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# Coastal Scenic Evaluation: A Study of Some Dalmatian (Croatia) Areas

**A. Ergin†; T. Karakaya†; A. Micallef‡; M. Radic∞ and A. T. Williams#**

†Civil Engineering Dept. Middle East Technical University, Ankara, Turkey. ergin@metu.edu.tr

‡ ICOD, Int. Foundation Studies, University of Malta, Valetta, Malta. a.micallef@icod.edu.org

∞ SUNCE Envir. Org. Baba Jelacica, 4, Split, Croatia. .marina.radic@sunce-st.org

#Built Environment. Swansea Institute, University of Wales, UK allan.williams@virgin.net.

**ABSTRACT**

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Many scenic assessments have been carried out on a subjective base. A novel technique addressed scenic evaluation, through application of fuzzy logic methodologies to values obtained from a checklist that itemized 26 physical and human parameters. These parameters, obtained by consultation with coastal experts and users, were rated on a five-point attribute scale, covering presence/absence or poor quality (1), to excellent/outstanding (5). These attributes, subjected to fuzzy logic analyses producing matrices/weightings, which reflected parameter importance and culminated in weighted averages and membership degree figures, gave an overall result for scenic assessment over attributes. These values enabled calculation of an Evaluation Index (D), which categorized all sites and statistically best-described attribute values in terms of weighted areas. High weighted averages for attributes 4 (excellent) & 5 (outstanding) reflected high scenic quality. For Croatia, 33 sites were investigated and areas found to group into five distinct categories: CLASS 1: Extremely attractive natural sites with a very high landscape values and a D value > 0.85. CLASS 2: Attractive natural sites with high landscape values and a D value between 0.65 and 0.85. CLASS 3: Mainly natural sites with little outstanding landscape features and a D value between 0.4 and 0.65. CLASS 4: Mainly unattractive urban sites, with a low landscape value and a D value between 0 and 0.4. CLASS 5: Very unattractive urban sites, with intensive development, a low landscape value and a D value below zero.

**ADDITIONAL INDEX WORDS:** *Fuzzy logic analyses, matrices.*

## INTRODUCTION

Landscape is a veritable palimpsest and assessment of landscape scenery has evolved considerably during the past 30 years, even though Appleton's (1973) dictum still prevails. Ideas that permeate the field have followed the pattern shown by SMITH *et al.* (2002) for geomorphological research in landscape development, i.e. the pattern conforms to the model for scientific change proposed by KUHN (1962). Major shifts characterise conceptual thinking, rather than a gradual diffusion of ideas and 'falsification' as advocated by Karl Popper. The application of fuzzy logic systems to scenic evaluation is such a shift. Scenery is a resource, but measurement of this resource has taxed the brains of many eminent scientists. Many checklists and photographic inventories have been utilised, and important concepts expressed, for example by, amongst many others, FINES (1968), LEOPOLD (1969), STAFFORDSHIRE COUNTY COUNCIL (1973), LINTON (1968, 1982), CARLSON, (1977), BRIGGS and FRANCE (1980), BUYOFF and ARNDT (1981), PENNINGROWSELL (1982,1989), CC (1987,1993), CCW (1996, 2001). This paper utilises a new technique based upon fuzzy logic mathematics.

## BACKGROUND

A pilot study for coastal scenic evaluation of some Dalmatian areas, was undertaken in two Dalmatian Counties - Split-Dalmatia and Dubrovnik-Neretva, which covers some 18% of the total Croatian land surface area. The studied areas included the town of Split, together with the islands of Vis, Bisevo, Brac, Hvar (all in the Split-Dalmatia county); and in the Dubrovnik area the islands Mljet, Lastovo and Korcula (DURBESIC,1995). The coastline epitomizes a drowned mountain chain, in that numerous islands occupy the coastal areas. The geology is mainly limestone and dolomites, and vegetation is typically maquis and garigue, with the occasional Mediterranean pine forest. Poljes and dolines abound on the islands of the archipelago. A growing trend in tourism has resulted in it become one of its most important economic activities. The CROATIAN BUREAU of STATISTICS (2002) reported that the number of tourists visiting Croatia in 2002 was 8,320,203, out of which 1,375,858 were domestic, the remainder being foreigners (mostly Italians, Germans, Slovenians, Czechs). Tourists stay mainly in the coastal areas because of outstanding scenery and clear water.

## METHODOLOGY

Scenic evaluation for some 33 coastal areas along the Dalmation coastline, were assessed by a new checklist technique (WWF, 2003), (Table 1). The basic approach was formulated upon the seminal work of LEOPOLD (1969), where parameters were inventoried and assessed as to their suitability for addressing the aesthetic aspects of scenery. LEOPOLD (1969), aimed to reduce subjectivity so that results '*could be used in many planning and decision making contexts*' (LEOPOLD, p4, 1969).

In scenic evaluation, the checklist which itemized physical and human parameters was the first step. Parameter selection was achieved by interviews of coastal users (>500) and experts, as to what items constitute the essence of coastal scenery, together with a ranking for the parameter importance. Results were tabulated and summarized into 26 distinct parameters. For details, see ERGIN *et al*, (2003, 2004*)*. Each of the 26 parameters (grouped under the headings of Physical / Human; Table 2), was assessed and given an evaluation number ranging from 1-5.Analysis of results was via:

### Fuzzy Logic Systems

To attain an optimum semi-quantifiable analysis for coastal landscapes through the checklist approach, a fuzzy logic Systems approach (AMBALA, 2001; CZOGOLA and LESKI, 2001) enabled an expert group to quantify any uncertainties and subjective pronouncements.

Table 1. *Calculated values of the D parameter: The Site Evaluation Index.*

| No: | Sites | $D = [(-2xA_{12})+(-1xA_{23})+(1xA_{34})+(2xA_{45})]/A_T$ (see text) |
|---|---|---|
| 1 | Zlatni Rat (Br) | 1.21 |
| 2 | Zaglav (V) | 1.18 |
| 3 | BigLake (M) | 1.09 |
| 4 | Struga (L) | 1.08 |
| 5 | Zabarje (L) | 1.07 |
| 6 | Sv.Mihajlo (L) | 1.06 |
| 7 | Mezuporat (B) | 0.83 |
| 8 | Zaklopatica (L) | 0.82 |
| 9 | Korcula (K) | 0.80 |
| 10 | Polace (M) | 0.78 |
| 11 | Srebrna (V) | 0.69 |
| 12 | Stiniva (V) | 0.68 |
| 13 | Salbunara (B) | 0.67 |
| 14 | Skrivena Luka (L) | 0.67 |
| 15 | Sobra (M) | 0.66 |
| 16 | StariGrad (H) | 0.66 |
| 17 | Porat (B) | 0.65 |
| 18 | Komiza 2 (V) | 0.54 |
| 19 | Komiza 1 (V) | 0.51 |
| 20 | Milna (V) | 0.49 |
| 21 | Croatia beach,Cavtat (D) | 0.46 |
| 22 | Jadran (S) | 0.46 |
| 23 | Sustipan (S) | 0.44 |
| 24 | Ploce (D) | 0.40 |
| 25 | Bonje (D) | 0.33 |
| 26 | Bobovisca Luka (Br) | 0.26 |
| 27 | Albatross beach, Cavtat (D) | 0.26 |
| 28 | Dance (D) | 0.25 |
| 29 | Kastelet (S) | 0.22 |
| 30 | Milna (Br) | 0.21 |
| 31 | Supetar (Br) | 0.13 |
| 32 | Uvala Lapad (D) | -0.26 |
| 33 | Bacvice (S) | -0.26 |

Key:
V = Vis island; Br = Brac island; M = Mljet island;
B = Bisevo island; L = Lastovo island; S = Split region;
D = Dubrovnik region

## Weightings and Matrices

Weight matrices affect the final assessment results as some parameters are more important than others, as shown by the perception studies (ERGIN *et al*, 2004). For every graded i'th assessment parameter, a possible square membership-grading matrix $M_i$ was established with the estimated membership grades. This was undertaken as it is probable that an error may be introduced re the chosen attribute grades. Attributes were formed from a set of five ordered grades (1,2,3,4,5). An example for the 17th parameter, (natural vegetation), the membership grading matrix $M_{17}$ and related attributes were:

$$M_{17} = \begin{array}{c|ccccc} & 1 & 2 & 3 & 4 & 5 \\ \hline 1 & 1 & .2 & 0 & 0 & 0 \\ 2 & .2 & 1 & .2 & 0 & 0 \\ 3 & 0 & .2 & 1 & .2 & 0 \\ 4 & 0 & 0 & .2 & 1 & .2 \\ 5 & 0 & 0 & 0 & .2 & 1 \end{array}$$

- 1- Bare <10%
- 2- Scrub/garigue
- 3- Wetlands/meadows
- 4- Coppice/maquis
- 5- Mature tree variety/ natural.

In matrix $M_{17}$, each row corresponds to each attribute listed above with the order 1 to 5. The first row's elements is reserved for the grading of 'bare <10%', the second row for 'scrub/garigue' etc.(WWF, 2003). Estimated membership grades for each attribute element of the matrix, were assessed from possibilities ranging from 0 (no possibility) to 1 (highest possibility). Values for the possibilities were obtained via expert opinion based on the possible error margin that could be made in deciding grades. If the parameter was absent, then the first element of the first row is 1 while all other entries of the row are zero. In the example given, 'vegetation covered <10%' the error margin was considered to be 0.2, so this possibility was given to the second row item (BCR, 3003). For the remainder, it is extremely unlikely that the error 'jumps' an assessment grade, and an 'error margin' or 0.2 was given either side of the assigned grade. The remaining matrix rows were constructed via similar logic. As an example, graded attributes for Zaglev is shown in 'Assesment Matrix', ( Table 2).

## Fuzzy Logic Approach Calculations

Fuzzy Logic Approach calculations were carried out in two basic steps:

- Fuzzy assessment matrices for assessment parameters as weighted averages of physical and human factors ( $V_P$ , $V_H$), ( Table 2).
- Membership degrees of physical and human factors (final assessment matrix R of attributes (from 1-5), (Table 2). These calculations were carried out for all investigated sites. The results are represented in graphical forms for all sites:
- The graph of weighted average of attributes grouped into physical and human parameters ($V_P$ , $V_H$ ). In Fig.1 a, Zaglev is given as an example.
- The graph of membership degrees of attributes(R). In Fig.1b, Zaglev and Fig.1c, Uvala Lapad are given as an example.

## Site Evaluation Index D

Based on the above given data, a parameter criteria (termed D) enabled scenic values for any site to be calculated. This was termed a Site Evaluation Index (D), and gives the site scenic value, calculated from membership degree versus attributes graphs (Figs1b and c).

$$D = \frac{(-2.A_{12}) + (-1.A_{23}) + (1.A_{34}) + (2.A_{45})}{\text{Total area under curve}}$$

Where: $A_{12}$ = total area under the curve between attributes 1 and 2. Similarly, areas under the curve may be calculated for $A_{23}$, $A_{34}$, $A_{45}$. The higher this value, the higher the scenic evaluation. The Site Evaluation Index distinguished five categories or classes of scenery.

## RESULTS AND DISCUSSIONS

The computations presented as weighted averages of attributes grouped in physical and human parameters, form a base for a relative comparison of factors both physical and human. Attribute values ranging from 1 to 5 signifies the rating value of the scenic assessment.

High weighted average on attributes e.g. attributes 4 or 5, reflected a high scenic assessment (high rating) value (Fig. 1a). Conversely, a high weighted average value on attributes, such as attributes 1 or 2, reflected a low scenic (low rating) value.

A Membership degrees vs. Attribute curve, gives the overall scenic assessment result over the attributes. Interpretation of these curves is based on the curve skew; where a curve skews to the right hand side this reflects high scenic assessment value (Fig. 1b, Zaglav). Conversely, a curve skewed to the left reflects a low quality assessment value arising from high scores on attributes 1 and 2. (Fig.1c, Uvala Lapad). The results provide a means for protection/improvements through effective management of any area. D values of 0.85, 0.65, 0.4, and zero

Table 2. *Assessment matrix for Zaglav.*

| Zaglav (V), D = 1.18 | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Assessment Matrices** | | | | | | | | | | | | | | | | | | | | | | | |
| **No;** | **Assessment Parameters** | | **Graded Attributes** | **Weights Of Parameters** | **Input Matrices $d_i$** | | | | | **Fuzzy Assessment Matrices** | | | | | | | | | | | | | |
| | | | | | | | | | | **A Matrices** | **Grade Matrices $G_i$** | | | | | **R Matrices** | **Fuzzy Weighted Assessment Matrix $R_m$** | | | | |
| | **Physical** | | | | | | | | | | **Attributes (1-5)** | | | | | | **Attributes (1-5)** | | | | |
| | | | | **$W_P$** | | | | | | | **1** | **2** | **3** | **4** | **5** | | **1** | **2** | **3** | **4** | **5** |
| 1 | Cliff Height | (1-1) | 1 | 0,019 | 1 | 0 | 0 | 0 | 0 | | **1,00** | 0,00 | 0,00 | 0,00 | 0,00 | | **0,019** | 0,000 | 0,000 | 0,000 | 0,000 |
| 2 | Cliff Slope | (1-2) | 1 | 0,017 | 1 | 0 | 0 | 0 | 0 | | **1,00** | 0,00 | 0,00 | 0,00 | 0,00 | | **0,017** | 0,000 | 0,000 | 0,000 | 0,000 |
| 3 | Special Features | (1-3) | 1 | 0,028 | 1 | 0 | 0 | 0 | 0 | | **1,00** | 0,00 | 0,00 | 0,00 | 0,00 | | **0,028** | 0,000 | 0,000 | 0,000 | 0,000 |
| 4 | Beach Type | (2-1) | 1 | 0,034 | 1 | 0 | 0 | 0 | 0 | | **1,00** | 0,00 | 0,00 | 0,00 | 0,00 | | **0,034** | 0,000 | 0,000 | 0,000 | 0,000 |
| 5 | Beach Width | (2-2) | 1 | 0,029 | 1 | 0 | 0 | 0 | 0 | | **1,00** | 0,00 | 0,00 | 0,00 | 0,00 | | **0,029** | 0,000 | 0,000 | 0,000 | 0,000 |
| 6 | Beach Color | (2-3) | 1 | 0,024 | 1 | 0 | 0 | 0 | 0 | | **1,00** | 0,00 | 0,00 | 0,00 | 0,00 | | **0,024** | 0,000 | 0,000 | 0,000 | 0,000 |
| 7 | Shore Slope | (3-1) | 4 | 0,014 | 0 | 0 | 0 | 1 | 0 | | 0,00 | 0,00 | **0,50** | **1,00** | **0,50** | | 0,000 | 0,000 | **0,007** | **0,014** | **0,007** |
| 8 | Shore Extent | (3-2) | 4 | 0,015 | 0 | 0 | 0 | 1 | 0 | | 0,00 | 0,00 | **0,50** | **1,00** | **0,40** | | 0,000 | 0,000 | **0,007** | **0,015** | **0,006** |
| 9 | Shore roughness | (3-3) | 3 | 0,022 | 0 | 0 | 1 | 0 | 0 | $A_P$ | 0,00 | **0,10** | **1,00** | **0,60** | 0,00 | $R_P$ | 0,000 | **0,002** | **0,022** | **0,013** | 0,000 |
| 10 | Dunes | (4) | 1 | 0,039 | 1 | 0 | 0 | 0 | 0 | | **1,00** | 0,00 | 0,00 | 0,00 | 0,00 | | **0,039** | 0,000 | 0,000 | 0,000 | 0,000 |
| 11 | Valley | (5) | 1 | 0,079 | 1 | 0 | 0 | 0 | 0 | | **1,00** | 0,00 | 0,00 | 0,00 | 0,00 | | **0,079** | 0,000 | 0,000 | 0,000 | 0,000 |
| 12 | Landform | (6) | 4 | 0,085 | 0 | 0 | 0 | 1 | 0 | | 0,00 | 0,00 | **0,60** | **1,00** | **0,20** | | 0,000 | 0,000 | **0,051** | **0,085** | **0,017** |
| 13 | Tides | (7) | 5 | 0,036 | 0 | 0 | 0 | 0 | 1 | | 0,00 | 0,00 | 0,00 | 0,00 | **1,00** | | 0,000 | 0,000 | 0,000 | 0,000 | **0,036** |
| 14 | Landscape Features | (8) | 4 | 0,122 | 0 | 0 | 0 | 1 | 0 | | 0,00 | 0,00 | 0,00 | **1,00** | **0,20** | | 0,000 | 0,000 | 0,000 | **0,121** | **0,024** |
| 15 | Vistas | (9) | 4 | 0,095 | 0 | 0 | 0 | 1 | 0 | | 0,00 | 0,00 | 0,00 | **1,00** | **0,30** | | 0,000 | 0,000 | 0,000 | **0,095** | **0,029** |
| 16 | Water Color | (10) | 5 | 0,139 | 0 | 0 | 0 | 0 | 1 | | 0,00 | 0,00 | 0,00 | **0,20** | **1,00** | | 0,000 | 0,000 | 0,000 | **0,028** | **0,140** |
| 17 | Vegetation Cover | (11) | 5 | 0,117 | 0 | 0 | 0 | 0 | 1 | | 0,00 | 0,00 | 0,00 | **0,20** | **1,00** | | 0,000 | 0,000 | 0,000 | **0,023** | **0,117** |
| 18 | Seaweed | (12) | 5 | 0,086 | 0 | 0 | 0 | 0 | 1 | | 0,00 | 0,00 | 0,00 | **0,20** | **1,00** | | 0,000 | 0,000 | 0,000 | **0,017** | **0,086** |
| *FUZZY WEIGHTED AVERAGES MATRIX FOR SUBSET PHYSICAL $V_P$* | | | | | | | | | | | | | | | | | **0,269** | **0,002** | **0,088** | **0,412** | **0,461** |
| **Human** | | | | **$W_H$** | | | | | | | | | | | | | | | | | |
| 19 | Disturbance Factor | (1) | 5 | 0,137 | 0 | 0 | 0 | 0 | 1 | | 0,00 | 0,00 | 0,00 | **0,20** | **1,00** | | 0,000 | 0,000 | 0,000 | **0,027** | **0,137** |
| 20 | Litter | (2) | 5 | 0,149 | 0 | 0 | 0 | 0 | 1 | | 0,00 | 0,00 | 0,00 | **0,20** | **1,00** | | 0,000 | 0,000 | 0,000 | **0,030** | **0,149** |
| 21 | Sewage | (3) | 5 | 0,149 | 0 | 0 | 0 | 0 | 1 | | 0,00 | 0,00 | **0,20** | 0,00 | **1,00** | | 0,000 | 0,000 | **0,030** | 0,000 | **0,149** |
| 22 | Non-built Environment | (4) | 5 | 0,064 | 0 | 0 | 0 | 0 | 1 | $A_H$ | 0,00 | 0,00 | **0,20** | 0,00 | **1,00** | $R_H$ | 0,000 | 0,000 | **0,013** | 0,000 | **0,064** |
| 23 | Built Environment | (5) | 4 | 0,137 | 0 | 0 | 0 | 1 | 0 | | 0,00 | 0,00 | **0,30** | **1,00** | 0,00 | | 0,000 | 0,000 | **0,041** | **0,137** | 0,000 |
| 24 | Access Type | (6) | 4 | 0,091 | 0 | 0 | 0 | 1 | 0 | | 0,00 | **0,20** | 0,00 | **1,00** | **0,20** | | 0,000 | **0,018** | 0,000 | **0,091** | **0,018** |
| 25 | Skyline | (7) | 5 | 0,137 | 0 | 0 | 0 | 0 | 1 | | 0,00 | 0,00 | 0,00 | 0,00 | **1,00** | | 0,000 | 0,000 | 0,000 | 0,000 | **0,137** |
| 26 | Utilities | (8) | 4 | 0,137 | 0 | 0 | 0 | 1 | 0 | | 0,00 | 0,00 | **0,20** | **1,00** | 0,00 | | 0,000 | 0,000 | **0,027** | **0,137** | 0,000 |
| *FUZZY WEIGHTED AVERAGES MATRIX FOR SUBSET HUMAN $V_H$* | | | | | | | | | | | | | | | | | 0,000 | **0,018** | **0,111** | **0,421** | **0,654** |
| *Fuzzy Weighted Averages Matrix* | | | | | | | | | | | | | | | | | | | | | |
| **Elements of Fuzzy Weighted Averages Matrix** | | | | **Weights Of Subsets $W_F$** | | | | | | | | | | | | **Attributes (1-5)** | | | | | |
| | | | | | | | | | | | | | | | | | **1** | **2** | **3** | **4** | **5** |
| Fuzzy Weighted Averages Matrix of Subset Physical $V_P$ | | | | 1/2 | | | | | | | | | | | | **Matrix K** | **0,269** | **0,002** | **0,088** | **0,412** | **0,461** |
| Fuzzy Weighted Averages Matrix of Subset Human $V_H$ | | | | 1/2 | | | | | | | | | | | | | **0,000** | **0,018** | **0,111** | **0,421** | **0,654** |
| *Final Fuzzy Assessment Matrix ($W_F$ x K)* | | | | | | | | | | | | | | | | | | | | | |
| **Final Assessment Matrix ( R ) : Membership Degree** | | | | | | | | | | | | | | | | | **0,134** | **0,010** | **0,099** | **0,417** | **0,558** |

respectively (Table.1) demarcate classes. Details as to the choice of these values are given extensive discussion in BCR (2003) and WWF (2003).

## i) Class 1

Six sites qualified for this classification (Table 1). These sites rate highly due to outstanding features in both natural and anthropogenic parameters. The top five rated parameters were absence of sewage and litter, watercolour and consequent clarity, noise absence, quality of built environment and landscape features (caves, arches etc.). Other highly rated parameters included beach type and natural vegetation cover. Zlatni Rat epitomises areas, which would rate highly on any scenic assessment list. It has very low scores regarding attributes covering grades 1-3, because no rocky shore, dunes or river exists in the area. A higher human score for grade 4 reverses for grade 5 with respect to the physical. The site is located on a bleached cobble spit surrounded by a well-wooded landscape and is backed by mountains. Little beach litter is evident and management is currently sound. Despite an absence of cliffs and rocky shore platforms, Barje was classified as a grade 1 site and exhibited some magnificent water-colour emerald green.. Its human parameter rating was almost 100% in grade 5. Struga boasts a lighthouse having panoramic views over the area but did not have a beach. Management of these sites plus the other three in this category appears to be extremely sound, reflecting a sound management methodology influenced by the high human attribute scoring. Zaglev, despite having no cliffs and beach scored extremely highly on the human parameters (Fig. 1a).

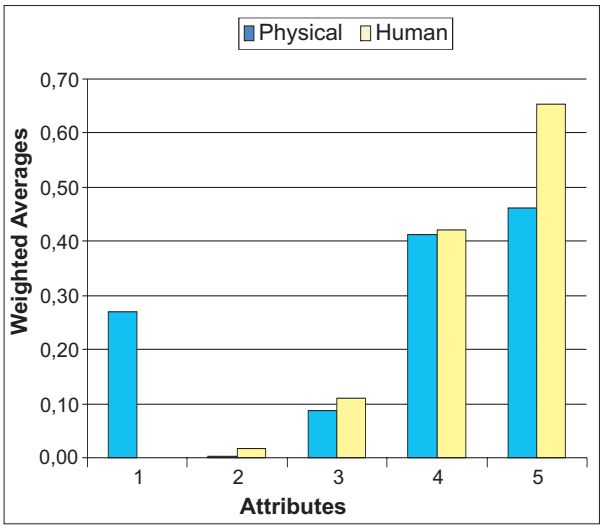


Figure 1a. Weighted averages vs. Attributes: Zaglev.

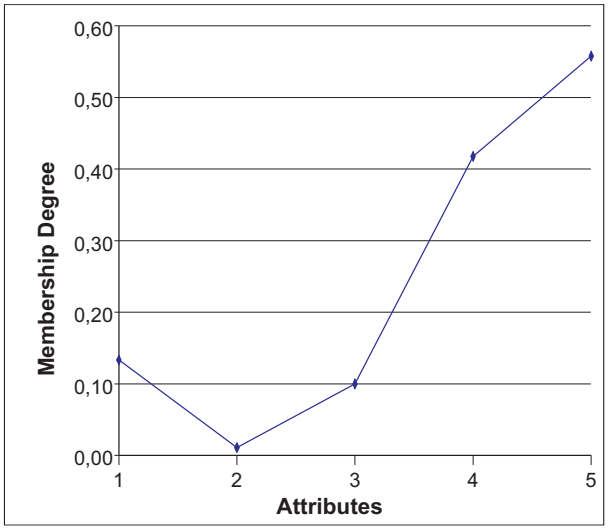


Figure 1b. Membership Degree vs. Attributes: Zaglev.

## ii) Class 2 Sites

Eleven sites qualified for this class (Table 1). These sites rated slightly lower in parameter values, for example, a pebble rather than sand beach. Negative aspects of these sites mainly included litter and tourism related development. Stiniva is located in a superb area with cliffs, a pebble beach, excellent water, but its litter problem is immense. Huge accumulations of bottles, cans, paper etc, were common on this remote beach. It has open access only on one side, as it is a pocket shaped cove only accessible via boat or by climbing down a steep path. Clearance of litter would improve this area immensely. Srebrna also is located in an area of high scenic value but one whose beauty is marred again by excessive amounts of litter at the rear of the beach. For human parameters, it scored attribute grade 5 for all parameters apart from litter. Polace, is situated at the edge of the National Park on Mljet island. Litter and the absence of a concealed managed parking lot, detracts from the otherwise high quality scenery that abounds in the region. Korcula is a charming medieval village and scored the highest value of any urban scene investigated in this Croatian project.

## iii) Class 3 Sites

Seven sites qualified for this class (Table 1). Many of these had degrees of urbanisation associated with the ratings. Komiza 2 was the main town beach and has a dominant historic church built at the rear of the beach. No rocky shore is evident plus there is a marked absence of a buffer zone. The physical factors scored well. Croatia beach was located on a small bay and scored highly on cliff scenery and beaches. The natural vegetation score was excellent and the little restaurants on the bay edge were well in keeping with sensitive tourist development

## iv) Class 4 Sites

Seven sites qualified for this class (Table 1). Typically, negative aspects were dominated by creeping urbanisation with its associated problems of utilities, litter, poor skyline quality and noise disturbance. Adequate buffer zones would mitigate such negative features. The Dance area has an attractive air, but one that falls down on three main items. It has no beach; there is a very ugly burnt out hotel (Hotel Libertas), a relic of the nineties war, which dominates the scenery. Hideous concrete bathing platforms cover the sea access area. If management attended to these matters, the area could easily move up a grade. Supetar, is a harbour town which lacks cliffs and a buffer zone. It has a limited vista and the natural vegetation cover is sparse. Albatross beach, has no cliff scenery or beach but a mountainous skyline and many attractive coastal; features. No buffer zone exists and many utilities mar from the areas potential.

## v) Class 5 sites

Two sites qualified for this class (Table 1). typically, these had features such as unattractive urbanisatiOn, ugly coastal structures, Intensive tourIsm (hotel) development, high amounts of litter and noise and degraded natural environments e.g. loss of beach arising from anthropogenic developments. Uvala Lapad, is one of the main recreation beaches in Dubrovnik. Its attribute rating peaks at grade three and falls **st**eeply either side of the peak (5 items scoring a 1 attribute; and only 1 a 5 attribute; Fig. 1c).

The main reason for such a low grade is the graffiti covered dilapidated concrete shelters that skirt the beach, together with the litter found in the artificial beach and its many ugly utilities. Bacvice is a town beach situated in Split, and has a narrow, dark tan coloured beach with little non-built environment left. It experiences heavy tourism. The skyline surrounding the beach is unattractive, and management has an uphill task to obtain a higher grading.

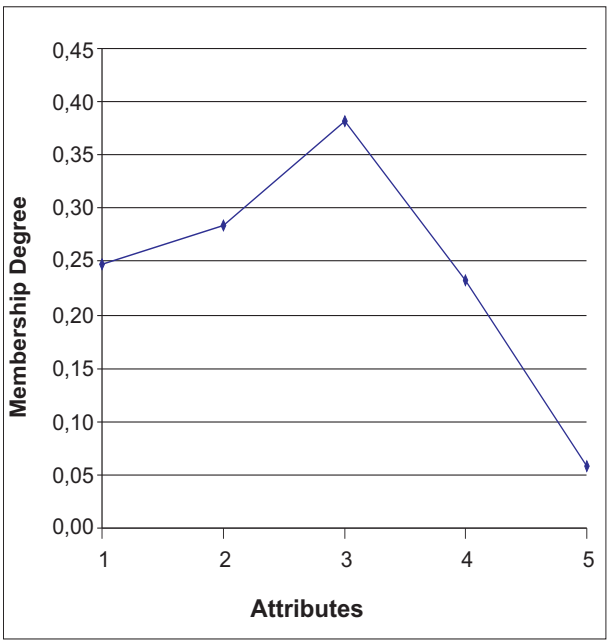


Figure 1c Membership degree vs. Attributes: Uvala Lapad.

## CONCLUSIONS

Managers can do little with respect to physical site factors, but many of the lower ratings found were so scored because of human factors. These can be changed. This reflects the important contribution that the Coastal Scenic Evaluation technique offers to the management and planning process. Generally, urban areas will rarely match remote areas with respect to coastal scenery, but some locations are jewels e.g. Korcula and the highest ranked site Zlatni Rat, was sited close to a large urban town. Concretization was the main reason why Uvala Lapad ranked last of the 33 sites investigated. In essence, the following are the main conclusions reached:

- The Coastal Scenic Evaluation System composed 18 physical and eight human parameters and was based on a five-scale attribute rating system.
- A parameter ranking importance via a weighting index was derived from a perception study.
- A mathematical model based on a fuzzy logic approach was developed.
- Management tools reflected strengths and weaknesses of evaluated sites based on data presentation in the form of assessment histograms and graphs of weighted averages versus attributes. The latter reflects the effect of physical and human parameters on a scenic assessment, be used as a tool by coastal planners.
- Membership degree vs. attribute curves identified the most appropriate D (Evaluation index) criteria. The skew of the membership degree vs. attribute curve immediately reflects the scenic value of the assessed sites.
- A Coastal Scenic Classification Table/Curve could be determined for all evaluated sites based upon calculated Evaluation index values (D). The latter reflected a five-class evaluation system for coastal scenery. Classes were characterised as:

  CLASS 1: Extremely attractive natural sites with a very high landscape values, having a D value > 0.85.
  CLASS 2: Attractive natural sites with high landscape values, having a D value between 0.65 and 0.85.
  CLASS 3: Mainly natural sites, little outstanding landscape features, and a D value between 0.4 and 0.65.
  CLASS 4: Mainly unattractive urban sites, with a low landscape value, and a D value between 0 and 0.4.
  CLASS 5: Very unattractive urban sites, with intensive development, low landscape values, and a D value below zero.

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