DESCRIPTORS IN SCENIC HIGHWAY ANALYSIS: A TEST STUDY ALONG ITALIAN ROAD CORRIDORS

Gianluca Dell'Acqua[1], Raffaele Mauro[2], Francesca Russo[3]
[1,3] *University of Napoli Federico II, Department of Transportation Engineering, Via Claudio 21, Napoli, Italy*
[2] *University of Trento, Department of Mechanical and Structural Engineering, Via Mesiano 77, I-38123, Trento, Italy*

Received 9 May 2011; accepted 15 June 2011

Abstract: The following paper illustrates the application and the verification of detailed methodologies employed by international agencies to assess the Scenic Quality of a landscape. Several States determine a landscape's visual quality using predictor variables. This research aims to validate the recognized ability of these predictor variables to reproduce untrained observers' preferences. The definition of the Scenic Quality of a landscape is often affected by subjective opinions but sometimes exceptions exist. Public judgment recognizes a high Visual Quality to landscape when natural reserves, national parks, and archaeological interest exist. Various procedures collected in international literature suggest the use of predictor indicators to evaluate public preferences. Three variables have been chosen to analyze a series of selected Italian landscapes: Vividness, Intactness and Unity. Photographic inventories were created for different landscapes. Pools of landscape architects judged the slides associated to each landscape using a 7-point scale for the three indicators. Identical slides were then shown to untrained observers composed of 201 students that used a 10-point scale to evaluate Scenic Beauty for each picture. Students' judgments were then related to the expert judgments. The results indicate that vividness is most correlated with Scenic Beauty that presents a much weaker correlation with intactness.

Keywords: highway, landscape management, visual quality, scenic beauty.

1. Introduction

The design of new roadway infrastructures contains significant meaning not only in terms of the functional and safety improvement of the network but also regarding to the socio-economic development of a territory beyond regional barriers. This process is obliged in every case to mitigate and reduce any negative impact on the community. Today the roadway design features are mostly subject to the judgments and decisions of designers that often don't have the instruments to accurately estimate nor verify the effective output related to their decisions until the project is finished.

In many countries attributing to context-sensitive road design is not new, as it is in Italy, but a recognized procedure exists. Some methods have been developed to examine roadway-landscape interaction while several other procedures related to landscape assessment from the road and assessment of road from the landscape have been produced.

[1] Corresponding author: gianluca.dellacqua@unina.it

Garré et al. (2009) analyzed for example the dual landscape role of secondary and tertiary roads in a semi-rural setting, to be understood as the access to scenery and as their direct influence to the landscape characteristics. A combination of techniques was used including a radiocentric morphological landscape analysis, a perception study on landscape photographs and a cumulative logit model to assess the factors of landscape appreciation in this kind of environment. The results showed that roads and built fabric seemed to have a negative impact on landscape appreciation. The methodology applied proves to be useful and is probably applicable in other geographical contexts and it can be a supporting tool to plan and manage road networks for improvement of landscape quality, especially in parts of the countryside strongly affected by urban sprawl.

Today landscape is still understood and experienced mostly through the complex of external structures, mosaics, patches, pictures. Therefore, technosphere (structural imprint from cultural and technological processes) of landscape expresses itself and is received through the elements of material culture – mostly built up territories and land-use patches – formations created by processes of land surface exploitation and change.

Veteikis and Jankauskaitė (2009) have conducted an investigation to discover territorial differences in landscape technosphere. The object of their analysis in general is the cultural landscape of Lithuania, in a narrow sense – its cultural (technogenic) structure, made up of built-up areas, infrastructure and land-use (agricultural, silvicultural, of natural swamps, etc.) divided into territorial complexes – techno-morphotopes (TMTs). Each TMT was descrive by its inner structure according to the areal proportions of the mentioned structural elements. For this task the main methods applied were GIS-based overlay operations and database calculations. Later the process of classification was performed for the 1969 TMTs. The obtained data could be applied in land management by finding the best way to relate the administrative and economic regional system and technosphere structure.

Many States and Federal Agencies in the US have adopted scenic highway programs or programs with elements analogous to scenic-based planning. Generally, each one applies an expert-based methodology, using descriptors to formulate statements of *Visual Quality*. These predictor indicators interpret, with adequate accuracy, the predilections of a community, if it was possible to get information from the community. Public participation is an important component of most programs, and the preferences expressed by the community give an impression of how the public perceive *Scenic Beauty*.

This study illustrates the application of two methods applied in the international literature, though with a specific reference to the Italian context. The analysis will demonstrate the capacity of a number of predictor indicators to correctly interpret public preferences. This study brings together homogeneous landscapes: landscapes with similar physiographic features (climate, morphology and soil), landscapes with the same land use, similar environmental aspects, socio-economic and demographic factors.

Jankauskaitė and Veteikis (2010) have offered an original method of distributing the landscape sample areas in Lithuanian territory, differing from most methods based on random choose of sample areas though thorough analysis of the analogous methods abroad was performed. In accordance to the spread of different natural landscape types (like clayey plains, morRainic hills, sandy plains, etc.), a set of 100 sample areas (2.5 km^2 each) was distributed in Lithuanian territory. To increase the sample area number in smaller landscape types (spit, coastal sandy plain, delta), some proportional corrections were made. Thus, the largest number of the sample areas was assigned to the most spread clayey plains, the smallest number – to sandy coastal plain. In order to find a concrete place for each sample area inside the landscape type a computer program was employed and the highest representation principle applied. Several tens of thousands possible positions of the sample areas were tested in order to find the best in representing land cover structure.

Infrastructure development must always ensure minimization of project costs and times, but at the same time, maximization of social and economic benefits reducing negative impact on the community. Medineckien et al. (2010) have discussed for example the construction impact on the environment, people and their health, taking into account its subsequence. Multicriteria assessment of the alternatives was made, considering impact not only on humans, but also on the environment.

Constraints are also specified by Italian standards where it is clearly stated that the direct and indirect effects on the landscape of infrastructural projects must be analyzed.

Land use planners in many countries have recognized the importance of the aesthetic values of landscape. Their desire to incorporate these values into decision-making processes has created a need to identify valid ways to quantify the scenic characteristics of landscapes. This has led to an increasing interest in the use of spatial data and geographic information systems (GIS) methodology in assessing visual attributes of the landscape. Ayad (2005) has assessed for example in him study the visual changes in a rapidly developing coastal area of Egypt using remotely sensed data (satellite images and aerial photographs) and raster GIS modeling. Using land use/land cover classes extracted from the satellite images and aerial photographs, four visual attributes of landscape were identified: land use/land cover diversity, activity (degree of naturalness), proximity to the shoreline, and topographic variety. A composite index was also developed. Although these attributes and the composite index rely mostly on the type of land use/land cover information on the landscape under consideration, the adopted techniques succeed in detecting several changes in the attributes, spatially locating them and mapping the magnitude of their changes. This study demonstrated what can be done to analyze and assess what is usually considered an incommensurable resource, the visual attributes of landscapes. It also revealed the extent of the impact of unplanned or ill-planned activities on one of the fragile resources of arid landscapes.

Rogge et al. (2007) studied the perceptions of landscapes between farmers, landscape experts and the general public. A method based on a picture enquiry was used to measure landscape perception in the 'Pajottenland', a central Belgian, rural area. Additional questions assessed the importance of meanings and functions of the landscape and revealed differences in perception among three target groups (farmers, landscape experts and country-dwellers). The results confirmed that the three groups look at landscapes in a different way, attaching importance to different landscape features and finding different functions appropriate for the considered landscapes.

The comparison between a method using only an expert pool's judgment and that of untrained observers of a landscape was previously conducted by Clay and Smidt (2004) along a road corridor in California's Central Coast region. Results indicated that *Vividness* and *Variety* were significant for preference but the contribution of *Variety* was however limited and it did not supply additional information beyond that provided by *Vividness* in the regression equation. *Naturalness* wasn't significant and was not considered to predict preference.

The European Landscape Convention (2000) defines the landscape as a portion of territory whose features draw from natural and anthropogenic factors and consequently interrelationships. This Convention wishes that all States involved in major infrastructural projects recognize the landscape as part of the living space of the community, but also as the expression of their cultural and natural heritage diversity and as a source of their individuality. These considerations must be extended to all natural, rural and urban environments and must include terrain, inland and marine waters, and embrace also degraded landscapes. Clear and objective methods to assess a landscape's *Visual Quality* are yet to be recognized and clearly defined. A great number of researchers have been dealing for years with this question developing highly subjective or more complex and quantitative methodologies. Significant advances subsist in this field but no single methodology is universally accepted today in assessing the *Visual Quality* of a landscape.

The Bureau of Land Management (1986) in the US applies an evaluative system to landscape units, based on seven factors: landform, vegetation, water, color, adjacent scenery, scarcity and cultural modifications. A contrast rating system is employed to analyze the potential visual impact of proposed projects and activities. Because of an emphasis on impact, the BLM system implies that natural landscapes are the ideal.

The Arizona Department of Transportation (1993) employs a multi-stepped designation process, focusing on identifying natural and cultural resources. The program first designates discrete areas (landscape units) via some mapping operation. An evaluation is then performed to determine levels of visual quality, applying three descriptor variables: *vividness*, *intactness* and *unity*. A *visual quality* rating is then weighted according to the road's length.

The Washington State Department of Transportation's byway program (2001) applies an expert approach. Predictor variables used as indications of *scenic value* are *vividness*, *intactness*, *unity* and *uniqueness*. According to the Arizona DOT program, unique geographic zones must first be divided into landscape units. The units are then evaluated using the descriptors, on a 7-point scale. Individual ratings are merged, with cumulative scores above 30 being designated "exceptional scenery", scores of 25–29 designated "highly scenic", and scores of 20–24 designated "scenic".

The CALTRANS, California Department of Transportation, (2001a), (2001b) has procedures modeled on FHWA's *Visual Impact Assessment for Highway Projects* (1988). In the CALTRANS Guidelines, DOT states its purpose as being to conserve and increase California's natural beauty: *the more pristine and unaffected by intrusions, the more likely the nominated highway will qualify as scenic*. Landscapes are judged in terms of *vividness*, *intactness* and *unity*. Landscape additions (referred to as intrusions) are viewed negatively. The CALTRANS procedure is derived directly from the FHWA method where the landscape's assessment related to *visual quality* is directly submitted to an expert pool. This procedure does not involve the direct opinions of the local community, and so fails to avoid later to avoid later dissatisfaction, protests and subsequent increase of the times and costs to road design. The FHWA method generally employs photographs to illustrate selected landscapes. The expert pool assigns a score to the predictor indicators for each picture to assess *visual quality*. The first step of this analysis is the identification of the position occupied by the general observer. In fact it is necessary to differentiate landscape observed from the roadway and landscape observed by non-users of roadways from the outside.

Vividness occurs when an element is particularly intense, clear and brilliant to view and depends on the morphology of the environment and on the union of water, flora and artificial development.

Intactness subsists when the landscape is free from visual intrusion and depends also on the position of the elements in the image. It can be reduced, not only by adding a new visual resource, but also by the subtraction from the landscape of existing visual resources.

Unity is the last of the indicators used in the FHWA method. This parameter measures the power of the union in the visual resources of the landscape to produce a coherent and harmonious view. Homogeneity between natural and anthropogenic elements is one aspect of this criterion. In many cases, the uniform presence of natural and artificial components reinforces the *unity* of a landscape producing high *visual quality*. It is well known that *unity* is also influenced by transitory ambient factors such as light and weather conditions, glare and shadows created by the play of light. These circumstances can sometimes enhance it and sometimes diminish it.

De la Fuente de Val et al. (2006) analyzed the relationships between landscape spatial pattern and the rating of visual aesthetic quality. Eight landscape photographs were evaluated for 11 visual attributes by 98 respondents. The scores obtained for these 11 attributes were subjected to principal components analysis in order to summarize the qualities used by the respondents and thus determine their visual preferences. For each photograph, three window sizes were defined (with respect to a landcover map) to cover the different areas corresponding to the visual field (foreground, mid-ground and background). The landscape spatial structure for each window was analyzed using spatial metrics. The correlation between each dimension and the spatial pattern indices of the landscape were then calculated. Positive correlations were obtained between visual aesthetic quality and a number of landscape pattern indices. The results suggest that landscape heterogeneity might be an important factor in determining visual aesthetic quality. Public participation is desirable and it is a component of most programs to assess the *scenic quality* of a landscape.

Arriaza et al. (2004) presented a methodology for assessing the visual quality of agricultural landscapes through direct and indirect techniques of landscape valuation. The first technique enables us to rank agricultural landscapes on the basis of a survey of public preferences. An application based on two Mediterranean rural areas in Andalusia in Southern Spain was presented. The photos used in the survey included man-made elements, positive and negative, agricultural fields, mainly of cereals and olive trees, and a natural park. Each participant ranked an average of 7.3 panels. The results show that perceived visual quality increases, in decreasing order of importance, with the degree of wilderness of the landscape, the presence of well-preserved man-made elements, the percentage of plant cover, the amount of water, the presence of mountains and the color contrast.

A universally accepted procedure is not yet recognized to illustrate how data from the untrained pool can be later incorporated into an organic overall process. Most researchers study how it is feasible to interpret public preferences using only the expert pool's assessment. This operation is reasonable when the identified preferences of a limited group of observers are correlated with the landscape experts' judgments to verify if the regression equation is statistically significant.

The USDA Forest Service (1995) developed a methodology where untrained observers are involved directly and they assign a score to the *visual quality* of a landscape shown in pictures. There are various procedures to involve untrained observers and to collect data live, for example walkers, where the questioned observers are living the visual quality of the landscape, and questionnaire can be sent by mail to a list of selected observers. *Scenic Beauty* is not completely contained "in the eyes of observers" according to this procedure and it must be appreciated not only as a specific property of the landscape, but it can be derived from the judgments of untrained observers in response to their perception of the environment. Their assessments jointly depend, however, on the perceived scenic beauty of the landscape and on the evaluation criteria employed.

2. Methods

Numerous researchers are interested in verifying and authenticating the power of the predictor variables used in this method to evaluate the *Visual Quality* of a landscape and above all to provide the chance to predict public preference through an expert pool's assessments only concerning these indicators. One of these studies (Clay and Smidt, 2004) has provided an analysis where the experts' assessments of pictures of various selected landscapes are combined with the judgments of untrained observers.

The study described here illustrates similar analysis in the Italian context. Preferred landscapes were chosen from the classification contained in Landscape Guidelines from Italy (2007). This study brings together homogeneous landscapes: landscapes with similar physiographic features (climate, morphology and soil), landscapes with the same land use, similar environmental aspects, socio-economic and demographic factors. Fig. 1 shows all the Italian Regions and in particular the partition of the Campania Region into 46 homogeneous landscapes. According to these categorizations, the study corridors belonging to landscapes 6, 7 and 46 have been chosen.

The first study corridor belonging to landscape 7 is a segment (5.9 km) of the national highway S.S. 145 from *Vico Equense* to *Meta*. The second study corridor belonging to landscape 46 is a segment (5.9 km) of the national highway S.S. 166 from *Atena Lucana* to the river *Tanagro*. The third study corridor belonging to landscape 6 is a segment (9.5 km) of the national highway S.S. 7 bis from *Mugnano del Cardinale* to *Monteforte Irpino*.

The first corridor belongs to a coastal and partially urbanized landscape, the second belongs to a flat region with predominantly agricultural land use and the third belongs to a mountainous and slightly urbanized landscape as shown in Fig. 2.

Two related analyses were carried out along the corridors (Clay and Smidt, 2004). The first analysis required the scenic assessments of an expert pool of seven individuals who are U.S. and Italian professional landscape architects or professors. They evaluated selected landscapes using three descriptor variables; *vividness*, *intactness* and *unity* chosen from a larger group. All the experts know the meaning of these predictor variables because, before the evaluation, detailed instructions concerning the assessment were provided them. The second analysis was carried out using 201 untrained observers. These observers rated *scenic beauty* on the same test slides used during the expert assessment.

The results from the two studies were then statistically compared to verify the existence of a correlation between the experts' assessments, using selected descriptor variables, and the untrained observers' *scenic beauty* evaluation.

An inventory of color pictures was made along the study corridors in the autumn and summer of 2008. The slides were taken between 10:00 a.m. and 2:30 p.m. using the same procedure presented in the Handbook for Scenery

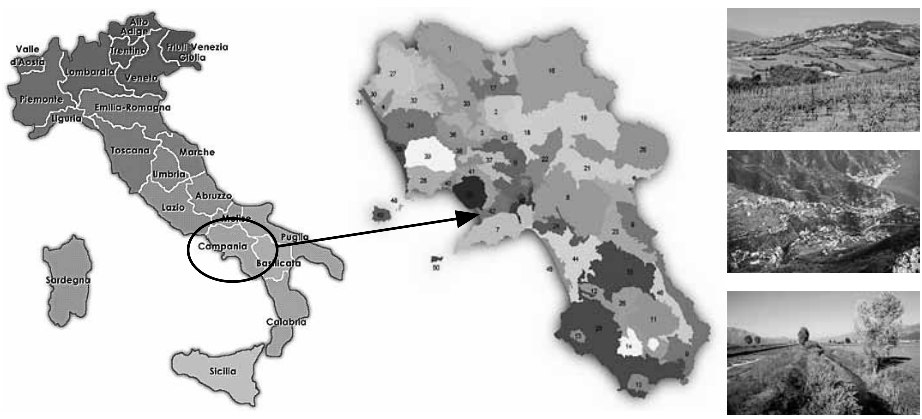

Fig. 1.
General Map of the Study Corridors

Study corridor 1 *Study corridor 2* *Study corridor*

Fig. 2.
Study Corridors Details

Management of USDA Forest Service (1995). Photographic points were established at 1.5 km intervals along the corridors. At each point two photographs were taken from four possible positions (two on each side of the highway). The photo-positions at each location were selected by drawing two out of the possible four photo-positions at random. This insured that no bias was applied to the photography. Furthermore no effort was made to isolate or remove any scenic elements from the acquired photographs. The intention was to simply acquire photographs of the landscape conditions, as they are per-photo-position.

Thirty-six pictures were taken along the first study corridor, forty along the second and forty-four along the third. Resulting collection is composed of 111 slides (32 for the first corridor, 39 for the second and 40 for the third). According to other applications, it was necessary to select a set of these 111 slides because this number would have been too high. Psychology confirms gradual decrease of attention, owed to symptoms of tiredness and boredom, when an observer is focused for too many times on an object. Final test slides were selected randomly to reach a suitable pictures number that conducted also suitable statistically results. Fifteen slides for each landscape were selected. The experts for each picture have judged using a 7-point scale (1 = Very Low, 4 = Middle, 7 = Very High) three parameters: *vividness*, *intactness* and *unity*.

Once acquired the expert pool's assessments, *visual quality* for each picture has calculated according to FHWA procedure as mean of all rates assigned to the three parameters by seven experts. Table 1 shows descriptive statistics of three parameters according to expert assessment. It is noted how *intactness* is the indicator with highest standard deviation, while mean value is quite similar for all parameters. *Unity* has however highest mean.

To appraise the level of internal consistency in the expert judgments Cronbach's Alpha statistic was calculated for the indicators. Results show high level of consistency when Cronbach's Alpha coefficient exceeds for each variable 0.70. The *vividness* descriptor received the highest alpha score (A = 0.949) but also *intactness* (A = 0.940) and *unity* (A = 0.938) received high alpha score. This is a signal how the experts had strong agreement with that concept and expert judgments are reliable in terms of their consistency to assess the scenic characteristics of chosen variables.

Identical slides were then presented to untrained observers composed of 201 university students, who participated voluntarily without payment. Before showing 45 slides, some indications relating to selected landscapes were given and

Table 1
Descriptive Statistics of Variables for Expert Pool

	Mean of min. values	Mean of max. values	Mean Value	Dev. Stand
Vividness	3.143	5.750	4.269	0.644
Intactness	2.500	6.500	4.510	0.978
Unity	2.857	6.500	4.689	0.959

Table 2 *Descriptive Statistics of Scores for the Untrained Pool*

	Picture	Min value	Max value	Mean value	Std. Dev.
Corridor 1	1	5	10	8.04	1.43
	2	1	10	5.56	1.83
	3	1	10	8.38	1.46
	4	3	10	8.11	1.33
	5	5	10	8.10	1.39
	6	1	10	7.27	1.66
	7	1	10	5.16	1.63
	8	4	10	7.37	1.39
	9	1	10	5.51	1.72
	10	2	10	6.88	1.56
	11	1	10	7.09	1.63
	12	1	10	7.49	1.59
	13	5	10	8.14	1.29
	14	1	10	7.33	1.64
	15	3	10	7.45	1.62
Corridor 2	16	1	10	6.18	1.59
	17	1	9	5.77	1.65
	18	1	10	5.11	1.73
	19	1	9	4.96	1.44
	20	1	10	6.72	1.70
	21	1	10	6.14	1.69
	22	1	9	5.76	1.56
	23	1	10	6.12	1.70
	24	1	10	5.54	1.65
	25	1	10	5.74	1.77
	26	1	10	6.20	1.61
	27	1	10	5.62	1.60
	28	2	10	6.99	1.57
	29	1	10	6.31	1.66
	30	1	10	6.89	1.64
Corridor 3	31	1	10	6.45	1.77
	32	1	10	5.35	1.91
	33	1	10	4.48	1.64
	34	1	10	5.31	1.74
	35	1	8	4.38	1.69
	36	1	10	6.44	1.83
	37	1	10	5.71	1.60
	38	1	10	5.61	1.84
	39	1	9	4.65	1.56
	40	1	10	5.24	1.81
	41	1	9	4.78	1.55
	42	1	10	4.76	1.77
	43	1	9	4.75	1.59
	44	1	10	4.90	1.75
	45	1	9	5.12	1.76

the purpose of analysis was clarified. No details were given as to the goal of comparing their responses with those from the expert pool. Respondents were asked to image themselves in the landscape represented per slide, and to rate the scenic beauty of the landscape on show on a 10-point scale, where a 1 represented very low scenic beauty and a 10 represented very high scenic beauty. Respondents were encouraged to use the full extent 10-point scale. Prior to the actual testing, preview slides taken along the test corridors were presented. These gave respondents an opportunity to practice using the 10-point rating scale, and to observe the range of conditions to be rated. After the preview, the test scenes were presented one at a time for approximately 4-5 seconds each. Each participant independently rated each scene on the 10-point scale as it was presented. Table 2 shows the statistics indicators of scores as expressed by the untrained observers for each slide.

Fig. 3. shows 4 slides with the maximum and minimum scores for visual quality derived in the expert assessment, and the scenic beauty as indicator of the untrained observers' preferences.

3. Results and Discussion

The goal was to determine the contribution of predictor variables to interpret public preferences. An examination of the correlations between the responses for perceived levels of scenic beauty and the expert assessments using three descriptors was conducted. The correlations are presented in Table 3.

Table 3 also includes Visual Quality and Scenic Beauty indicators, in order to highlight the existence of relationships between the latter indicator and the three variables to verify if it's possible to predict public preferences directly using expert judgments.

Table 3 shows how a strong relationship (r = 0.857) exists between *Unity* and *Intactness*, while to a lesser degree correlations exists between *Unity* and *Vividness* (r = 0.579) and between *Intactness* and *Vividness* (r = 0.307).

Vividness is also significantly correlated to *Scenic Beauty* (r = 0.774), while weaker a correlation to *Scenic Beauty* is shown by *Unity*

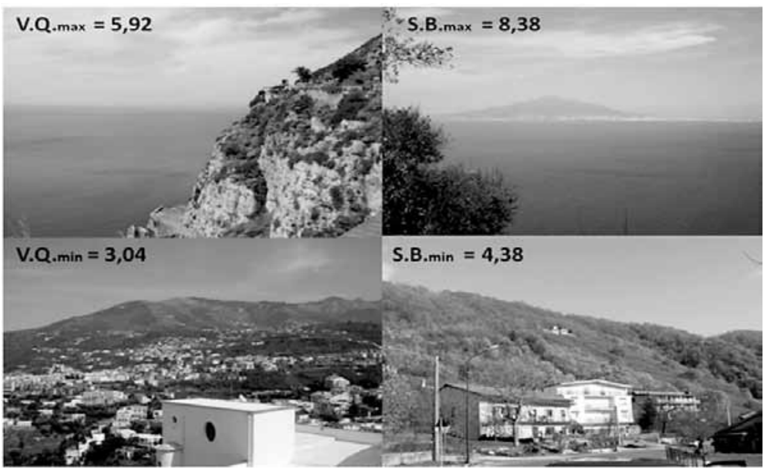

Fig. 3.
Pictures With Maximum and Minimum V.Q. and S.B

(r = 0.247). *Intactness* has no correlation with Scenic Beauty (r = - 0.077).

Visual Quality is poorly correlated with Scenic Beauty (r = 0.295). This result demonstrates how a simple arithmetical mean of three indicators does not explain public preferences well. It was therefore necessary to perform a multiple linear regression analysis.

Table 3
Correlations

	Vividness	Intactness	Unity	Visual Quality	Scenic Beauty
Vividness	-	0.307	0.579	-	0.774
Intactness	0.307	-	0.857	-	-0.077
Unity	0.579	0.857	-	-	0.247
Visual Quality	-	-	-	-	0.295
Scenic Beauty	0.774	-0.077	0.247	0.295	-

Regression analysis was conducted using two stepwise techniques: forward selection and backward elimination. This approach involves several regression models to verify if a significant relationship exists between the descriptor variables and public preference. This method makes it possible to appraise public preference relating to the *scenic beauty* of a landscape using the expert pool's assessments that correctly interpret it. Table 4 contains the results of two techniques. Analyzing the forward selection it can be observed how *Vividness* came into the model at the first step because it had the highest correlation with *Scenic Beauty* (T = 8.024, P-value = 0.000) as confirmed by the results of the correlations using the expert pool's judgments. When *Intactness* enters into the model (T = - 3.970, P-value = 0.000) with *Vividness* (T = 10.070, P-value = 0.000) their correlation with *Scenic Beauty* is high and considerable contribution is offered to viewer preference. Once *Unity* was included in the regression model (T = 1.042, P-value = 0.303) with *Intactness* (T = -2.833, P-value = 0.007) and *Vividness* (T = 7.037, P-value = 0.000), correlation with *Scenic Beauty* increases but *Unity* is not significant. Backward elimination gave the same results as shown in Table 4.

This procedure uses in the first step all three selected descriptors and then the variables less significant are deleted one by one.

In the first step this procedure uses all three selected descriptors and then the less significant variables are deleted one by one. In the first stage, a model containing *Unity*, *Intactness* and *Vividness*, was created, but *Unity* was then deemed unnecessary.

In the second stage *Intactness* and *Vividness* were considered, and two variables are both significant to predict *scenic beauty*. The regression model contains a high adjusted coefficient of determination and provides the same regression model as obtained by forward selection using two predictor indicators. In the last stage, *Vividness* was regressed against *scenic beauty* and although it is significant, the correlation is somewhat lower than in the previous case.

The combination of *Intactness* and *Vividness* is the best model to predict *Scenic Beauty*; each indicator has a P-value of less than 5% and the model has a high adjusted correlation coefficient (R^2_{adj} = 0.695). the second best model contains only *Vividness* but the adjusted coefficient of determination is lower (R^2_{adj} = 0.590). The model with *Unity (U)*, *Intactness(I)*, *Vividness(V)* has the highest adjusted coefficient of determination (R^2_{adj} = 0.696) but *Unity* is not significant (T-value = 1.042, P-value = 0.303).

Table 4
Regression Analysis: Forward Inclusion and Backward Elimination

			Backward Elimination		Forward Inclusion	
			Step		Step	
			1	2	2	1
Unity		Constant	0.255			
		t-value	1.042			
		p-value	0.303			
Intactness		Constant	-0.583	-0.395	-0.395	
		t-value	-2.833	-3.970	-3.970	
		p-value	0.007	0.000	0.000	
Vividness		Constant	1.389	1.521	1.521	1.337
		t-value	7.037	10.070	10.070	8.024
		p-value	< 0.0001	< 0.0001	< 0.002	< 0.0001
S.B. predicton model		R^2	0.716	0.709	0.709	0.600
		$R^2_{adj.}$	0.696	0.695	0.695	0.590
	ANOVA	SSR (k)	39.831 (3)	39.413 (2)	39.413 (2)	33.338 (1)
		SSE (n-k-1)	15.771 (41)	16.189 (42)	16.189 (42)	22.264 (43)
		F-Fisher	34.515	51.125	52.125	64.388
		p-value	< 0.0001	< 0.0001	< 0.0002	< 0.0001

Table 5
Intactness/non-Intactness conversion system

non-Intactness = presence of visual intrusion		Intactness	
Absent	1	Very High	1
Few	2	High	2
Certain amount	3	Medium-High	3
Normal	4	Normal	4
Several	5	Medium-Low	5
High	6	Low	6
Very High	7	Very Low	7

Table 6
Principal Component Factor Analysis

Factors		F1	F2	F3
Eigenvectors	Vividness	0.471	0.841	-0.268
	Intactness	0.592	-0.526	-0.611
	Unity	0.654	-0.129	0.745
	Eigenvalues	2.192	1.019	0.089
	% Variance	73.062	23.965	2.973
Proportion of total grant accounted for by each variable (%)	Vividness	22.148	70.680	7.173
	Intactness	35.033	27.658	37.309
	Unity	42.819	1.662	55.518

Table 7
Regression Analysis: Scenic Beauty vs. F1 and F2 (a)

Factor	Constant	T-value	P-value
F2	1.020	9.364	< 0.0001
F1	0.244	3.908	0.000

Table 8
Regression Analysis: Scenic Beauty vs. F1 and F2 (b)

R^2	R^2_{adj}	SSR (k)	SSE (n-k-1)	F-Fisher	P-value
0.71	0.696	39.492 (2)	16.110 (42)	51.478	< 0.0001

The final equation which can be used, according to the results shown in Table 4, to predict the perceived *Scenic Beauty (SB)* of a landscape using the expert pool's assessments is the following, Eq. (1):

$$SB = 1.521 \cdot V - 0.395 \cdot I \qquad (1)$$

The results shown in Table 4 prove that *Scenic Beauty* decreases when *Intactness* increases, i.e., Scenic Beauty increases when *non-Intactness* ($\underline{I}$) increases. The equivalence system used by the experts was changed (Table 5) to assess *non-Intactness*, reversing score order.

This conversion was necessary to introduce *non-Intactness* into the *Scenic Beauty* model and to assign a weight to the predictor variables.

Vividness has a weight within the regression model equal to, Eq. (2):

$$W_V = \frac{1.521}{1.521 + 0.395} = 0.79 \qquad (2)$$

non-Intactness has a weight within the regression model equal to, Eq. (3):

$$W_{\underline{I}} = \frac{0.395}{1.521 + 0.395} = 0.21 \qquad (3)$$

The final regression equation to predict *Scenic Beauty* from expert assessments using *Vividness* and *non-Intactness* is as so follows, Eq. (4):

$$SB = 0.79 \cdot V + 0.21 \cdot I \qquad (4)$$

Factor analysis has been also performed to analyze this subject. The aim of principal components analysis is to rightly describe generic phenomena removing redundant information because of correlated variables. Eigenvalues, eigenvectors, the proportion of total variance accounted for by each factor and the proportion of total grant accounted for by each variable are presented in Table 6.

The factors extracted from this analysis are F1 and F2; the F3 factor cannot be used to regression because usable factors must be a standardized variable that must have a variance (or eigenvalue) greater than one or very near to one. Factor 1 as shown in Table 6 is a right combination of *Unity* and *Intactness*, and accounted for 0.73 % of the variability. Factor 2 is correlated directly with *Vividness* and inversely with *Intactness*, and accounted for 0.24 % of the variability. F1 and F2 were used in a multiple regression equation to predict *Scenic Beauty* for all 45 pictures. Results of this analysis are shown in Table 7 and in Table 8.

The adjusted coefficient of determination ($R^2_{adj.}$ = 0.696) of the *Scenic Beauty* prediction model that involves *F1* and *F2* factors is not significantly greater than the adjusted coefficient of determination ($R^2_{adj.}$ = 0.695) obtained in the regression analysis using *Vividness* and *Intactness* as predictor variables.

The *F1* (*Unity + Intactness*) and *F2* (*Vividness + non-Intactness*) factors are not useful because of the non-significant improvement of the model. Hence the role as predictors of preference of *Vividness* and *Intactness* was confirmed.

4. Conclusions

The results derived from the multiple regression analysis, where the assessments of the expert pool were related to untrained observers' preferences, have shown that of the three descriptors, *Vividness* is the main component of the model to predict public preference (or *Scenic Beauty*). In fact *Vividness* has recorded the highest correlation and significance in the regression equation. *Unity* had weaker correlation to *Scenic Beauty* (*r* = 0.247) and so it was excluded from the prediction model.

The results showed a negative correlation between *Scenic Beauty* and *Intactness*; consequently a strong correlation between *Scenic Beauty* and *non-Intactness* exists, and it is a necessary component of the final regression model because it is highly significant and increases the adjusted coefficient of determination ($R^2_{adj.}$ = 0.695).

Future developments will be also devoted to the investigation of relationships between the landscape and air pollution to optimize strategic territory planning.

The negative effect of heavy metals and other potentially hazardous trace elements was observed for example by Jankauskaitė et al. (2008) in different environmental compartments: atmosphere, surface and underground water and soil in the urbanized nucleus of Vilnius. The aim of this investigation was to find out the distribution and connection between the urban landscape sensitivity to chemical pollution (S), which was an opposite index to self-regulation potential, and the total topsoil contamination level (Z_d) in the urbanized nucleus of Vilnius city taking into account different functional zones. Z_d was calculated according to concentration coefficients of 13 chemical elements, and the scores of S were based on integrated evaluation of 7 criteria. Analysis of both indices revealed the location of contaminated and sensitive to chemical pollution sites. Their highest percentage was in industrial, infrastructural, old town public, old town residential and centre functional zones.

Cserekly (2010) has also analyzed the environmental pollution due to the heavy metals in different classifications of landscape. The examined territory was located in Danube-bend Region in Pest County on the southern boundary of the interior of Vác, partly on the periphery of the town. The natural advantages of this examined area were affected by air pollution due to the increased industrial, commercial, and economic life of the city. Even though the heavy metals are a natural component of the environment, it need to look them as toxic materials. This paper is focused on the pollution analysis with various plant samples. It was showed that the main toxicology pollutants were present in different landscape combinations and concourses. In tree species, like Salix alba, near the band of a motorway were observed 5–8 times more values as compared with samples from the Duna-Ipoly National Park and nearly all kinds of heavy metals was elevated in Plantago major.

In conclusion it can assert that a thorough understanding of visual and non-visual environmental aesthetics is needed, including examinations of the possibility that affect elicited by scenic encounters with preferred landscapes can lead people to form emotional attachments to the land and thereby develop a greater appreciation for sustainability goals (Parsons and Daniel, 2002).

Acknowledgement

The authors would like to thank: Scott D. Bradley (Chief Landscape Architect, Minnesota DOT), Barbara A. Petrarca (Landscape Architect), Giorgio Chiarello (Senior Architect, One Works SpA), Karen Van Citters (Principal, Van Citters Historic Preservation LLC), Keith Robinson (Principal Landscape Architect, CALTRANS), Nikiforos Stamatiadis (Professor, University of Kentucky) and Alessandro Dal Piaz (Professor, University of Naples Federico II).

References

Arizona Department of Transportation. 1993. *Application Procedures for Designation of Parkways, Historic and Scenic Roads in Arizona*. Phoenix, Arizona 82 p.

Arriaza, M.; Cañas-Ortega, J. F.; Cañas-Madueño, J.; Ruiz-Aviles, P. 2004. Assessing the visual quality of rural landscapes. *Landscape and Urban Planning* 69(1): 115–125.

Ayad, Y. 2005. Remote sensing and GIS in modeling visual landscape change: a case study of the Northwestern arid coast of Egypt. *Landscape and Urban Planning* 73(4): 307–325.

B.U.R.C. Special issue. 2007. *Landscape Guidelines*. Campania Region, Italy.

Bureau of Land Management (BLM). 1986. *Visual Resource Inventory*. US Department of the Interior, Office of Public Affairs, Washington DC. BLM Manual Handbook 8410-1.

California Department of Transportation (CALTRANS), 2001a. *The California Scenic Highway Program*.

California Department of Transportation (CALTRANS), 2001b. *Highway Design Manual. Scenic Values in Planning and Design (Chapter 100)*. 39 p.

Clay, G.; Smidt, R. 2004. Assessing the validity and reliability of descriptor variables used in scenic highway analysis. *Landscape and Urban Planning* 66(4): 239-255.

Csereklye, E. 2010. Monitoring of landscape combinations and concourses in the Hungarian Danube-bend. *Journal of Environmental Engineering* and *Landscape Management* 18(1): 5–12.

De la Fuente de Val, G.; Atauri, J.; de Lucio, J. 2006. Relationship between landscape visual attributes and spatial pattern indices: A test study in Mediterranean-climate landscapes. *Landscape and Urban Planning* 77(4): 393–407.

ETS 176:2000. 2000. *European Landscape Convention*. Explanatory Report. Council of Europe, Florence. 16 p.

Garré, S.; Meeus, S.; Gulinck H. 2009. The dual role of roads in the visual landscape: A case-study in the area around Mechelen (Belgium). *Landscape and Urban Planning* 92(2): 125–135.

Jankauskaitė, M.; Taraškevičius, R.; Zinkutė, R.; Veteikis, D. 2008. Relationship between landscape self-regulation potential and topsoil additive contamination by trace elements in Vilnius City. *Journal of Environmental Engineering* and *Landscape Management* 16(1): 5–14.

Jankauskaitė, M.; Veteikis, D. 2010. On the problem of territorial distribution of sample areas for landscape monitoring purposes. *Journal of Environmental Engineering* and *Landscape Management* 18(3): 234–241.

Medineckien, M.; Turskis, Z.; Zavadskas, E. 2010. Sustainable construction taking into account the building impact on the environment. *Journal of Environmental Engineering* and *Landscape Management* 18(2): 118–127.

Parsons, R,; Daniel, T. 2002. Good looking: in defense of scenic landscape aesthetics. *Landscape and Urban Planning* 60(1): 43–56.

Rogge, E.; Nevens, F.; Gulinck, H. 2007. Perception of rural landscapes in Flanders: Looking beyond aesthetics. *Landscape and Urban Planning* 82(4): 159–174.

U.S. Department of Transportation, Federal Highway Administration, Office of Enviromental. 1988. *Visual Impact Assessment for Highway Projects*. In Publication No. FHWA-HI-88-054.

USDA Forest Service. 1995. *Landscape Aesthetics: a Handbook for Scenery Management*. Agriculture Handbook Number 701, 1995. 730 p.

Veteikis, D.; Jankauskaitė, M. 2009. Territorial regionalization of landscape technosphere in Lithuania. *Journal of Environmental Engineering* and *Landscape Management* 17(1): 60–67.

Washington State Department of Transportation. 2001. *Scenic Byway Designation Process Report Washington State Department of Transportation*. Olympia, WA.

POKAZATELJI U ANALIZI IZGLEDA PREDELA U OKOLINI AUTO-PUTA: TEST STUDIJA DUŽ DRUMSKIH KORIDORA U ITALIJI

Gianluca Dell'Acqua, Raffaele Mauro, Francesca Russo

Sažetak: U radu je prikazana primena i verifikacija iscrpnih metodologija koje upotrebljavaju međunarodne agencije kako bi ocenile kvalitet izgleda predela u okolini auto-puta. U svetu danas, nekoliko država utvrđuje vizuelni kvalitet predela primenom nezavisnih promenljivih veličina. Prikazano istraživanje ima za cilj verifikaciju definisanih nezavisnih promenljivih koje bi omogućile adekvatnu procenu i od strane neobučenog posmatrača. Na definiciju kvaliteta izgleda predela u okolini auto-puta najčešće utiču subjektivna mišljenja, ali ponekad postoje izuzeci. Opšte mišljenje ukazuje na visok vizuelni kvalitet predela ukoliko postoje prirodni rezervati, nacionalni parkovi i arheološke znamenitosti. Različite procedure predložene u međunarodnoj literaturi ukazuju na primenu promenljivih indikatora za ocenu javnih prioriteta. U radu su izabrane tri promenljive za analizu razmatranih predela u Italiji: živopisnost, očuvanost i skladnost. Za svaki od razmatranih predela snimljene su kolekcije fotografija. Grupe pejzažnih arhitekata su ocenjivale slajdove svakog predela koristeći skalu od 1-7 za sva tri indikatora. Identični slajdovi su zatim pokazani grupi neobučenih posmatrača na uzorku od 201 studenta, korišćenjem skale od 1 do 10 za ocenu lepote predela u okolini auto-puta na svakoj ponuđenoj slici. Ocene studenata su zatim upoređene sa dobijenim ekspertskim ocenama. Dobijeni rezultati ukazuju na to da je živopisnost u najvećoj meri u korelaciji sa lepotom predela koja je u daleko slabijoj korelaciji sa očuvanošću.

Ključne reči: auto-put, menadžment predela, vizuelni kvalitet, lepota predela.