixteenth century, when the term "*landschap*" was introduced by Dutch painters, who used it to refer to paintings of inland natural or rural sceneries. The word "landscape", first recorded in 1598, was borrowed, then, from a term used in a completely different context from now. The actual definition of landscape, instead, has been recently recognized by the Council of Europe (European Landscape Convention, 2000). The official recognition makes it a more stable factor to be determined and calculated through quantitative and qualitative analysis techniques. Nonetheless, the dimension of perception can still be a problematic element to be defined and delineated. It is, then, a concept that can be strongly related to the livelihood of our environment (see, on this topic, Hormaila, 2015).

We must say that the theory of the 3 worlds of Karl Popper (1978) can significantly help the evaluator in determining which are the dimensions to be analyzed in a local context, considering the Geographical information systems (GIS) functionalities. This is to be considered, as «Geospatial data or geographically referenced data describe both the locations and characteristics of spatial features» (Chang, 2010, in Azlizan et al., 2016). The chance of using procedures that could be standardized through GIS tools is particularly relevant in the European Union, that is in constant demand for the definition of best practices (Boskovic, 2015).

If we consider a local context, we may acknowledge that it is divided into 3 main domains, that interact the one to each other: the world of bodies (world 1), the perception of subjects (world 2), and the overlapping of all the products of the human mind (world 3). The first world is represented, then, by the spatial distribution of the variable quality of physical objects, which is the effect of the actions carried out by external factors (including, the ones related to world 3). This is the part of a context that could be quantitatively and qualitatively measured in a comparative way, considering the ever-changing conditions of the physical world: this is the reason why many experts relate it to the concept of environment. The trend and the intensity of these actions depends on the different kinds of contexts, making each subsequent configuration influenced by the interactions with the consequences produced by world 3, which is the result of the political, legislative, socio-demographic, cultural-technological, and economic systems.

The world 2, instead, is related to the perception that the observer has of the physical objects: each context is, then, perceived in a different way from every possible different subject. This world is connected to the mental process (or subjective conscious experience) that determine the behavior development and the subjective assessment construction. This is related to the physical, cultural and social visions of the bodies that together outline the world: it is easily identifiable, nowadays, with the concept of "landscape". Each subject builds, individually or collectively, a specific reality, through the direct, active and selective exploration of a given physical context. This process tends, then, to decode the physical reality, determining, besides, the definition of specialized contexts. These settings are related to the different visual interrelations established by each observer with every element or process that belongs to the concept of landscape. This is known as the active interpretations of coded inputs (Popper, 1963). The word 2, then, depends not only on the type of landscape and on the person who observes it, but it is also the result of many contingent components. In most cases, the observing actors do not even need it to be completely defined.

1.1 The concept of landscape in the "European Landscape Convention"

In the light of the general and specific measure (art. 5-6) provided by the "European Landscape Convention" (Council of Europe, 2000), it is crucial to implement new tools for the identification and assessment of the world 2, that Popper identified so clearly. This is even more important in the light of the fact that the European Union always demands for specific best practices to be implemented in all the relevant fields (Boskovic, 2015). The process of identification and assessment is still far to be closed, as it is lacking a common methodology, that the Convention itself was trying to spread. The Convention, that is built on one of the most important principles of the EU, that is the identity preservation, was urging the involved parties (Council of Europe, "European Landscape Convention", 2000):

- to identify their own landscapes,
- to analyze the landscapes features and the forces and pressures transforming them,
- to take note of the changes,
- to assess the landscapes, considering the values assigned to them by the interested parties and the population concerned.

Most of these objectives and measures could be efficiently implemented through GIS procedures, involving quantitative and qualitative analysis techniques, that could lead to the complete identification of the relevant factors which the world consists of. This will take to the definition of the landscape quality objectives described in the "European Landscape Convention", after proper public consultation (Council of Europe, 2000). This will lead to put landscape policies into effect, for which all the involved parties will have to introduce specific tools aimed at protecting, managing and/or planning their landscapes.

1.2 The different perspectives of the landscape concept

The word "landscape" describes a concept that can be seen from different perspectives, taking, then, many different meanings, depending on the purpose which the term is used for. It is not only seen under an archaeological, historical and cultural approach, which is the most common outlook in Europe, and, especially, in Italy. We must say that, in Italy, there is a multifaceted and stratified legislation, that is giving to these dimensions the preeminent role in the landscape planning. It is also an ecological approach, since the "Landscape Ecology" has become a science, that focuses on landscape through its ecological definitions. It is, then, a matter of wildlife, of forestry and its use (see also Hormaila, 2015), but also of fire management, hydrological controlling, recreational approach, and so on.

Assessing the landscape means, then, working on, at least, two different scales: on one hand, it is necessary to understand its intrinsic features and the life cycles of its components. This means always considering that the concept of environment, the world 1 of Popper, with its objective dimension, should be kept apart from the idea of landscape. On the other hand, it is important to recognize its extrinsic features and the life cycles of that systems (urban, transportation, regional and so on) that could influence the ever-changing condition of the world of bodies and of its perception. In the following dissertation, we will always consider the subtle limit that stands between what the environment is, with its objective and mainly quantitative dimension, and what landscape represents, with its subjective and somehow unspecified facet.

In the perspective of the application of the GIS potential (Azlizan et al., 2016) to the landscape analysis, the availability of data is usually crucial, as the environmental dimension could be easily determined using the existing information. It is easy to refer, then, to factors, like the geographical, geomorphological, ecological, biological, forestry information. This comes from the fact that most of the modern sciences have already structured a geospatialized corpus of data, mainly available in most of the European and North-American countries (de Smith et al., 2007).

The landscape analysis, instead, still needs a significant development in the collection, structuring and sharing of information, that is now mainly divided into different documents and planning tools. This lack of a systematic availability of information is relevant in terms both of historical data, and to its spatial distribution. This significant downplay could be overcome, on one side, by reworking the great amount of existing information in a landscape-oriented view. On the other side, it could be overwhelmed by involving, in a more direct, but still effortless way, the number of possible stakeholders, using some efficient techniques, such as the stated preference methods (Mattia et al., 2000).

In this perspective, the concept of the perception of landscape is deduced from the need of measuring the value of use for environmental goods and the positive or negative externalities, which they are exposed to. The environmental economy and, above all, the regional and environmental assessment sciences will take, then, a relevant role in determining the qualitative and quantitative extent of world 2. This comes from the fact that, through their techniques, it is possible to estimate the value (and, consequently, the perception) of the assets constituting the natural resources, using the value of use in a social meaning. This will mean dealing with the impact of human actions on the environment, to provide, to the competent agencies, the base knowledge elements. Using this spatialized information base (see also Azlizan et al., 2016), they can decide whether to approve, suspend or modify a project, a plan or a program.

2. A Case Study: The Landscape Value in a Damage Scenario

The integrity of ecosystems is a concept referring to the sustainable development that measures the level of declension and deterioration of ecosystems, due to anthropic activities and their related effects (see also Paolillo et al., 2009, 2013 & 2016). This concept is at the base of some of the factors calculated to evaluate the aesthetic and cultural variables and the landscape value, that represent one of the three main elements of the environmental damage model formulated by Mattia and Miccoli (1989). The model was recently improved to settle it into the actual background, in the field of the environmental damage evaluation through a monetary approach (Mattia et al., 2012[1] & 2012[2]). To be more precise, the model focuses on:

- socio-economic activities and public health (*H*),

- aesthetic and cultural factors and landscapes (*K*),
- natural and ecological elements of ecosystems (*Y*) in terms of the consequences that a real or a potential environmental damage scenario might have on them.

The main stages of this evaluation method, with specific reference to the aesthetic and cultural factors and the landscape variables, unravel the underestimation issues that concern the available assessment systems. These methods are commonly applied in Europe, to determine the total damage amount, only considering the reparation and the punishment costing, according to the local law and jurisprudence. Different studies have already dealt with the appraisal procedures for socio-economic and natural factors, that are now commonly recognized (Mattia et al., 2013 & 2012[3]). The monetary function of the social damage is, then, to be calculated as follows (*ibidem*):

$$D^S_{\max} = \sum_{i=1}^{S} \Delta R_i \frac{q^{m_i}-1}{r_{1\times q^{m_i}}} + \sum_{j=1}^{t} \frac{K_j}{q^{nj}} + \sum_{k=1}^{p} \Delta R_k \frac{q^{v_k}-1}{r_k^{qv_k}} + \sum_{i=1}^{s} Vk_i \tag{1}$$

in which:

- D_{max} is the value of the social damage;
- R_i is the variation of the ordinary income flows that is suffered by the good *i*, underlying to the action that takes the ecosystems from the initial situation C_0 to the configuration C_1, that is not permitted by laws;
- r_i is the capitalization rate determined for the reference market for every ΔR_i;
- K_j is the reproduction cost for the damaged parts of assets that are out of market, that, though damaged, do not have an effect on income flows of market assets;
- ΔR_k are the variations of the ordinary income flows that are suffered by people damaged from the environmental transformation action;
- r_k is the capitalization rate determined for every single ΔR_k;
- m_i and v_k are the durations of every loss flow;
- Vk_i are costs values for the recovery or recomposition of the involved elements.

The esthetic and cultural damage (*K*) depends on the changes of social values that each society attaches to any given configuration of the natural or built environment that surrounds it. It depends on the fact that recovery actions to the complete recomposition of such places are impossible. The first factors to be calculated is, then, V_{c0}, or the social, aesthetic and cultural value of the configuration before the harmful action. After that, the second parameter to be determined is V_{c1}, or the situation resulting from the event. The aesthetic and cultural damage is (*ibidem*):

$$D_{\max}^{EC} = K = V_{C_0} - V_{C_1} \tag{2}$$

This model was implemented, on one side, with the introduction of the GIS analysis for the scenario definition, through the calculation of the relevant indexes. On the other side, it was updated thanks to the examination of the potential of the Contingent valuation method (CVM). The CVM is the most viable practice to assess aesthetic and cultural factors and landscape values in a holistic way (Mattia et al., 2012[4]). It is usually implemented through a population direct poll technique. Thanks to the description of a hypothetical market (built through a GIS procedure; see Paolillo et al., 2013), it will elicit the market estimation of goods, that are usually out of market, such as the integrity value of ecosystems (Mattia et al., 2010). As a matter of fact, the results of a CVM survey highlight the amount of money that the respondents are willing to pay for the repayment of the damaged scenario. It will, also, consider that the same interviewee could state different value ranks, referring to the specific initial configuration of the same areas, simply referring to different integrity levels of the damaged ecosystems.

The final amount expressed through this survey could be implemented for different practical aims, starting from the need of determining the legal fines, that an intentional criminal activity could be subject to, after being judged. This method is also interesting, as it could be developed in a systematic way, to support specific policies, strategies and decisions, that could have a significant effect on the environment. These policies should deal with the increasing integrity worsening, e.g. by deciding where an essential, but pollutant, activity should be placed. This will minimize the potential effects that it could have in terms of aesthetic, cultural and landscape values. The same method could be used to monetize that same outcomes, as it has been stated for activities involved in the CO_2 emissions trade, set by the Kyoto protocol.

3. A Proposed Catalogue for the Quantitative and Qualitative Landscape Analysis

The centrality of landscapes in the land and urban planning is reflected in the experimentation of innovative analytical techniques, designed to understand the peculiarities of the different urban and suburban contexts. The most refined analytical techniques now available can even return the status of the landscape in the most detailed way possible (Agouris et al., 2005). Using GIS packages for exploring the available spatial information, it is possible to calculate the landscape indices, which can be measured for each cell using the following procedures (Paolillo et al., 2013).

On one side, there is the presence of classes, describing different typological landscape descriptors, multiplied for the values of incidence. This indicator is calculated in terms of degrees of relevance, instability and insecurity, and distributive entropy. On the other side, there is the value of proximity (to the relevant element) of concentric zones (isotropic areas). It influences the perception of the *j-th* element, by a multiplication factor (coefficient of perception), that grows as it consequently approaches the variable. This coefficient expresses the descending character of the value in the relative field of influence (Paolillo et al., 2013). The last option is using three-dimensional spatial analysis applications, to estimate the relevance of the views of each cell through the cumulative outcome of vision simulations regarding different areas (Viewshed). This is to be conducted through the substantial elements of perception, thus calculating different degrees of visual intensity generated by the morphological and landscape interdependence with the elements that are aesthetically and visually relevant, observable from any position in the area (Casetti et al., 2016).

Concerning the measures of proximity value, the intensity of relevance in the urban context, in terms of existing historical heritage and landscape, considers the valuable factors available in any document source, such as municipal and local databases (Paolillo et al., 2013). This means, it concerns not only the preserved physical items, but also other civil, military and religious architectures, that have a particular meaning for the local identity. The matrix describing the landscape and the environment of a context is characterized by a rooting corpus of the historical memory in the area. This comes from the stability and management of economic and human activities, specifically identifiable in the rural settlements, characterized by the community modeling and the adaptation to the local features (Paolillo et al., 2016).

About the measures of heterogeneity in terms of distribution, the multiplicity and variability within defined study units is related to the identification of methods that could measure the distributive unevenness in the recalled units (Paolillo et al., 2016). It is important to inquiry the relevant geographical unit, at the analytical mesoscale, considering it is the portion of land to be distinguished in terms of complexity. It is the unit that, in an overall analysis, is able to express significant indicators, referring to the three orders of relevant geographies: the out-of-town, the suburban, and the urban level. Identifying these units means classifying a more general investigation reference area, holding the role of a spatial macro-container (Paolillo et al., 2013). On such a large, extensive and heterogeneous scale, it is impossible to promote any kind of interpretive hypothesis, nor it is reasonable to deduce any reliable analytical practice. Then, the proper classification procedure will follow, after the identification of the general investigation area, the determination of each study unit or, as by literature, the research landscape units.

In terms of heterogeneity in cells of a regular grid, the ecosystem, the basic ecological unit, is an open system, that is far from being balanced. It lives thanks to the energy input/output exchange, in which nutrients circulate, accumulate and are transformed, generating a complex interactive structure between populations of producers, consumers and decomposers (Paolillo et al., 2009). The presence of food chains ensures the flow of energy and the matter cycle, determining the evolutionary process. Therefore, assessing the ecological potential of landscape in terms of ecosystem connotation means analyzing its environmental stability factor. In its dynamic connotation, this is the biological capability of maintaining a functional and structural consistency beyond (or absorbing) the different perturbations, mainly human, together with those of naturalistic relevance, primarily related to environmental value of the actual uses.

In this context, the stability of an ecosystem – namely, its ability to preserve a dynamic balance through its self-regulation process – grows with the number of its components. The most relevant indicator, in terms of heterogeneity through cells of a regular grid, is the bio-potential analysis, developed to identify the naturalistic value of the different ecosystems in a context (Paolillo et al., 2013). The reference area is, therefore, divided using a matrix of cells with a regular peace, in which the values will be calculated considering the actual dominant one, or an interpolation algorithm, when the internal variability is significantly high.

4. The Importance of Landscape Analysis for the Urban Planning

Once physical and structural factors describing the research area are defined, the illustration of an organic representation of each landscape type can be derived from the characters defined in the previous chapters, using the following descriptors (Paolillo et al., 2013 & 2016):

- the morphological structure of the general context, outlined through the elevation energy, organized into intensity classes;
- the altitude, classified through different vertical features that identify homogeneous areas;
- the main soil cover, compared to the natural value of the use and/or to the degree of human presence in the area.

The elevation energy contributes, then, to the definition of the vector that describes the intensity of appearance and structural classification of landscapes. This contribution is set on returning an index that can summarize the morphological, lithological, vegetation and land use maps, produced for the landscape analysis (Paolillo et al., 2013). This summary will include, then, consistent and recognizable links (or patterns) of elements involved in the geomorphological, lithotype, vegetation, and land use domains, defined as physiographic units, to be classified at the local scale (Paolillo et al., 2016).

The three-dimensional representation of the elevation energy will, then, show that the taxonomy of landscapes, to be identified in the reference area, can follow (or not) the trend of the soil morphology. In a recent case study (Paolillo et al., 2016), the Barzio area (Lecco, Italy) was analyzed and found to reflect this trend. The first class is the valley floor, that is characterized by permanent grasslands, without tree or shrub species, that have a low elevation energy. When altitude increases, multiple landscapes alternate, with different typological features, specifically, on one hand, along the mid part of the hillside, between the valley floor and the town (that has a medium-high elevation energy level, thanks to the presence of woods swapping with grasslands). On the other hand, in the hillside between the town and the upland (Piani di Bobbio), the higher values of elevation energy are reached, thanks to the presence, in the lowest heights, of woodlands (medium and high density broad leaves forests) and, in the highest ones, of natural grasslands without tree or shrub species in the uppermost part.

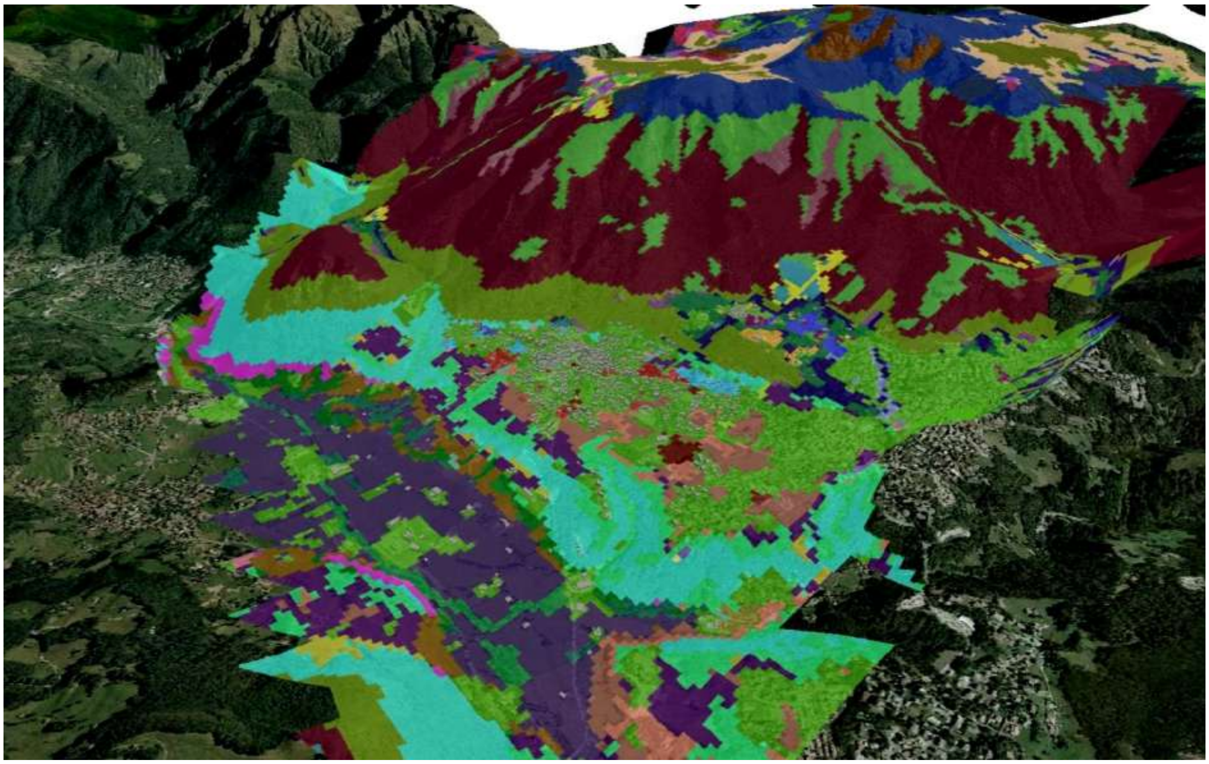

Figure 1: *Three-dimensional summary map of the local landscape taxonomy in the Barzio area*

The landscape analysis highlights the significant involvement of the local features in the alterations inevitably implemented by the human presence (Paolillo et al., 2016). The recent alterations, however, seem to be characterized by an aberrant relation between natural resources and human actions, which often generated loss of identity, poor philological significance, and spatial incoherence. It has been basically a frantic fight with the poor exploitation (*ibidem*) that turned cities and countryside in the realm of undistinguished indifference: local communities have never realized that landscape is the nourishment of consciousness and culture, recognition and membership. The more it is brutally reworked, the more it is taken apart from the local history. It is right, then, that a good sensitivity indicator is, certainly, the late transformation degree or, on the other hand, the (relative) integrity of landscapes, both referring to its (hypothetical) natural state, and with respect to the historical shapes of the settlements evolution (Paolillo et al., 2013).

Linear transportation systems, together with the disorganized urban development, are the first causes of the marginalization effects, which are directly related to the loss of value factors and the increase of pressure and risk factors in the local historical landscapes (Paolillo et al., 2013 & 2016). The urban development can, consequently, be considered as the first expected kind of physical interference and impairment risk, in terms of perception of landscape systems. This can create different levels of decline and instability, up to the total deprivation and physical transformation of landscape units (Paolillo et al., 2009). Above all, the marginalization index describes the degree of decline that the anthropic interference can cause to landscapes features and sensitivity, in terms of high levels of impairment and decontextualization of the existing units features and human intrusiveness upon the usability of the local environmental resources. In analytical terms, the marginalization degree can be considered as a descriptor of the structural features of a local landscape unit and, mostly, of basic factors of its size and of the permeability of its borders and its geometrical shape (Paolillo et al., 2016).

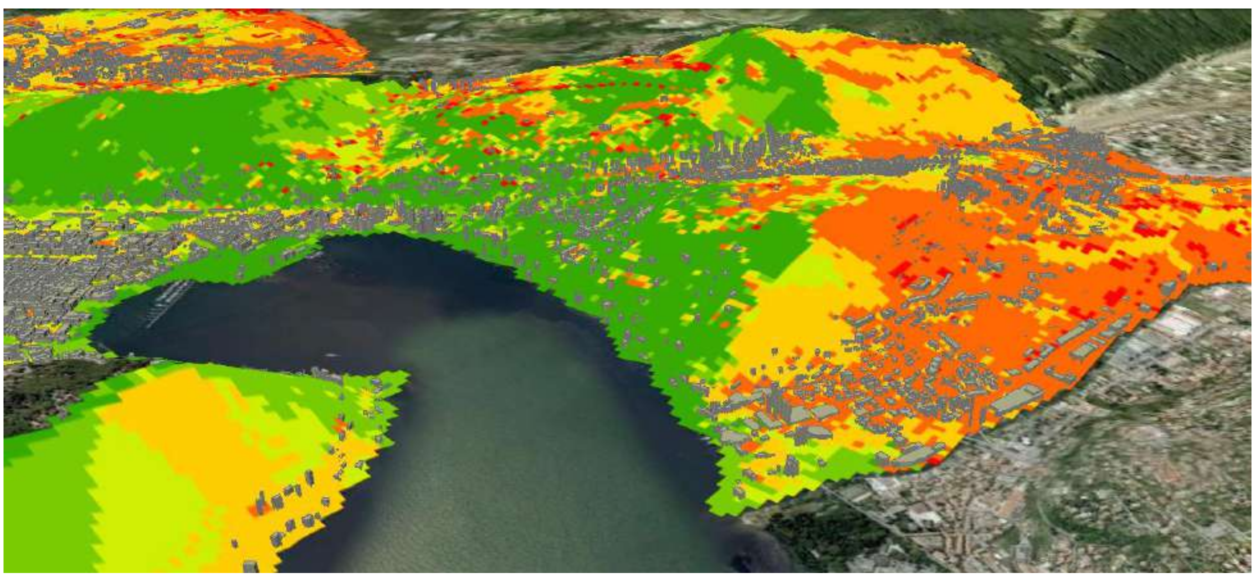

Figure 2: *Three-dimensional views analysis in the local landscape units*

One of the most important factors in the local layout evaluation is the analysis of views, that characterize the local landscape units, compared to the visual enjoyment of the aesthetic quality values of the perceptual space (Paolillo et al., 2016). Through the classification of the perceptual function of landscapes, the protection of the high aesthetic quality and view perspective values could be implemented on local units, by identifying their visual predispositions and potentialities, and their multiple focal points (Paolillo et al., 2013 & 2016).

Thanks to three-dimensional spatial analysis tools (Paolillo et al., 2013), the relevance of views in each cell can be estimated, together with the cumulative outcome of visual simulations (Viewshed), through the substantial elements of perception. The visual intensity degrees can be described through the morpho-landscape interconnection with the main aesthetic and visual elements, observable from any position in the reference area (Paolillo et al., 2016).

The landscape is revealed, then, in the extent of how it is perceived by individual through their cultural backgrounds, generally soliciting the personal sensitivity thanks to the characters of the different units, which generate a feeling of well-being and life quality (Paolillo et al., 2009, 2013 & 2016). Above all, the richness of the urban landscape can be revealed describing the relation between public roads, buildings and the historical urban development. In this sense, the view analysis of buildings within the urban landscape, made with the Viewshed analytical tool, can help to predict the perceptibility of a construction in its local surrounding, considering the obstacles represented by the volumetric interaction with the local built environment, assessing its potential conservation and improvement, even amidst the pressures of the urban development.

References

Agouris, P., Croitoru, A. (2005). Next generation geospatial information: from Digital Image Analysis to Spatiotemporal Databases. Leiden: Taylor & Francis group.

Azlizan, A. M., Noorsazwan, A. P., Halmi, Z. (2016). The GIS application in smartphone for tourism. [Special issue]. MATTER: International Journal of Science and Technology, 1, 59-69. doi: https://doi.org/10.20319/Mijst.2016.s21.5969

Boskovic, B. M. A. (2015). European social model in the 21st century: revisited and towards social investment. [Special issue]. PEOPLE: International Journal of Social Sciences, 1, 1566-1579. doi: https://doi.org/10.20319/pijss.2016.s21.15661579

Casetti, R., Paolillo, P. L. (2016). Urban planning in transition: principles and methods. Sesto San Giovanni: Mimesis.

Chang, K.T. (2009). Introduction to Geographic Information Systems (5th Revised Edition). New York: McGraw-Hill.

Council of Europe (2000). European Landscape Convention. Retrieved from http://www.coe.int/en/web/landscape/home

De Smith, M. J., Goodchild, M. F., Longley, P. A. (2007). Geospatial analysis: a comprehensive guide to principles, techniques and software tools. Leicester: Troubadour. Retrieved from http://www.spatialanalysisonline.com/HTML/index.html

Hormaila, G. Z. (2015). Forest and livelihood: the Naga traditional practice of prudent use of forest resources for a sustainable livelihood. [Special issue]. PEOPLE: International Journal of Social Sciences, 1, 912-926. doi: https://doi.org/10.20319/Mijst.2016.s21.5969

Mattia, S., Bianchi, R. (2000). Il valore dell'ambiente: intervento pubblico e CVM: principi, modelli teorici, casi di studio. Bologna, Guerini Studio.

Mattia, S., Miccoli, S. (1989). La valutazione del danno ambientale. Elementi per la definizione di un modello operativo. Firenze: Atti del XIX Incontro Ce.S.E.T.. Retrieved from www.fupress.net/index.php/ceset.

Mattia, S., Oppio, A., Pandolfi, A. (2012). An assessment model for the environmental damage simulation through scenarios predicted with a Geographic information system. Aestimum, 2, 459-477. doi: http://dx.doi.org/10.13128/Aestimum-13156

Mattia, S., Oppio, A., Pandolfi, A., Poletti, A. (2012). Modelling and Evaluating an Environmental Damage Scenario: Discussing an Assessment Model Predicted Through a Geographical Information System Procedure. Chemical Engineering Transactions, 28, 241-246. Doi: 10.3303/CET1228041.

Mattia, S., Oppio, A., Pandolfi, A., Poletti, A. (2013). Il ruolo dei G.I.S. e dell'analisi di scenario per la stima del danno ambientale. Valori e valutazioni, 10, 171-184.

Mattia, S., Oppio, A., Pandolfi, A., Poletti, A. (2012). The environmental damage simulation and evaluation: discussing an assessment model predicted through a scenario procedure developed thanks to GIS tools. *Proceedings of the International Symposium of Sanitary and Environmental Engineering, 9th Ed. - SIDISA 2012 - Sustainable Technology for Environmental Protection* (pp. 1-8). Milano: Politecnico di Milano - MIP.

Mattia, S., Oppio, A., Pandolfi, A. (2012). Testing the use of Contingent Valuation Method in Real Estate Market: first results of an experiment in the city of Milan. Aestimum, 2, 721-734. doi: http://dx.doi.org/10.13128/Aestimum-13174

Mattia, S., Oppio, A., Pandolfi, A. (2010). Contingent Valuation Method and Market Value: Applying Stated preference methods in Real Estate Market. Proceedings of the 17th ERES 2010 Conference. doi: 10.15396/eres2010_083.

Paolillo, P.L., Venturi Ferriolo, M. (2016). Relazioni di paesaggio: tessere trame per rigenerare i luoghi. Milano, Mimesis.

Paolillo, P.L., Venturi Ferriolo, M. (2013). La tecnica paesaggistica: stimare il valore dei paesaggi nel piano. Santarcangelo di Romagna: Maggioli.

Paolillo, P.L., Benedetti, A., Terlizzi, L. (2009). La costruzione della carta del paesaggio nel retroterra ambientale di Expo 2015: la variante generale del piano delle Groane. Territorio, 50, 98-112. doi: 10.3280/TR2009-050012.

Popper, K. (1978). Three Worlds, The Tanner Lecture On Human Values, delivered at the University of Michigan, April 7, 1978. Retrieved from http://tannerlectures.utah.edu/_documents/a-to-z/p/popper80.pdf

Popper, K. (1963). Conjectures and Refutations: The Growth of Scientific Knowledge. London: Routledge.