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Using A MultiPLE criteria Decision Analysis approach for Landscape Quality Assessment

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ABSTRACT

This paper aims to propose a framework for the valuation of the quality of landscape based on two complementary techniques developed in the context of multiple criteria decision analysis. The MACBETH technique is used to define numerical values based on verbal statements. It is complemented by the silent negotiation technique which is a heuristic technique used for the purpose of reaching a consensus within a group of people. We present the view that in order to determine the preferences of individuals with respect to the beauty of the landscape, cardinal data is required as an input for econometric procedures so as to quantify (in monetary or other terms) these preferences. The information is provided in the form of representative scores located within intervals of values.

Keywords: LANDSCAPE QUALITY, LANDSCAPE ASSESSMENT, MACBETH, SILENT NEGOTIATION, CARDINAL SCALE

RÉSUMÉ

L'objectif de ce papier est de proposer un cadre pour l'évaluation de la qualité du paysage basée sur deux techniques complémentaires développées dans le contexte de l'analyse d'aide multicritère à la décision. La technique MACBETH est utilisée pour définir des valeurs numériques basées sur des informations verbales. Celle-ci est complétée par la technique dite de négociation silencieuse, qui est une technique heuristique utilisée dans le but d'atteindre un consensus au sein d'un groupe de personnes. Afin de déterminer les préférences des individus quant à la beauté du paysage, des données cardinales sont nécessaires dans l'application de procédures économétriques visant à quantifier (en monnaie ou dans d'autres mesures) ces préférences. L'information est donnée sous forme de valeurs représentatives comprises dans des intervalles.

Mots-clés : QUALITE DU PAYSAGE, EVALUATION DU PAYSAGE, MACBETH, NEGOCIATION SILENCIEUSE, ECHELLE CARDINALE

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1. INTRODUCTION

Given its position on the boundary between an object, space/place and a subject, i.e. the observer, the eminently subjective concept of the landscape is difficult to contemplate outside of the individual sphere (Berque, 1991). However, Shuttleworth (1980) established that landscapes have an intrinsic or objective beauty which can be comparable and, therefore, quantifiable, although it can only be subjectively attributed to a specific landscape.

Various methods have been developed with the aim of evaluating or quantifying the visual quality of a landscape. The so-called "public preference" methods (Arthur et al., 1977) belong to an anthropocentric approach to the evaluation of the landscape using psychological and even phenomenological methods. Others try to measure this qualitative dimension through the different components of the landscape without really focusing on the perceptive dimension unique to each individual. These are descriptive inventory-type methods which include the formal aesthetic models and the ecological models. Finally, other approaches, known as quantitative holistic methods, try to establish a mathematical relationship between the components of the landscape and the preferences of individuals by means of multiple regression analyses. The surrogate component model and economic evaluation methods are typical examples of such approaches.

There is no getting around the fact, however, that due to the difficulty in expressing qualitative concepts in numerical terms, it is often difficult to obtain the data necessary to establish a relationship between the quality of the landscape and individual preferences. However, in many circumstances, access to a quantitative measure of the perceived quality of landscape is required. It is definitely a prerequisite for the integration of this variable into econometric evaluation processes for modelling individuals' preferences for landscape. For example, the hedonic price approach is a method that aims to explain house prices with various characteristics of the house being used as explanatory variables, one of which could be the quality of the landscape (Freeman, 1993).

Of course, when it comes to valuing the quality of a landscape, the question arises as to who should provide such evaluations. It would be difficult to rely on the views of a single expert in an area as subjective as this. Indeed, it may be assumed that a result based on a consensus reached by a group of experts is more credible than one based on the views of an individual.

To address these issues, this paper aims at proposing a framework to value the quality of landscape based on two complementary techniques developed in the context of multiple criteria decision analysis. The so-called MACBETH technique (*Measuring attractiveness by a categorical based evaluation technique*) is used to define numerical values based on verbal statements. It is complemented by the silent negotiation technique which is a heuristic technique for the purpose of reaching a consensus within a group of people. The piece of information it allows to obtain provides the basic data to apply the MACBETH technique. The paper reports the results of this process when applied to value the aesthetic quality of the natural landscapes of six ski resorts in the Swiss Alps. In an attempt to assess the validity of the method, it also discusses the extent to which the outcome is sensitive to the composition of the group.

The paper is structured as follows. Section 2 presents the proposed framework to value landscape quality, including the silent negotiation and the MACBETH techniques. The empirical results are presented in Section 3 and some of the issues arising from the processing of the results of silent negotiation using the MACBETH tool are discussed in Section 4. Brief conclusions are drawn in Section 5.

2. A FRAMEWORK TO VALUE THE QUALITY OF LANDSCAPE USING VERBAL STATEMENTS

2.1. Types of valuation scale

The use of scales helps us to get to the bottom of complex concepts like the quality of a landscape and provides valid measures of them, thus increasing the reliability and precision of the analysis (de Vaus, 1993). Fundamentally two main types of scale exist: the cardinal scale and the ordinal scale. The cardinal scale has regular divisions based on levels or stages (including a – sometimes conventional – point of origin) which subdivide it and enable measurements and calculations. For example, space and time have scales which enable calculations such as speed (distance/time); in this case the basic operators (addition, subtraction, multiplication and division) have a meaning (e.g. 4 m/s is twice 2 m/s). In this case, we speak of **ratio scale**.

The ordinal scale works in a different way. The only information available concerns the relative position of objects. For example, A is "as beautiful as" or "more beautiful than" B. In this case, the numbers that could be associated with each object represent the rankings

in an order (first, second, third etc.) and cannot, therefore, be manipulated using basic operators. For example, it is not possible to "add" the first and second rankings to extrapolate the third.

Thus, in order to be able to take non-cardinal dimensions into account in numerical evaluations, it makes sense to add information to the ordinal ranking. This information concerns the difference that exists between two pairs of objects. For example, one can ask experts to express their opinions on statements of the type "is the difference between A and B greater than that between C and D?". Thus, difficulty lies in the appropriate processing of the responses provided. To our knowledge, the only mathematically correct way of processing such responses is that provided by MACBETH.

2.2. Macbeth

MACBETH is a tool that originated in the area of **multiple criteria decision analysis** and has been developed since the early 1990s by Bana E Costa and Vansnick (2003). It has been used in numerous projects. [1] A total number of five stages are involved in the MACBETH process:

1. Classification of the objects in order of attractiveness; equal rankings or ties are allowed. In the interest of simplicity, the sequence of ordered objects is named (A, B, C, D, E). All of the pairs (A, B) form a square matrix. As can be seen in Figure 1 below, only the upper triangle of the square matrix is of interest. [2]

2. For each object pair (A, B) , the difference (i.e. in attractiveness) between A and B is defined by means of a verbal expression (e.g. "no", "very weak", "weak", "moderate", "strong", "very strong" and "extreme"). This information is only meaningful in the context of the differences provided for the other pairs (C, D). MACBETH can also function with the minimum of (n − 1) responses (in general the diagonal line of

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[1] MACBETH was used, for example, as a basis for the allocation of resources for the construction of new roads in the municipalities of the Lisbon region (Bana E Costa, 2001) and for the management of conflicts concerning (environmental, social and economic) objectives between the actors representing the municipalities. It was also used for the identification of priorities for the municipality of Lisbon in the context of the management of the budget allocation for its housing stock. What was involved here was the prioritization of activities such as the maintenance of buildings, the work to be carried out and renovation (Bana E Costa & Carvalho Oliveira, 2002).

[2] The "no difference" relationship is indicated by the diagonal (A, A) and the fields for the pairs (B, A) are empty: if A is more attractive than B, there is no "no difference" or positive difference in favour of B.

successive pairs), based on the hypothesis that the difference for the other pairs is positive (Figure 1).

Figure 1
Representation of the ranking of objects in matrix form, indication of difference in attractiveness and generation of scores using MACBETH software

	A	B	C	D	E	Current scale
A	no	v. strong	positive	positive	positive	100.00
B		no	very weak	positive	positive	54.55
C			no	moderate	positive	45.45
D				no	weak	18.18
E					no	0.00

3. MACBETH checks the consistency of the responses provided. The first test is easy to understand: if the differences between A and B and between B a C are "moderate", the difference between A and C is "moderate". More complex tests are also necessary, however these are beyond the scope of this paper.

4. If necessary, MACBETH proposes minimal changes to ensure the consistency of all of the responses.

5. MACBETH then calculates **numerical values** (*current scale* column) which are compatible with the verbal expressions provided. Thus, the resulting scale may be considered as cardinal; these compatible numerical values are not more precise than the verbal expressions on which they are based. For practical reasons, MACBETH proposes a representative score and indicates the interval of the compatible values with the verbal evaluations (Figure 2). Thus, the user is free to use the value that seems most appropriate.

Figure 2
The changing of the value of an object within an interval respects the consistency of the results of the verbal evaluation
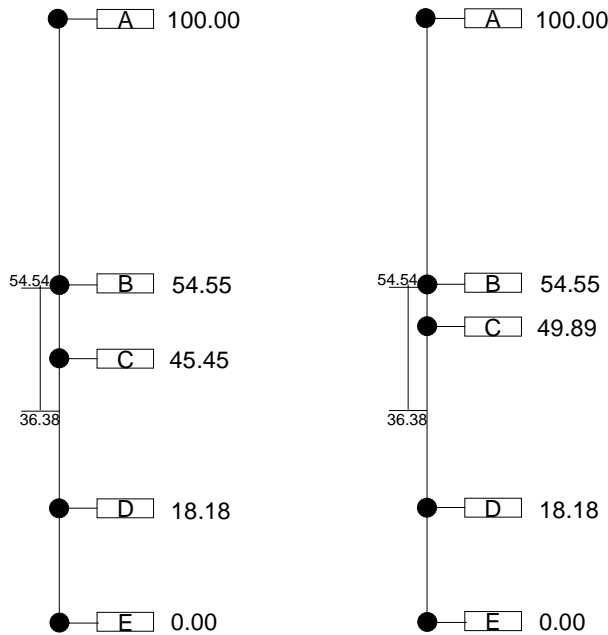
2.3. Silent negotiation

Like many decision aids, MACBETH was designed for use by a single decision-maker. When it is used for the purpose of reaching agreement between several actors or stakeholders, their mode of interaction should be adapted. This can be done in various ways. We used the **silent negotiation approach** (Pictet & Bollinger, 2004) which seeks to voluntarily limit the discussion of motivation in favour of the expression of preferences so that points of convergence and divergence can easily be identified. This process is carried out in silence.[3] The silent negotiation approach can be adapted smoothly to the MACBETH process if one takes care of two aspects. First, in order to categorize the objects, the actors can make a given number of changes in the ranking of the objects (i.e. shifting of an object one ranking up or down); it may be necessary to have several rounds of changes until a stable situation emerges.[4] Second, the differences between the objects are defined *a priori* as "moderate". Initially it is possible to confine oneself to the successive

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[3] These periods are framed by discussions, before the silence to explain the rules of the game and after the silence to discuss the results and alleviate the tensions that accumulate during the period of silence due to the fact that the majority of actors are not used to working in this way.

[4] This stable situation may be a single ranking with or without disagreement on the position of one object or another. Any disagreements that arise are duly noted to be dealt with at a later stage.

pairs of objects as the difference between certain other pairs of objects can be defined by checking. The actors may make a given number of changes (upward or downward shifting of a difference) in turn; it may be necessary to have several rounds of changes until a stable situation emerges.[5]

3. EVALUATING THE QUALITY OF THE LANDSCAPE OF SKI RESORTS

3.1. Starting point

The proposed framework was used to assess the quality of the landscape in six selected ski resorts, all located in the Swiss canton of Valais, namely Anzere, Champery, Grimentz, Haute-Nendaz, Ovronnaz and Verbier. A group of "**experts**" was brought together for an evaluation session. The group was made of people from different sectors so as to incorporate a number of varying perceptions into our qualitative evaluation of the landscape. Thus, the group included representatives from the tourism (specifically employees of tourism offices[6]), ecology and tourism research sectors and from public bodies. The evaluation session begun with an introductory phase during which the objective of the study and the reason for the participants' involvement were explained to them. This made it possible to confirm the role assigned to them.

Members of the group were then presented with the objects for comparison, i.e. they were shown a series of photographs of the natural landscape to be valued. The landscape was depicted using one panoramic photograph of the most prominent view from the ski resort[8]. The photographs were taken at the end of winter 2002-03. Thus, they all show a natural snow-covered landscape. An attempt was made to maintain consistency in terms of exposure and brightness. The six photographs were identified using letters as the use of names could have prompted the participants to be less objective in their assessments. An opportunity for discussion was also provided so as to clarify any doubts and questions the

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[5] This stable situation may involve disagreements on the differences. Any disagreements that arise are duly noted to be dealt with at a later stage.

[6] Obviously, those selected did not work in the resorts included in our sample.

[8] These prominent views were not selected randomly. We took the photographs after consultations with estate agents and/or members of the tourism offices in each location.

participants may have had. The participants were then requested to complete the two evaluation phases:

1. To **rank the objects** from most beautiful to least beautiful, equal rankings or ties being allowed. The facilitator explained the rules involved, i.e. the number of rounds during which the participants could change the ranking (unlimited in this instance) and the number of changes authorized during each round (three in this instance).

2. Once the ranking had been established, the participants were asked to **define the difference** between the pairs of objects using a verbal (ordinal) scale comprising seven expressions, ranging from "no difference" to "extreme difference". Here too, once the facilitator had explained the rules involved in this phase, he defined the number of rounds and changes allowed per person and per round (as above).

The evaluation of the landscape using photographs lent itself well to the silent negotiation approach: the photographs were placed on a single line (equal ranking) and each participant was allowed to move the photographs or cards symbolizing the differences until an agreement was reached. In this way it is possible to resolve eventual value conflicts between project protagonists by asking them to assess whether one object is better or worse than another. It should be noted again, that the fact that an object is "worse" (in relative terms) than another does not mean that it is "ugly" (in absolute terms).

Finally, it is also important to keep in mind that the consensus is not an end in itself and that the participants may well fail to reach an agreement on the ranking of the different objects presented for their assessment. This is the case when changes made are redundant with respect to either the ranking or definition of differences. If this occurs, the facilitator must act as a mediator and propose a consensual solution. However this was not the case with the group of experts.

3.2. Results

Figure 3 shows the resulting ranking and the verbal definition of the differences between each pair of objects in matrix form for the experts' evaluation. Note that the ski resorts are identified using the first letter of their names. The natural landscape of Champery

occupies the top position in the ranking. Thus, it was evaluated as being relatively more beautiful than the natural landscape of Verbier. Moreover, the qualitative difference between these two landscapes – reflecting the preferences of the experts – is defined as *strong*. Similarly, based on the evaluation, it may be suggested that in terms of beauty the difference between the natural landscape of Ovronnaz and that of Grimentz is *weak*. It should again be noted that the position achieved by Champery does not provide any basis for the assumption that its natural landscape is the most beautiful (in absolute terms), or that the natural landscape of Haute-Nendaz is the ugliest (in absolute terms). It is merely possible to state, e.g., that there is a difference between the quality of the natural landscape of the latter and that of Anzere. This difference is expressed by the difference between their scores.

Figure 3
Results of the evaluation of the quality of the natural landscape

|	C	V	O	G	A	H-N	Current scale
C	no	strong	positive	positive	positive	positive	100.00
V		no	moderate	positive	positive	positive	75.00
O			no	weak	positive	positive	56.25
G				no	strong	positive	43.75
A					no	moderate	18.75
H-N						no	0.00

C : Champery V : Verbier O : Ovronnaz
G : Grimentz A : Anzere H-N : Haute-Nendaz

The *Current Scale* column shows the results of the conversion of the verbal expressions into numerical values, i.e. the scores generated for each station by MACBETH. These scores are based on a scale ranging from zero (the natural landscape deemed least attractive by the participants) to 100 (the natural landscape deemed most attractive by the participants). This makes it possible, firstly, to evaluate the qualitative difference between the beauty (or aesthetic quality) of each natural landscape and also to generate a score for each ski resort. Given that the verbal expressions are rather vague, the representative score generated by MACBETH is accompanied by the value of the interval within which it is located[8]. This is shown in Figure 4 in which both the ranking of each station and the score generated by MACBETH are presented on the local scale. The intervals within which the scores are located are represented in graphic form and make it possible to visually

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[8] In effect, it is possible to adjust the score allocated by MACBETH in this interval of value while remaining consistent with the verbal evaluation

grasp the scope of the differences that qualify each pair of landscapes. Thus, as the difference between Ovronnaz and Grimentz is *weak*, the intervals overlap (moreover, the upper limit of the interval within which Grimentz's score is located corresponds to Ovronnaz's score). Conversely, as the difference between Grimentz and Anzere is *strong*, there is no overlap between the intervals.

Figure 4
Graphical representation
of the MACBETH results
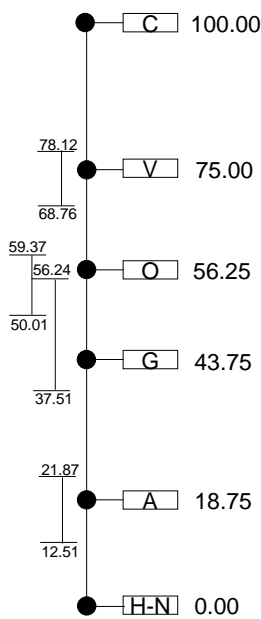
3.3 *The sensitivity of results based on the composition of the group*

In order to test the sensitivity of the aforementioned results based on the composition of the group that carries out the silent negotiation, the experiment was repeated using **control groups**. The validity of the method would, in fact, be reinforced –however not proven– if the evaluation based on the group of experts were consistent with that of the control groups. Alternatively, the legitimacy of the group of experts would be reinforced if the control groups provide evaluations that do not coincide with that provided by the experts. Four control groups were formed using students from two institutions, i.e. a graduate school of public administration and a business high school.

The columns in Figure 5 present the results of the group of experts (EG) followed by those of each of the four control groups (CG1 to CG4). The score computed using

MACBETH is shown beside each of the ski resorts, which are identified using the first letters of their names. The score is accompanied by its interval value. As can be seen, the rankings differ from one group to another. For example, the first group (CG1) judges the natural landscape of Verbier as being relatively more beautiful than that of Anzere. As opposed to this, the results for the fourth group (CG4) show that it values the natural landscapes of Anzere and Champery as being equal in quality, but relatively less beautiful than that of Verbiers.

Figure 5
Rankings, scores & interval values from the expert & control groups' (CG) evaluations

Experts	CG1	CG2	CG3	CG4
C = 100	V = 100	A = 100	A & V = 100	V = 100
V = 75 [68-78]	A = 69 [61-73]	O = 90 [80-100]	C = 78 [56-88]	A & C = 86 [64-100]
O = 56 [50-60]	C = 46 [38-53]	V & H-N =60 [55-70]	O & H-N = 44 [39-78]	G = 29 [0-43]
G = 44 [38-56]	O = 38 [31-46]	C = 20 [10-30]	G = 0	O & H-N = 0
A = 19 [12-22]	H-N 15 [8-19]	G = 0		
H-N = 0	G = 0			

C : Champery   V : Verbier   O : Ovronnaz
G : Grimentz   A : Anzere   H-N : Haute-Nendaz

When the experts' results are compared with those of the four other groups, although there is some evidence that the control groups' preferences differ from the experts' preferences, there is some consistency between the evaluations. Indeed, several rankings are similar and several intervals overlap. For example, the top ranking natural landscape in the experts' view, namely Champery, overlaps with the extremum of the interval value awarded to this resort by the fourth group [64-100]. This evidence is reinforced by the value assigned to Champery by the third group (CG3): the interval [56-88] overlaps with that of CG4. A degree of consistency can also be observed between the values of the control groups: three groups (CG1, CG3 and CG4) rank Verbier as being more beautiful than Anzere for CG1, Champery for CG3 and Anzere and Champery for CG4. Haute-Nendaz and Grimentz are ranked lowest on more than one occasion, i.e. three times in the case of Grimentz and twice in that of Haute-Nendaz.

However, differences also emerge from the different groups' evaluations. For example, Ovronnaz, which ranks third in the eyes of experts, is poorly evaluated by the control groups; CG1 and CG3 award it a score of less than 50 and CG4 considers, together with Haute-Nendaz , as being relatively less beautiful than Grimentz and awards it a score of zero. The same applies to Anzere which is deemed as being more beautiful than Haute-Nendaz by the experts (rank 5), whereas it is ranked as the top resort by CG2 and CG3.

The preferences expressed by CG3 and CG4 are virtually identical. For example, Anzere, Verbier and Champery are ranked first or second with overlapping intervals. Thus, these resorts are judged as showing very little difference in terms of the aesthetic beauty of their natural landscapes. Moreover, Grimentz, Ovronnaz and Haute-Nendaz are the lowest ranked resorts with almost perfect inversion.[11]

4. DISCUSSION

The aim of processing of the results of the silent negotiation with the help of the MACBETH method was not to define a reference standard in terms of the aesthetic quality of natural landscapes of the six selected ski resorts in the Swiss canton of Valais. Firstly, in order to do this it would have been necessary to take all of the resorts in Valais into account so as to create an eventual frame of reference for a specific region. Secondly, the evaluative procedure used incorporates a relative dimension (comparison by pairs) and the assessment of the aesthetic criteria is largely characterized by subjectivity. Thus, it would have been rather over-ambitious, if not foolhardy, to try to define a qualitative standard on the basis of which all landscapes would be considered as either ugly or beautiful. However, it can be expected that a more "absolute" assessment will be obtained if the actors are able to compare real objects (photographs) with abstract elements (the concept of a "beautiful" landscape).

In attempting to compare a number of perceptions in the establishment of a ranking for a given landscape, the use of the MACBETH method makes it possible to incorporate new ideas and to generate numerical values that can be used directly in a multiple regression analysis (e.g. in the use of the hedonic price method for the purpose of defining the willingness of individuals to pay for a high quality landscape; Tangerini & Soguel, 2004). In effect, basing an econometric analysis on ordinal data would not provide any

additional information should a change in status occur. It simply does not make sense and it is, moreover, mathematically unacceptable to use an ordinal ranking of the landscape quality in this kind of analysis if the differences between the rankings are unknown. Thus, the consideration and conversion of the differences that qualify each pair of objects on a cardinal scale makes it possible to create a basis that can be further exploited using econometric methods.

If Macbeth provides valid results which, like the hedonic price approach, can be used as input in econometric evaluations, the fact that these results can be influenced by those who take part in the silent negotiation should not be ignored. As our study shows, the outcome of negotiations by a group of experts was not fully consistent with that delivered by control groups. It proves that it is essential that the people involved in the negotiations be carefully selected and that reliance on a group that is representative of the various stakeholders is all but illegitimate.

Eventually, several points still need to be developed so as to test and stabilize our findings. Thus, given that it is – to our knowledge – pioneering in its field, this research needs further development. Firstly, seasonal variations were not taken into account. Thus, the same landscapes minus the snow cover would need to be presented so as to establish whether the texture or dominant criteria (season, luminosity etc.) trigger a change in the ranking and scores generated by MACBETH. The evaluation sessions would then have to be repeated with different groups of actors if one wants to overcome the problem of representativity of the group of experts. For example, it would make sense to repeat these sessions with other groups such as tourists (based on their location of origin or not), the resident population and representatives of different age and socio-economic groups. Finally, it is not inconceivable that the same results will be obtained from a given group if the evaluation is repeated after a year or two. For this reason, it would make sense to repeat the experiment with the same group of experts to see whether their perception of the aesthetic quality of natural landscapes remains stable over time.[12]

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[9] "Almost" because the interval for Ovronnaz and Haute-Nendaz [0-43] in CS4 overlaps with the ranking for Grimentz (29).

[10] Simos (1990, pp. 138-140) tests the consistency and evolution of six actors by comparing their classification of different criteria in 1987 and 1988. He concludes that the overall consistency of the group's judgements does not vary significantly and that the actors' preferences, which are based on their value systems, did not undergo any significant change.

5.   CONCLUSION

The aim of this paper was to present an approach that makes it possible to quantify preferences arising from a verbal evaluation of the quality of natural landscapes of six ski resorts in the Swiss Alps. We basically presented the view that in order to determine the preferences of individuals with respect to the beauty of the landscape, cardinal data was required for instance as an input for econometric procedures so as to quantify (in monetary or other terms) these preferences. The MACBETH technique together with the silent negotiation technique was used successfully to obtain this information. The information is given in the form of representative scores located within intervals of values.

As far as the silent negotiation is concerned, we were interested in finding out whether the results obtained using this kind of procedure would gain in credibility if based on the views of a group of experts rather than an individual. This leads back to the question of the antagonism between credibility and legitimacy. All we can say in this regard is that the method does not appear to be illegitimate. We admit that while there is a gain in credibility when using a group of expert, it has not been established that the legitimacy of the process warrants the description "*best practice*". However, this is in effect an innovative study which requires further development. However the consistency of its results is ultimately reinforced in two ways; firstly, through the consensus achieved between the five groups of negotiating individuals–each with different sensibilities; and, secondly, through the fact that the outcomes of the control groups were quite heterogeneous when compared with each other.

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