APPLYING GIS IN THE EVALUATION OF LANDSCAPE AESTHETICS

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DECLARATION

I, the undersigned, hereby declare that the work contained in this thesis is my own original work and that I have not previously in its entirety or in part submitted it at any university for a degree.

Signature: …………………………………..

Date: …………………………………..

ABSTRACT

Scenic beauty, or landscape aesthetics, should be regarded as a valuable resource, to be protected and enhanced in order to generate income. Current environmental impact assessment (EIA) studies do not include the evaluation of scenic beauty as a resource properly, due to the lack of effective evaluation methods. A general dilemma lies in objectively evaluating beauty. If scenic preferences can be associated consistently with the physical landscape features, the latter can be used as predictors of the former. Analysis of aesthetics can therefore be done with a degree of objectivity, based on these general preferences. A large number of these preferences are morphologically measurable. In other words, these preferences can be mapped in a Geographical Information System (GIS), rated, and evaluated quantitatively.

The first step in objectively evaluating landscape aesthetics entailed identification and compilation from the literature of conceptual components in a landscape, i.e. the units defining a landscape. Four components were identified: landform, vegetation, water features and man-made features. Each of the four components can be subdivided into several elements. Secondly, scenic preferences that can be consistently associated with landscape features were identified. It was found that any subjective experience of landscape aesthetics would be either one of calmness or one of excitement. The presence or absence of the landscape elements, and specific combinations of elements and element variables within the context of an individual landscape, will determine the type and extent of the aesthetic experience of the viewer.

Finally, this theory was put into practice. Coverages were created of a test region, with landscape elements as the features of the coverages, and element variables or characteristics as feature attributes. These landscape elements, as they enhance either calmness or excitement, were quantified by assigning value ratings to the elements according to the extent of the influence of the elements on the aesthetic value of the landscape. ArcInfo GRID functionality was used to convert the coverages to raster (or grid) overlays, using the element variables enhancing both calmness and excitement. A simple cumulative summing function was used to derive an aggregate Calm Aesthetic Experience map by adding grids enhancing calmness. An aggregate Exciting Aesthetic Experience map was constructed by adding grids enhancing excitement. Finally, these two grids were summed in order to construct a Total Aesthetic Experience map, which is an indication of the total aesthetic value of the test region.

The outcome of this research was a method for analysis and objective evaluation of a landscape, using a GIS for data creation, analysis and map construction. The resultant map is an indication of aesthetic value, showing the test region graded according to intrinsic aesthetic value.

OPSOMMING

Landskapskoonheid, of landskap-estetika, is ‘n kosbare hulpbron en behoort bewaar en ontwikkel te word om sodoende ‘n inkomste te genereer. Huidige omgewingsimpakstudies maak by gebrek aan effektiewe evalueringsmetodes onvoldoende voorsiening vir die evaluering van natuurskoon as ‘n hulpbron. Die objektiewe evaluering van skoonheid is ‘n algemene probleem, maar as natuurskoon-voorkeure konsekwent assosieer kan word met die fisiese landskap, kan laasgenoemde gebruik word as ‘n aanduiding van eersgenoemde. Analise van estetika kan dus gedoen word met ‘n mate van objektiwiteit, gebaseer op hierdie algemene voorkeure. ‘n Groot aantal van hierdie voorkeure is morfologies meetbaar. Met ander woorde, die voorkeure kan in ‘n Geografiese Inligtingstelsel (GIS) gekarteer, geskaal en kwantitatief evalueer word.

Die eerste stap in die objektiewe evaluering van landskap-estetika het die identifisering en samestelling van die konseptuele komponente waaruit ‘n landskap bestaan, d.i. die eenhede wat ‘n landskap definieer, uit die literatuur behels. Vier komponente is geïdentifiseer: landskapsvorm of morfologie, plantegroei, waterverskynsels en mensgemaakte verskynsels. Elk van dié komponente kan onderverdeel word in ‘n aantal elemente. Tweedens is natuurskoonvoorkeure wat konsekwent assosieer kan word met fisiese landskapsvorme geïdentifiseer. Daar is bevind dat enige subjektiewe ervaring van natuurskoon een van kalmte of van opwinding kan wees. Die teenwoordigheid of afwesigheid van landskapselemente en spesifieke kombinasies van elemente en element-veranderlikes binne die konteks van ‘n individuele landskap, sal die omvang en tipe estetiese ervaring van die waarnemer bepaal.

Laastens is hierdie teorie prakties toegepas. GIS-oorlegte van ‘n toetsgebied is geskep, met die landskapselemente as die oorlegeenhede, en die element-veranderlikes as die eenheidsattribute. Hierdie landskapselemente, in soverre dit kalmte en/of opwinding affekteer, is gekwantifiseer deur die omvang van die invloed van die elemente op die estetiese waarde van die landskap te skaal. ArcInfo se GRID-funksies is gebruik om die GIS-oorlegte te omskep tot rooster-oorlegte deur die veranderlikes wat beide kalmte en opwinding versterk, te gebruik. Eenvoudige kumulatiewe sommering van roosteroorlegte wat kalmte en opwinding meet, het kaarte van saamgestelde Kalm Estetiese Ervaring en Opwindende Estetiese Ervaring geskep. Hierdie twee roosteroorlegte is ten slotte gesommeer tot ‘n kaart wat Totale Estetiese Ervaring van die toetsgebied saamvat.

Die uitkoms van hierdie studie is ‘n metode van analise en objektiewe evaluering van ‘n landskap met behulp van ‘n GIS vir dataskepping, analise en kaartkonstruksie. Die finale kaart skaal die intrinsieke estetiese waarde van die toetslandskap.

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CHAPTER 1: THE CHALLENGE OF EVALUATING LANDSCAPE AESTHETICS

1.1 BACKGROUND TO SCENIC BEAUTY AND THE OBSERVER

A study done by SATOUR in January 1997 indicated a strong preference amongst foreign tourists in the Western Cape for scenic beauty as an attraction.[1] Scenic beauty is a major component of an encounter with the natural environment in tourism and recreation. It does not only benefit the individual, but represents an important contribution to the overall desirability of an area, and can thus be associated with extended economic benefits for a region (Clay & Daniel 2000). Scenic beauty is the result of specific combinations of physical features, e.g. topography, vegetation patterns, slope and building coverage (Sung, Lim, Ko & Cho 2001). Scenic beauty, or landscape aesthetics, should therefore be regarded as a valuable resource, to be protected and enhanced in order to generate income.

Current environmental impact assessment (EIA) studies do not properly include the evaluation of scenic beauty as a resource, due to the lack of effective evaluation methods. A general dilemma lies in objectively evaluating landscape beauty. Analysis of landscape beauty is bound to be subjective, as this is a personal and individual response to nature. According to Motloch (1991), the individual ascribes meaning to the perceptual characteristics of a landscape. This is what is referred to in this study as the "aesthetic experience". Motloch further explains that viewers, as a result of different perceptions, could interpret and experience landscapes in ten different ways. These interpretations are variously landscape as aesthetic (on which this study is based), as nature, as habitat, as artifact, as a system, as a problem, as wealth, as ideology, as history and as place. In landscape as an aesthetic experience, the primary emphasis is on the artistic quality of landscape features, i.e. as a visual scene (Motloch 1991). The viewer interprets visual forms based on some language of art, such as form, colour, texture, rhythm, proportion, balance, symmetry, harmony, tension, unity and variety. The landscape therefore becomes a vehicle for communicating aesthetic relationships, and the subjective reaction of the viewer to this is the aesthetic experience of the landscape.

If scenic preferences can be associated consistently with the physical landscape features, the latter can be used as predictors of the former (Zube et al. 1989, Bishop & Hull 1991, Bishop 1994, Yuan

1. Sixty one percent rated scenic beauty as the most appealing characteristic. Other characteristics that were rated include wildlife (29% preference), climate (27% preference), culture (17% preference) and value for money (15% preference) (SATOUR 1998).

1998, all four quoted in Sung et al. 2001; Motloch 1991). It is clear from the literature that a number of these generalised preference associations exist, for which the features can be identified in a landscape. Analysis of aesthetics can therefore be done with a degree of objectivity, based on these general preferences. A large number of these preferences are morphologically measurable. In other words, these preferences can be mapped in a Geographical Information System (GIS), rated, and evaluated quantitatively.

Against this background, it is clear that the current trend in place development in landscapes without proper, objective evaluation of the aesthetic impact thereof jeopardizes an important tourism natural resource – landscape aesthetics. Furthermore, planners, as development gatekeepers, have no objective method to gauge or rate the suitability of locating development in a landscape during the permitting phase. Yet, GIS holds the technical solution to the dilemma should the elements determining landscape aesthetic rating be made measurable in landscape space and combined into coherent landscape indices.

1.2 RESEARCH AIM AND OBJECTIVES

The aim of this research was to classify landscape in terms of potential attractiveness (aesthetic quality) based on its measurable morphological and dimensional characteristics, using GIS functionality.

The goals of the study were:

- To isolate from the literature and compile conceptual elements of landscape to be used as yardsticks of attractiveness, that are measurable in morphological terms.
- To deduce from the literature generalised aesthetic experiences and the associated features triggering the experience in most observers.
- To develop a grid-analytical methodology in GIS to identify objectively:
  - Individual measurable morphological elements or landscape features on a regional scale.
  - Landscape ensembles that consist of specific combinations of landscape elements, creating an aesthetic experience.
- To apply the derived GIS methodology practically in a test region.

1.3 THE STUDY AREA

A test region of about 14km x 14km in area was used for the purpose of this study. It is located in the *Koue Bokkeveld* region of the Western Cape, South Africa, between the lines of latitude 33° 03' and 33° 09' South, and the lines of longitude 19° 18' and 19° 27' East. This area was deemed sufficient because of the topographic and land use variety to be found here. This area is also representative of the Western Cape, and is currently undergoing intensive development pressure. The availability of six orthophoto images further permitted this decision.

The study area comprises a number of agricultural farms, including Odessa, Malabar Farm, Molenrivier, Ebenezer, Die Kruis, De Hoek, Parys and Rocklands. A partially tarred highway, route R303, passes through the study area. Three major dams, the Loch Lynne Dam, the Rocklands Berg Dam and the Rocklands Groot Dam can be found here. Topographically the area consists of a plateau >900m above sea level, flanked by the Skurweberge, rising 690m above it (1640m above sea level) on the west. Figure 1.1, a map of the test region, illustrates the location of the above-mentioned farms, mountain range, dams and highway. Figure 1.2 is a photograph of a view on the Skurweberge, taken from the south.

Figure 1.1: The test region

Figure 1.2: View on the Skurweberge from the south

1.4 DATA AND METHODS

Data was digitized, processed and analysed using the ArcGis modules ArcMap and ArcInfo GRID (ESRI 2004). The available data consisted of six digital colour orthophoto images of the study area (numbers 3319AB 7, 3319AB 8, 3319AB 9, 3319AB 12, 3319AB 13 and 3319AB 14), and a digital elevation model (DEM) for this area. The orthophoto images (0,8m resolution) and the DEM (20m resolution) were obtained from the Centre for Geographical Analysis, University of Stellenbosch. The analysis methodology and steps followed are described in Chapter 4.

1.4.1 Data capture

In order to perform aesthetic analysis of the study area, it was necessary to create vector data coverages using existing data. Four data layers needed to be constructed: a layer containing man-made features, a layer containing vegetation features, a layer containing water features and a layer containing prominent landform features. Digitizing of man-made, vegetation and water features was done using the orthophoto images, and the DEM was digitally processed using the spatial analyst functions of ArcMap to construct the landform vector layer.

The following GIS coverages were digitized:

- The coverage “Man-made features”, consisting of built-up areas, cultivated land and roads according to surface material and width. Four types where identified and digitized from the orthophoto images. They are tarred roads (>6m), main gravel roads (>6m), secondary gravel roads (3-6m), minor gravel roads and tracks (<3m). All man-made features were identified on the orthophoto images and built-up areas and cultivated fields were digitized as polygon features. Roads were digitized as line features, with width as an attribute.

- The coverage "Vegetation", consisting of tree clumps, wetlands and riparian vegetation around stream channels, natural but disturbed vegetation in built-up areas (recovered cultivated land) and cleared areas where soil is exposed either deliberately by landowners, or through erosion. Vegetation features were identified and digitized using the orthophoto images. The remaining natural, undisturbed vegetation (the background vegetation matrix) was not digitized. The acquisition of this data is discussed below.
- The coverage "Water features", consisting of dams and rivers/streams/channels. These features were identified and digitized using the orthophoto images.

1.4.2 Data processing

Some features of these data sets had to be processed and transformed to complete the preparation of the data for further analysis. Secondary data creation proceeded as follows:

- The "Landform" coverage had to be constructed using the DEM. A slope angle contour map was created from the DEM, which was used to analyse the shape of the landform. It was necessary for further analysis to separate horizontal and vertical elements, i.e. plains (horizontal) and hills and mountains (vertical). This was done by analysing the slope of the study area. A slope angle of less than 10º was taken to indicate relatively level landforms (plains). This decision was based on a study done by Tait (1997). The 10º-slope contour was therefore accepted as the border between horizontal and vertical landform features. The contour was selected and intersected with a polygon filling the full extent of the study region. The contour defined the borders of all plains. The remaining features in this landform layer were either hills or mountains, depending on absolute height (sharpness of local relief). An elevation above sea level contour map was derived from the DEM and was used to calculate the absolute height of the vertical features. A new attribute field "Height" was created for the coverage, and height was calculated by subtracting the lowest contour value (950m above sea level) from the actual contour value. The lowest contour line would therefore have a new value of 0 (950m – 950m), and the highest contour line would have a new value of 690m (1640m – 950m). Elements with an absolute height of up to 600m were reselected and renamed "Hills", and the remaining elements (up to 690m) were renamed "Mountains". This decision was based on the definitions of hills and mountains based on absolute height in the Dictionary of Geography (1998).

- The "Man-made features" coverages had to be completed by creating polygon features from the roads line features. This was done by creating buffers around the roads, which were originally digitized as line features. The relative width of the buffers reflected the relative width of the roads: 3m buffers on both sides (6m in total) of tarred and main gravel roads, 2m buffers on both sides (4m in total) of secondary gravel roads and 2m buffers on both sides (4m in total) of minor gravel roads and tracks. The width of roads was measured from the orthophoto images. All features in the "Man-made features" coverage were therefore polygon features and could be used in further analysis.
- The "Water features" coverage was completed by creating 10m buffers around the rivers (20m in total), and 2.5m buffers around streams/channels (5m in total), which were originally digitized as line features. The width of rivers and channels were measured from the orthophoto images. The resulting polygon coverage was used in further analysis.
- The "Vegetation" coverage was completed as follows: trees, wetland and riparian vegetation, natural vegetation in built-up areas (recovered cultivated land) and cleared areas had already been digitized. The remaining undisturbed vegetation was identified by removing everything else from the digital landscape as follows: the digitized vegetation features along with all man-made features and water features were combined using the UNION command in ArcMap. The combined features were again combined with a polygon layer that consisted of a single polygon filling the complete extent of the landscape. These features were selected and reassigned an ID number of 1 (random number). The remaining unidentified features with a number other than 1 were therefore natural, undisturbed vegetation, forming the background vegetation matrix.
- Attribute data was calculated where necessary according to the required element variables discussed in Chapter 2, using the features digitized and derived, and performing simple analysis functions in ArcMap. New attribute fields were added to the coverages to contain this additional attribute data. The acquisition of the attribute data will be discussed in detail in Chapter 4.

1.5 DEFINITIONS OF TERMS

For the sake of clarity, a number of often used and variously understood terms found throughout the thesis needs explanation here.

Scenery is the composition and appearance of landscape, and the visual identification of the coherence between natural and anthropogenetic processes and patterns (Meeus 1995). An **aesthetic experience** can be defined as the product of a human observer's personal response to scenery.

The term **landscape** will be consistently used in this thesis, such as in the phrases: "aesthetic landscape", landscape elements" and "landscape components". For the purpose of this research study, landscape is defined as the morphological surface of the earth, further subdivided into the natural landscape, formed by the forces of nature, which consists of landform, vegetation and water; and the cultural landscape: man-made features which are the result of interaction between man and nature. The Institute of Environmental Assessment and The Landscape Institute (1995) describe landscape as the appearance of the land, including its shape, texture and colours. Litton (1982) adds visual design terms such as form, space, scale, pattern and compositional type as descriptive attributes of landscape.

Landscape analysis is defined as the process of subdividing the landscape into its component parts to understand how it is made up; **landscape evaluation** is defined as the process of attaching value (non-monetary) to a particular landscape, usually by reference to an agreed set of criteria and in the context of the assessment; and **landscape assessment** is defined as an umbrella term for description, analysis and evaluation of a landscape. **Landscape** or **aesthetic quality** is therefore the term used to indicate value based on character, condition and aesthetic appeal (Institute of Environmental Assessment and The Landscape Institute 1995).

1.6 RESEARCH FRAMEWORK AND REPORT STRUCTURE

The research objectives correspond to the phases in which the research was done. Phase 1 entailed identification and compilation from the literature of conceptual components in a landscape, i.e. the units defining a landscape. Four components were identified: landform, vegetation, water features and man-made features. These components combine to form the mesostructure of a landscape and are discussed in Chapter 2. Phase 2 entailed identifying from the literature the previously mentioned scenic preferences that can be consistently associated with landscape features. The description of these preferences can be found in Chapter 3. During the third phase, the theory developed in the preceding phases was put into practice. This is described and explained in detail in Chapter 4. Figure 1.3 is a diagram illustrating the steps that were taken according to the phases described.

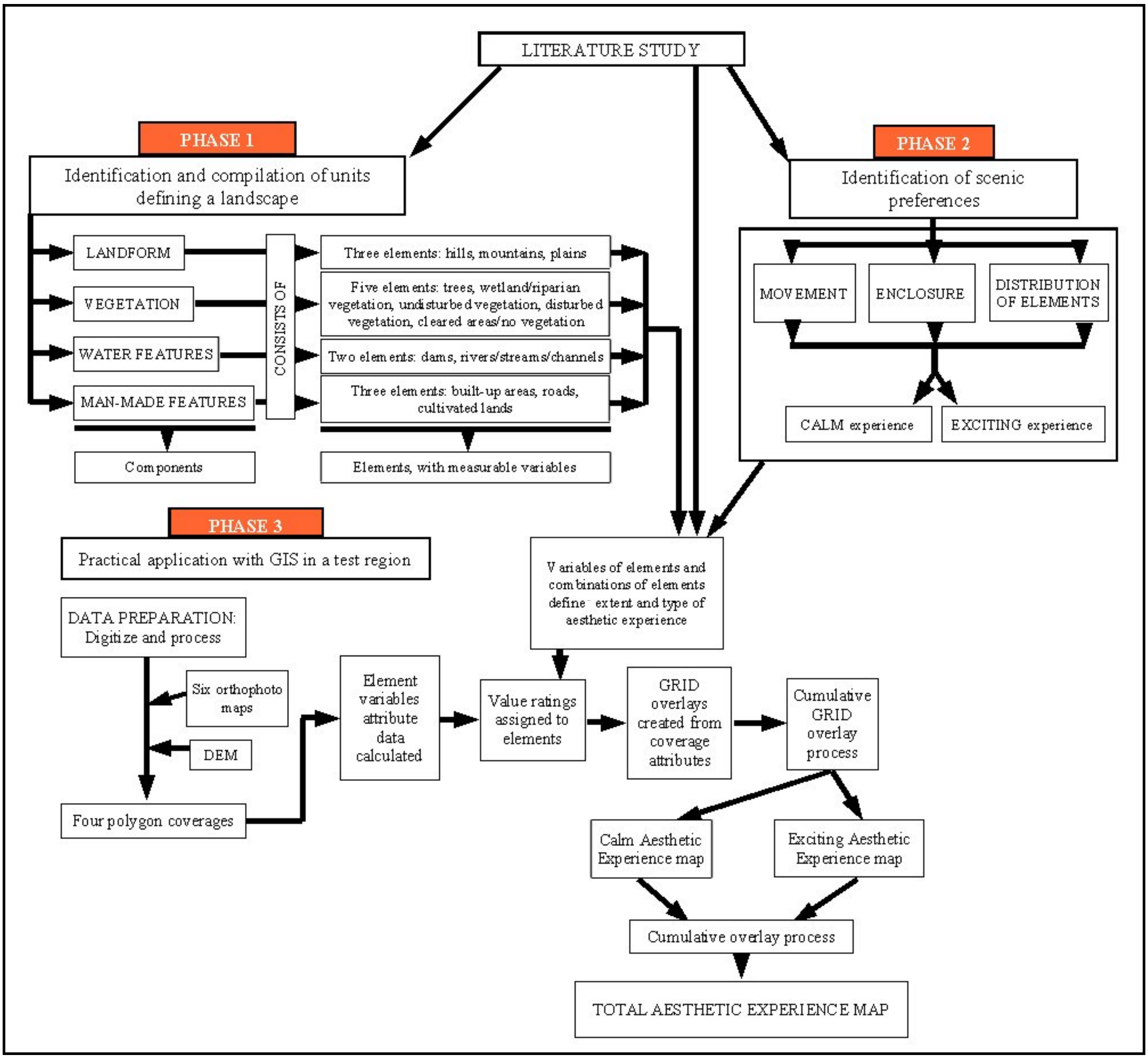


Figure 1.3: Research steps taken in the analysis of landscape aesthetics

The following chapter contains a complete description of the landscape components, elements and variables derived from the literature.

CHAPTER 2: DECONSTRUCTING LANDSCAPE

This chapter is a description of the conceptual components in a landscape, i.e. the units defining a landscape. The four components identified are landform, vegetation, water features and man-made features. The first section of this chapter is devoted to describing the relationships between components, elements and variables. This is followed by an overview description of components, subdivided into elements, with characteristic variables. The remainder of the chapter contains a complete description of the identified components, elements and variables.

2.1 A TYPOLOGY OF LANDSCAPE ATTRIBUTES

Any landscape can be subdivided into **components**, forming the mesostructure of the landscape. Components can be further subdivided into **elements**, forming the microstructure of the landscape. These elements can be quantified, measured and rated for evaluation purposes. Characteristics of these elements (**variables**) can be used as yardsticks of attractiveness. Figure 2.1 illustrates the relationship between components, elements and variables. Landform is used as an example. In this illustration, mountains and a plain are the elements of the landform component. Height is demonstrated as one variable of the mountain element.

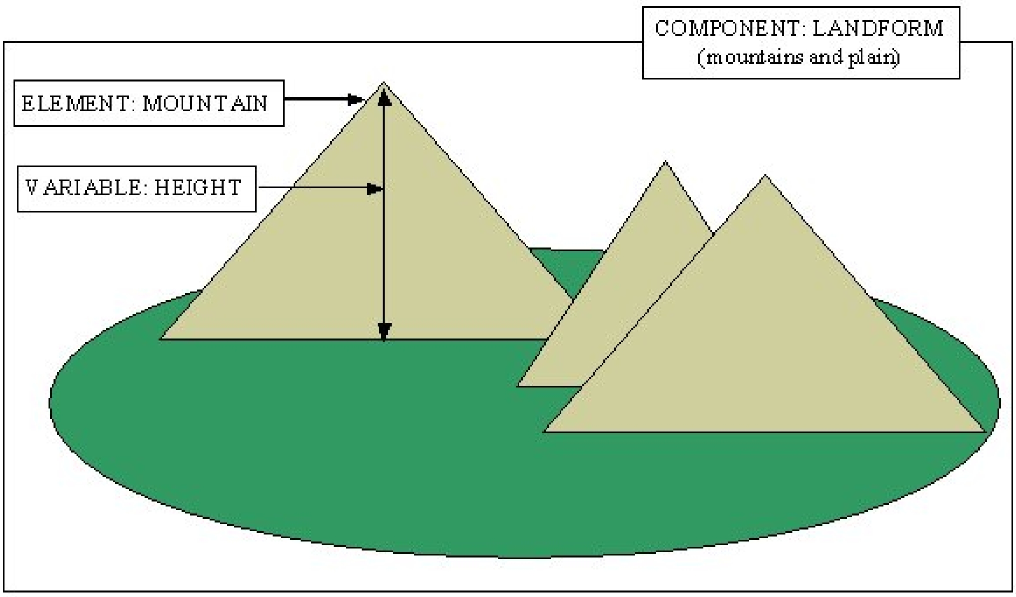


Figure 2.1: The component-element-variable relationship

2.2 OVERVIEW OF COMPONENTS, ELEMENTS AND VARIABLES

The selection of the components, elements and variables were based on measurability and the efficiency with which they could be mapped and analysed in a GIS. The lists of variables are by no means exhaustive, but will serve the purpose of this study. The chosen components (landform, vegetation, water and man-made features) play an important role in scenic quality and are mentioned repeatedly in the literature (Beer 1998; Institute of Environmental Assessment and The Landscape Institute 1995; Colvin 1970; Litton 1982). These specific features were selected as components to be analysed because of their visual, tangible, measurable morphological and dimensional characteristics. Other elements are, for example, environmental setting, e.g. sun angle, and climatic conditions, e.g. fog and mist, but difficulties in the measurability of these factors lead to them being excluded from the current research study. All the senses are involved in the aesthetic experience of a landscape, but research was focused on only the visual dimension, again because of difficulties in measurability.

Each of these components can be further subdivided into elements, describing the component in more detail. A number of characteristics or variables apply to these elements, as previously mentioned. Specific combinations of these elements from each component result in certain aesthetic experiences, discussed in Chapter 3. Figure 2.2 below illustrates the structure of the landscape, as used in this study. The rest of this chapter elaborates on this diagram.

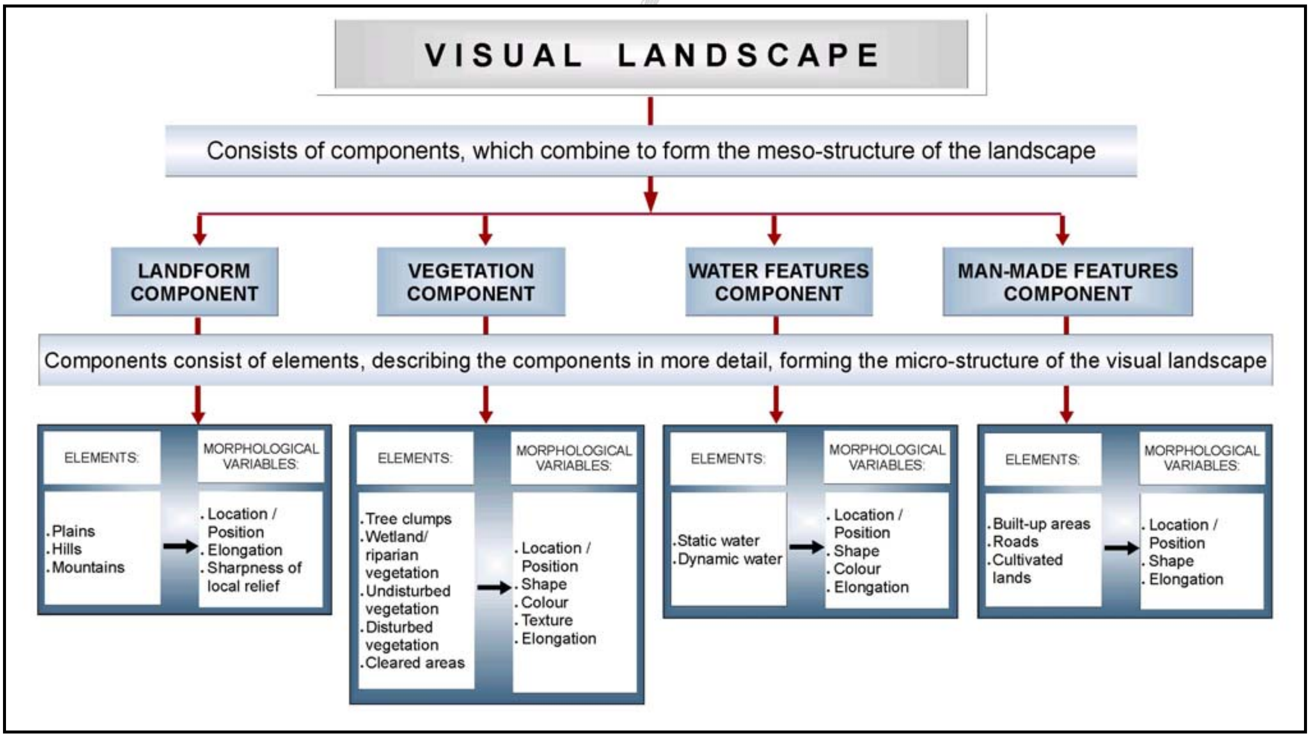


Figure 2.2: The breakdown of landscape into components, elements and variables

2.3 LANDFORM

The three-dimensional relief of the surface of the earth is called topography or landform (Motloch 1991). It is the combination of slope and elevation producing the shape and form of the land surface (Institute of Environmental Assessment and The Landscape Institute 1995). Landform elements range from large-scale features such as plains and mountain ranges to minor features such as individual hills and valleys (Blaszczynski 1997). Other components relate at some point directly to the underlying landform. Landform is then the common component in the landscape and the thread, which ties the other components together, ending only at the water's edge (Booth 1983). It functions as a unifying factor both visually and functionally.

2.3.1 The elements of the landform component

According to Booth (1983), landform can be categorised in a number of different ways, e.g. scale, character, steepness, geological origin and form. Form is the most important method when studying the aesthetic character of a landscape, because form influences the visual and functional qualities of the landscape. In this sense, a landscape is a continuous composition of forms, defined by Booth as level forms, convex forms, concave forms, valleys and ridges. These forms are found side by side, blending into each other, even though they can be segmented for the purpose of analysis (Booth 1983).

For the purpose of this study, three landform types (or elements) have been identified to be used in aesthetic evaluation: level and flat landforms or plains, mountains and hills.

- Plains or level landforms

Plains are defined as the lowest area in the region for the purpose of this study. A level landform can be defined as any land area visually parallel to the plane of the horizon (Booth 1983). Most surfaces have some degree of slope, so the term "level" here is used as indicating landform that generally appears "level", even if it is slightly sloped. A slope of less than 10 degrees was accepted as "level" (Tait 1997). Plains have a distinctive horizontal quality, which was of importance in analysis.

- Hills and mountains

Hills and mountains were treated separately in analysis. Booth (1983) defines these types of landform as "a high point of ground defined by a generally concentric arrangement of contours", e.g. knolls, knobs, buttes and mountain or hill summits. The Dictionary of Geography (1998) defines hills as landforms up to 600m in height above local landscape (local relief), and mountains as landforms greater than 600m in local relief. Large features often suggest importance in a landscape. A description like "monumental" does not necessarily refer to actual size, but the feeling that is created by something being visually dominant within its surroundings. Mountains and hills therefore have different aesthetic effects in a landscape (Stanton 1996). Hills and mountains have a vertical quality, as opposed to the horizontal quality of plains.

2.3.2 Variables applicable to the elements of the landform component

Lobeck (1939) mentions shape, size, position and colour as important characteristics, but the following measurable variables were considered important in describing landform elements, with the ultimate objective of analysing landscape aesthetic quality in a GIS.

- Location or position in relation to other elements has a variety of effects on the overall aesthetic value of a landscape in specific locations. The distribution, even or uneven, of elements has different aesthetic effects, as Section 3.4 further explains. Measurement is discussed in Section 4.3.
- Elongation, as the shape of landform elements, has specific aesthetic effects on a landscape. The close proximity of interlocking and sweeping hills or mountains result in them tending to be seen as a cohesive group (Stanton 1996). A plain could also serve the function of an axis, if it has a linear quality, i.e. length greater than width. These elements have an elongated shape, creating a sense of movement, thereby affecting the aesthetic experience of the landscape. Elements with no elongation (focal elements) are points, marking a position in space (Stanton 1996). Axial-focal interaction is discussed in more detail in Section 3.2. Measurement is discussed in Section 4.3.
- Sharpness of local relief is important when evaluating the effects of enclosure of landform elements in a landscape, as Section 3.3 further explains. Elevation values were used to calculate absolute height between neighbouring vertical and horizontal landforms creating an enclosure. Measurement was discussed in Section 1.4.

2.4 VEGETATION

Vegetation plays an important role in shape, colour and texture variety and diversity in a landscape. Vegetation adds beauty to the surroundings of human life, by adding form, symbolism, colour and texture. Beer (1998) states that plants stimulate the senses and the different forms, growth patterns, colours and sizes create a great variety in aesthetic experience. He claims that few people have not been enchanted by the beauty of flowers and plants.

2.4.1 The elements of the vegetation component

Marsh (1991) describes three types of classification schemes for vegetation:

- Floristic types, classified according to species, genera, families and botanical names.

- Form and structure or physiognomic types, classified according to the overall measurable form of vegetation or large assemblages, e.g. forest and grassland, with special attention to dominant plants.
- Ecological types, classified according to the habitat where they occur, e.g. sand dunes, wetlands or lake shores.

The form and structure type was used for current purposes in this study. This was done because of the ease of this categorisation method and the suitability in this context relating to the other visual landscape components. The chosen vegetation elements appropriate to the study area that were mapped are tree clumps, wetland and riparian vegetation in and around wetlands and stream channels, undisturbed background matrix vegetation covering most of the landscape, and natural but disturbed vegetation in built-up areas (recovered cultivated lands). Last-mentioned was classified separately because of the distinct unnatural or man-made appearance. Also included as an element in the vegetation component are areas where the vegetation has been either deliberately cleared away or excavated, or naturally eroded.

2.4.2 Variables applicable to the elements of the vegetation component

Vegetation has a number of structural functions in a landscape (Colvin 1970), for example, it can create masses and voids. The taller trees and shrubs provide the masses, in contrast to the voids, which are made up of the background matrix vegetation. Furthermore, vegetation adds shape, colour and texture to a landscape. The following characteristics were considered important in describing vegetation elements, with the ultimate objective of analysing landscape aesthetic quality.

- Location in relation to other elements and components is important when creating element ensembles and assessing landscape aesthetics. Vegetation has a positive effect on landscape, independent of the specific aesthetic experience determined by the shape, colour, texture and elongation of the masses. The voids (groundcover) enhance unity, depending on location. Measurement is discussed in Section 4.4.
- Shape is the outward form of an element produced by its horizontal outline (Stanton 1996). The contrasting shapes of vegetation masses add to the general diversity of the landscape. Distribution is important, either enhancing or compromising unity, as is further described in Section 3.4. Simple and complex shapes have different aesthetic effects on a landscape. Geometrical shapes are more complex than natural, flowing shapes. Measurement is discussed in Section 4.4.
- Colour: the contrasting colours of vegetation masses add to the general diversity of the landscape. Distribution is important, either enhancing or compromising unity, as is further

described in Section 3.4. Different colour intensities have different effects on the overall aesthetic experience of a landscape. Measurement is discussed in Section 4.4.

- Texture: the contrasting textures of vegetation masses add to the general diversity of the landscape. Distribution is important, either enhancing or compromising unity, as is further described in Section 3.4. Rough textures seem to come forward, whereas smooth textures seem to melt into the distance and may even suggest a sense of distance (Colvin 1970). Gericke (2002 Pers Com) states that vegetation can have a softening effect on a landscape, depending on the type. Fynbos, of which the background matrix vegetation mostly consists, specifically softens a landscape because of the fine texture of this type of vegetation. Fine textures often make spaces seem larger. Measurement is discussed in Section 4.4.
- Elongation: Depending on location, vegetation masses (e.g. a copse of trees) can function as focal features, and patches with elongated shapes can serve as axes in the axial-focal interaction in a landscape, creating a sense of movement. Axial-focal interaction is discussed in more detail in Section 3.2. Measurement is discussed in Section 4.4.

2.5 WATER

Unpolluted water plays an important role in the enhancement of aesthetic quality and greatly adds to the interest in a landscape. People are emotionally lured towards water and have a strong need to interact with it (Booth 1983). Motloch (1991) describes the stimulating power that water has, affecting both sight and sound. Essential to life, nourishing the landscape, it adds meaning on a symbolic and therapeutic level. Ulrich (1983 and 1986, in Yu 1995) and Steinitz (1990, in Yu 1995) state that water is widely considered as an “efficacious factor in enhancing landscape preference level”.

2.5.1 The elements of the water component

Water is classified into two general categories according to its motion: static (quiet, non-moving) or dynamic (moving, falling) (Booth 1983). Static water features can be subdivided into ponds, pools, dams, lakes and even very gently flowing rivers, and dynamic water features into flowing water (streams, creeks and rivers) and falling water (waterfalls).

- Static water bodies

Static water is peaceful, relaxing and mellow in character. It has a soothing and reflective effect on viewers, both visually and psychologically. It is visually placid, and may encourage the mind to think in an uninterrupted manner. This type of water expresses a balance and equilibrium with the force of gravity (Gericke 2002 Pers Com; Booth 1983; Motloch 1991).

- Dynamic water bodies

Flowing water is any moving water confined to a well-defined channel. Falling water is found where water drops abruptly from a higher elevation to a lower one. Flowing and falling water express movement, direction and energy (Booth 1983).

2.5.2 Variables applicable to the elements of the water component

The following characteristics were considered important in describing the above-mentioned water elements, with the ultimate objective of analysing landscape aesthetic quality.

- Location in relation to other elements and components is important when creating element ensembles and assessing landscape aesthetics. Water features have a positive effect on landscape, but static water adds calm, and dynamic water adds excitement to the aesthetic experience, because of the movement of the water. The effects of movement are discussed in more detail in Section 3.2. Measurement is discussed in Section 4.5.
- Shape: The edge of water features could be irregular as in nature, or straight and geometric when man-made. Straight rivers are more forceful, and curved or free-flowing rivers can be described as smooth, graceful or gentle and create a relaxing, and natural feeling (Ingram 1991). The contributions of shape to the effects of unity and simplicity are discussed in Section 3.4. Measurement is discussed in Section 4.5.
- Colour: Water movement needs to be noted - fast to slow, rapid white to still dark (Litton 1982). Dark water is an indication of purity, adding to the aesthetic effect of the specific element in a landscape. The contributions of colour to the effects of unity and simplicity are discussed in Section 3.4. Measurement is discussed in Section 4.5.
- Elongation: As a linear element, a river adds movement to a landscape, and dams with no elongation can serve as focal points, and dams with elongated shapes can serve as axes in the axial-focal interaction in a landscape, creating a sense of movement. Straight lines are more forceful and direct the observer’s eye to a point faster than curved lines. Curved or free-flowing lines are sometimes described as smooth, graceful or gentle and create a relaxing, progressive, moving and natural feeling (Ingram 1991). Axial-focal interaction is discussed in more detail in Section 3.2. Measurement is discussed in Section 4.5.

2.6 MAN-MADE FEATURES

Kaltenborn & Bjerke (2002) found a clear aesthetic preference for pristine wildland amongst test subjects. This was also found by Ulrich (1993, in Misgav 2000): modern forms of agriculture (newly cleared land, flat and open farm fields, and modern buildings) had the lowest preference.

Lamp & Purcell (1990, as quoted in Misgav 2000) also found that individuals prefer natural landscapes to urban landscapes. Yu (1995) found that natural landscapes and wilderness are more favoured than landscapes containing man-made landscape structures. This was also reported by Kaplan et al (1972), Zube (1973), Ulrich (1981, 1983, 1986), Kaplan (1983, 1985) and Steinitz (1990) (all five quoted in Yu 1995). According to Stanton (1996), a landscape may appear to epitomize an image of "wild land" where there is no evident human impact, and where there is an associated perception of remoteness and freedom. Human impact can compromise the perception of remoteness. Roads can either add to or detract from scenic value: modern, rigid two-lane roads definitely spoil a view, whereas tracks and footpaths, well placed in a landscape, can add to the beauty of the scene. Walkers in the country prefer quiet, independent tracks away from wheeled traffic (Colvin 1970). The material the path is made of is also important: hikers and walkers usually prefer the natural surface (Colvin 1970).

2.6.1 Elements of the man-made component

For the purposes of this study, the following elements were recognised to account for this component.

- Built-up areas.
- Infrastructure, i.e. roads. Power lines were not included because of the difficulties involved in identification and digitizing from the orthophoto images. Dam walls were evaluated along with dams.
- Cultivated lands.

2.6.2 Variables applicable to the elements of the man-made component

The following characteristics were considered important in describing the above-mentioned elements, with the ultimate objective of analysing landscape aesthetic quality.

- Location in relation to other elements and components is important when assessing landscape aesthetics. A discussion on the role of the distribution of diverse elements can be found in Section 3.4. Measurement is discussed in Section 4.6.
- Shape is the outward form of an element produced by its outline (Stanton 1996). The contrasting shapes of man-made features add to the general diversity of the landscape. Distribution is important, either enhancing or compromising unity. Simple and complex shapes have different aesthetic effects in a landscape. The contributions of shape to the effects of unity and simplicity are discussed in Section 3.4. Measurement is discussed in Section 4.6.

- <u>Elongation</u>: Roads are by definition elongated, thereby serving as axial elements. A cluster of buildings can serve as a focal point, but if the cluster is elongated, it serves as an axis. Axial-focal interaction is discussed in more detail in Section 3.2. Measurement is discussed in Section 4.6.

The elements discussed here can be found in a greater or lesser extent in any landscape. Not all elements can be found in all landscapes, and variables differ from landscape to landscape. Combinations of elements and element variables enhance or detract from the type and extent of aesthetic experience of a landscape. The specific aesthetic experiences are discussed in the following chapter.

CHAPTER 3: THE AESTHETIC EXPERIENCE OF COMPONENT AND ELEMENT COMBINATIONS

The presence or absence of the elements described in Chapter 2, and specific combinations of elements and element variables within the context of an individual landscape will determine the type of aesthetic experience of the viewer. This chapter consists firstly of an overview description of the two main types of aesthetic experience, and the three subtypes enhancing or detracting from the main type of aesthetic experience. Secondly, the remainder of the chapter consists of a more detailed discussion of the subtypes of aesthetic experience, and the contributions of landscape elements in either enhancing or detracting from the experience.

3.1 AN OVERVIEW OF AESTHETIC EXPERIENCES

As stated in Chapter 1, if scenic preferences can be associated consistently with physical landscape features, then the latter can be used as predictors of the former. It is clear from the literature that a number of these preferences exist, to be identified in a landscape. This chapter consists of an exposition of the two different types of subjective aesthetic experiences in viewers: a calm experience and an exciting experience. Both are considered positive aesthetic experiences, they are not opposites, and most scenic preferences are represented by a combination of the two. These experiences cannot all be applicable to every single viewer, but some or most will apply to the majority of viewers. A landscape with a high aesthetic value, whether calm or exciting, would justify preservation and conservation.

A landscape can be classified as completely calm, completely exciting, or partly calm partly exciting, with some sections calm and others exciting. The last mentioned landscape would be assigned an overall value of more calm than exciting or vice versa. In this case, either the landscape would have more calm areas than exciting areas, or the calm areas would have a higher aesthetic value than the exciting areas. The overall aesthetic value, regardless of calmness or excitement, will be an indication of whether conservation and preservation is justified.

Two different approaches can be taken in the aesthetic analysis of a landscape. Firstly, a viewshed analysis can be done from a specific location. Only landscape elements visible from this point on the landscape will be taken into account when aesthetic analysis is done, because some elements will be hidden behind others. The second approach is the one adopted in this study – the region is analysed as a whole and all elements are taken into account, regardless of where a potential viewer will be located. The reason for this decision is to accommodate all possible viewpoints in the area.

Both the first and second approach in landscape analysis can be used to classify a landscape as calm and/or exciting, but different subtypes of aesthetic experience can be found. Subtypes associated with the first approach will not be discussed here. With the second approach in landscape analysis, both calm and exciting experiences consist of three subtypes of aesthetic experience, which enhance one and detract from the other, depending on element variables that will determine the extent of the effect. The three subtypes of aesthetic experiences are:

- A sense of movement produced by axial-focal interaction.
- A sense of enclosure, leading to a sense of safety or threat.
- A sense of order or chaos.

The classification of a landscape is done by an analysis of the extent of these subtypes. A sense of movement, threat and chaos or complexity enhances excitement, and a sense of passivity, safety and order or simplicity enhances calmness.

These subtypes of aesthetic experiences, broken down into element variables, can be objectively evaluated with the use of a GIS as will be proven in Chapter 4. These subtypes form the subject matter in the ensuing sections.

3.2 A SENSE OF MOVEMENT PRODUCED BY AXIAL-FOCAL INTERACTION

Movement created by the specific combination of elements in an axial-focal interaction enhances excitement, but detracts from calmness in a landscape. Gericke (2002 Pers Com) states that certain elements in a landscape (axes) draw the eyes to a focal point. A sensation of enticement, surprise or fear is created, in other words, excitement. A focal point is the feature (or combination of features) that the eye is drawn towards. Examples of axes include linear features like rivers, rows of trees (elongated vegetation features) and ranges of hills or mountains (elongated landform features). Examples of focal points include isolated hills or mountains, vegetation patches and dams as point or polygon features in a landscape.

Colvin (1970) and Simonds (1983) also describe this “vista effect” as a combination of elements leading the eye in a certain direction towards a focal point, visible or invisible. All tracks, paths and waterways tend to draw the eye along to the farthest bend (Colvin 1970). The axial-focal interaction situation is therefore one which consists of linear and circular elements located closely together, with the focal, or circular, element at either end of the axial or linear element. The resulting sensation of movement enhances the excitement in a landscape.

Straight lines tend to be forceful and direct the observer's eye to a point faster than curved lines. Curved or free-flowing lines are gentle and create a relaxing and natural feeling (Ingram 1991). The defining characteristic of an axial feature is its elongation, defined as a length variable of an element, with length greater than width. For the sake of analysis, a width to length ratio of 1:1.5 was decided upon, since the length must be at least one and a half times greater than the width to have visual significance as an axial feature. Figure 3.1 illustrates this ratio with a rectangle and an oval as examples. Note the slight elongation visible with this ratio in width and length. Landscape elements with a length-width ratio of between 1:1 and 1:1.5 were classified as focal elements, since they approximate a point shape.

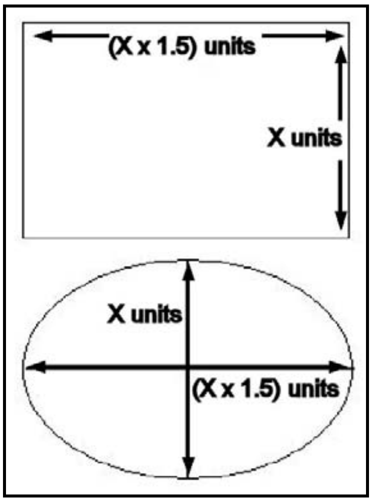


Figure 3.1: The length-width ratio indicating elongation

Figure 3.2 is a photograph of an exciting Columbian landscape, with angular mountains and a river creating a sense of movement.

Figure 3.2: An exciting Columbian landscape, with angular mountains and a river

Source: Mitchell 2001: 48

3.2.1 The role of landform in enhancing or detracting from the sense of movement

Landform elements could be either linear or point/polygon features, and can therefore function as either axes or focal features. Isolated hills and mountains can serve as focal points, particularly when surrounded by lower, more neutral forms.

Elongated ridges and plains in a landscape that serve as axial elements, combined with focal elements of any component at either or both ends, enhance excitement but detract from calmness in a landscape. The same is applicable to landform elements serving as focal features, adjacent to axial elements of any component. Movement is a positive quality in an exciting landscape, but is not conducive to a calm landscape because of the sensation of passivity and peace associated with calmness.

Large plains filling most of the landscape can be said to be multidirectional (Booth 1983): it allows for equal choice of movement in all directions to and from any viewpoint. The eye is not being led in any direction, therefore there is no sensation of movement. This creates sensations of stability, neutrality, rest, peace and equilibrium with the earth's gravitational forces. These types of plains therefore enhance calmness but detract from excitement in a landscape.

3.2.2 The role of vegetation in enhancing or detracting from the sense of movement

Elongated vegetation patches serving as axial features, combined with focal elements of any component, or, focal vegetation patches in combination with axial elements of any component enhance excitement but detract from calmness in a landscape.

Regularity in the distribution of relatively large homogenous vegetation areas enhances calmness and detracts from excitement in a landscape (see the discussion on multidirectional landform elements in Section 3.2.1 above).

3.2.3 The role of water in enhancing or detracting from the sense of movement

"Water in any setting is readily noticed because of its visual contrast to other elements in the outdoor environment" (Booth 1983: 267). Water elements serving as axial or focal elements therefore play a particularly large role in enhancing either excitement or calmness in a landscape. Apart from the linear quality of a river, flowing water expresses the forces of gravity, creating strong impressions of movement. Moving water is energetic and emotionally stimulating, and easily captures the attention of the viewer (Booth 1983). Steeper slopes and larger quantities of water lead to faster runoff rate, faster movement, and therefore higher level of excitement (Booth 1983).

Moving water elements create strong impressions of movement, while static water bodies create strong impressions of peace and tranquility. Even so, static water bodies that serve as focal elements, together with the axial elements of any component, enhance the impression of movement created by this axial-focal interaction. Simple and static water bodies, evenly distributed, with no focal qualities, enhance the experience of calmness. The absence of linear water elements (rivers or waterfalls) to serve as axes will further enhance this peaceful quality. This will however detract from the excitement in a landscape.

3.2.4 The role of man-made elements in enhancing or detracting from the sense of movement

Man-made features generally have a negative aesthetic effect in a landscape, since the presence of urban settlements, industries and major roadways or railways will enhance the impression of activity and movement, i.e. the modern lifestyle, which is generally considered to be rushed. The opposite is also true: the presence of small and rustic rural settlements or agricultural buildings, or small and gently winding footpaths could enhance the impression of rural placidity and peace. If these features blend in with the landscape (not serving as axes or focal points) they will enhance the impression of static passivity (i.e. calmness). Elongated built-up areas and cultivated fields function as axial features, and can also function as focal elements when the shape is roughly circular. These man-made features, in combination with axial and focal features of other components, will enhance an experience of movement and excitement in a landscape. A static and passive aesthetic experience is produced by the complete absence of these elements.

Roads are by definition elongated elements, and can therefore serve as axial elements in combination with the focal elements of any component. This enhances an experience of movement and excitement. A static and passive aesthetic experience is produced by the complete absence of these elements.

3.3 A SENSATION OF ENCLOSURE PRODUCING IMPRESSIONS OF SAFETY OR THREAT

The degree of enclosure or openness in a landscape contributes to the overall sense of safety or security an observer experiences. A “safe” landscape enhances calmness, and a landscape that is too exposed or too tightly enclosed (being a “dangerous” landscape) enhances an exciting aesthetic experience.

“Spaces can allow people to feel a relative sense of security or insecurity, belonging or alienation, fear or ease, awe or friendliness, delight or horror, and fascination or indifference” (Beer 1998:

194). According to Beer (1998), landscapes which encourage an impression of security are ones in which the setting is legible and comprehensible, so that the viewers know exactly where they are within the space or spaces that it comprises. Our sense of enclosure relates to the proportion between the width of the space and the height of the barrier as well as to the absolute size of the enclosure.

Enclosures can be rated as being safe or threatening. According to Stanton (1996), proximity and distinction of edges will determine the extent of enclosure of spaces and their resulting characteristics of shelter, visibility and perception of security. This is illustrated in Figure 3.3. The viewer in (a) is too exposed and vulnerable, and there is freedom of movement into and out of the enclosure. The viewer in (b) is too enclosed, and has restricted visibility and limited escape routes. Both situations are slightly threatening, enhancing excitement.

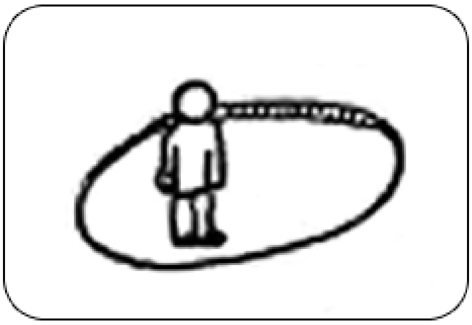
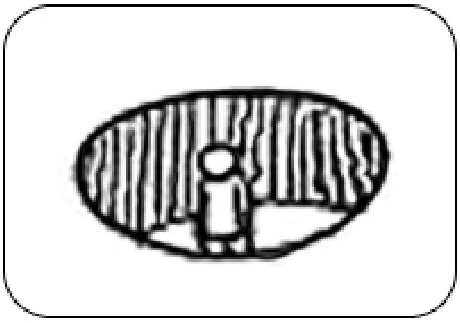
(a)  (b) 

Figure 3.3: The different circumstances of threatening enclosures

Source: Stanton 1996: vi.

The ratio between the width of the space being enclosed and the height of the enclosure determines whether the enclosure created is safe or threatening. A space that is too enclosed enhances a sensation of entrapment. Open, level landforms lack the vertical dimension, thereby creating open, spacious, exposed experiences – there is no feeling of enclosed space, no sense of privacy, no protection from objectionable sights or sounds and no defense against the sun or wind (Booth 1983). As the spacing of forms that create the visual edge increases, the landscape becomes more expansive, less personal, less sheltered (Motloch 1991). This change in spacing correlating with openness or enclosure is illustrated in Figure 3.4.

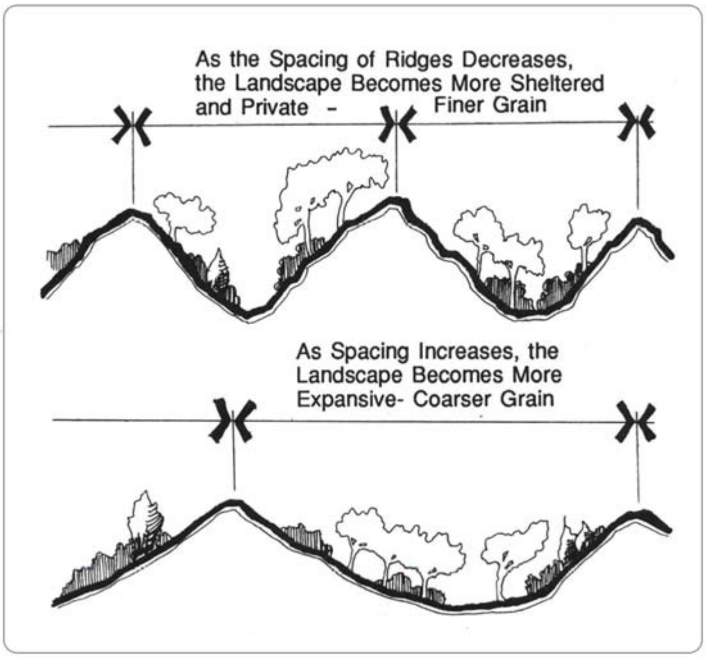


Figure 3.4: The relationship between spacing and landscape expansiveness

Source: Motloch 1991: 59

A sense of safety is therefore created when the enclosure is neither too tight nor too exposed. For the sake of analysis, a height to width ratio of 1:1-1:1.5 was used. Figure 3.5 illustrates the height-width ratio: the degree of enclosure imparted by these forms correlates to the amount of the vertical cone of vision that is occupied by the landform (Motloch 1991).

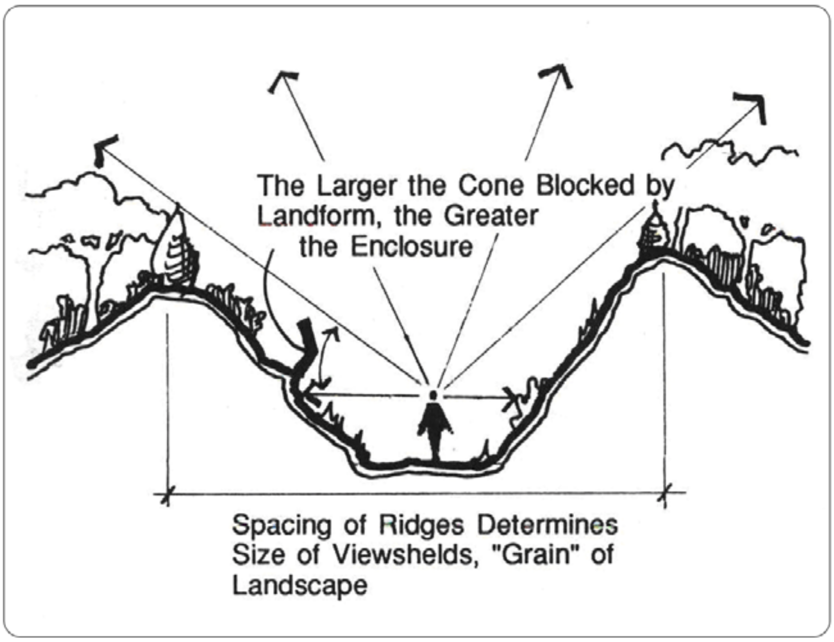


Figure 3.5: The vertical cone of vision created by enclosure

Source: Motloch 1991: 59

A safe enclosure enhances calmness, but detracts from excitement. A threatening enclosure enhances excitement, but detracts from calmness.

In any given landscape, the components that play a role in enclosure are those with vertical extent, i.e. landform, vegetation and built-up areas. Due to the large scale and landscape composition of the test area, it was decided that only landform elements would play a perceptible role in creating safe or threatening enclosures. The vegetation, water and man-made components were therefore excluded from this analysis, since they could not perceptibly contribute to the experience here.

Landform affects perception about the limits and feeling of outdoor space: visually level landforms lack vertical definition, but slopes and higher points occupy the vertical plane, thereby defining and enclosing spaces. Isolated hills and mountains and mountain and hill ranges establish the limits of a space, and control views into and out of it (Booth 1983). The higher the summit, the steeper the slopes and the smaller the floor area (central level area), the greater the sense of enclosure. A ridge also defines the edges of a space. It can function as a separator between valleys, thus background, backdrop to middle ground valleys.

Vertical extent is not an indication of enclosure by itself. Hills and mountains surrounding an inner area on at least two sides were considered to be enclosing.

3.4 A SENSE OF ORDER OR CHAOS

Unity and simplicity (producing order, or balance), and their opposites, fragmentation and complexity (producing chaos, or imbalance), are the direct results of the distribution of elements across the landscape and the variety in shape, colour and texture of those elements. This section considers how landscape elements contribute to produce these effects.

3.4.1 Unity and fragmentation, creating order or chaos

The distribution of elements in a landscape produces a sensation of unity or fragmentation, order or chaos. Unity (producing order) enhances calmness and detracts from excitement, and fragmentation (producing chaos) enhances excitement, but detracts from calmness. For the purposes of this study, unity was evaluated according to the distribution pattern of elements across the landscape.

In a landscape, unity is enhanced by the continuation of some element of design (Motloch 1991). Points, lines, form, colour or texture can continue from one part of the composition to another, thereby increasing unity. Order results from regularity and continuity of pattern. Elements located evenly in a grid-like fashion were taken to be an indication of ordered distribution, enhancing unity in the landscape. In an even distribution, attention is divided equally over the entire surface; order results from regularity and continuity of pattern. This effect of unity and order enhances calmness and detracts from excitement in a landscape. A fragmented distribution pattern with no order produces an impression of chaos and imbalance, ultimately enhancing excitement in a landscape. This type of distribution pattern detracts from calmness in a landscape.

Gericke (2002 Pers Com) described the importance of unity in a calm landscape. “Unity is the quality of all parts being joined together into a single and harmonious, coherent whole. Monotony is also unity but of low quality with variety and vividness in scant supply” (Litton 1982: 103). Unity implies that elements in a composition belong together and are clearly connected and related. Unity provides coherence to a composition; it makes it understandable. Design that lacks unity appears to lack order and is often perceived as fragmented and imbalanced (Motloch 1991).

An overall “oneness” is characteristic of unity in a landscape (Colvin 1970). It reconciles variety in the parts, so that each part, individual as it may be, is clearly related to the rest. Preece (1991) states that good environments should generally have a wholeness of character with the exclusion of discordant elements.

Van den Berg et al. (1998: 141) found that beauty ratings were positively related to perceived coherence (i.e. unity), asking the question, “Do you think the elements in this landscape fit together well?” Kaplan et al. (1989, in Hunziker 1995) state that the driving variables of landscape preference are coherence (i.e. unity), legibility, complexity and mystery, and the optimum combination of these factors.

Chaos typically comprises a confusing overlap of elements and visual movement. It arises from an attempt by the viewer to sort elements into some kind of order: trying to separate various layers of components by perceiving a hierarchy or by selectively focusing attention. This enhances excitement in a landscape. According to Stanton (1996), order can be defined as a state in which everything is arranged logically, comprehensibly or naturally. This is achieved when the visual forces within a landscape can be clearly discerned, or when there is no doubt about the relationship of elements to each other. Order creates a reassuring expectancy. This concept is illustrated in Figure 3.6. The elements in (a) are all clustered together, and the viewer is forced to try and separate elements in order to make sense of what is seen. The elements in (b) are evenly spaced, enabling the viewer to concentrate on one at a time.

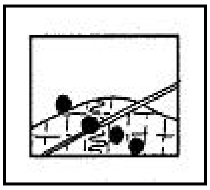
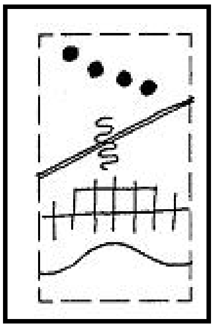
(a)  (b) 

Figure 3.6: Perception of chaos, (a), and order, (b), in a landscape

Source: Stanton 1996: v

Figures 3.7, 3.8 and 3.9 are photographs of two calm landscapes and one exciting landscape. The first, Figure 3.7, is of a calm Welsh landscape, with flowing green hills and evenly spaced hedges. Figure 3.8 is a photograph of a calm Afghan desert landscape, with evenly spaced, repetitive flowing dunes and a homogeneous vegetation patch. Figure 3.9 is a photograph of an exciting Parashant landscape in Oregon (USA), depicting irregularly distributed mountains and hills.

Figure 3.7: A calm Welsh landscape, consisting of simple flowing hills, and evenly distributed vegetation

Source: Worrall 2001: 69

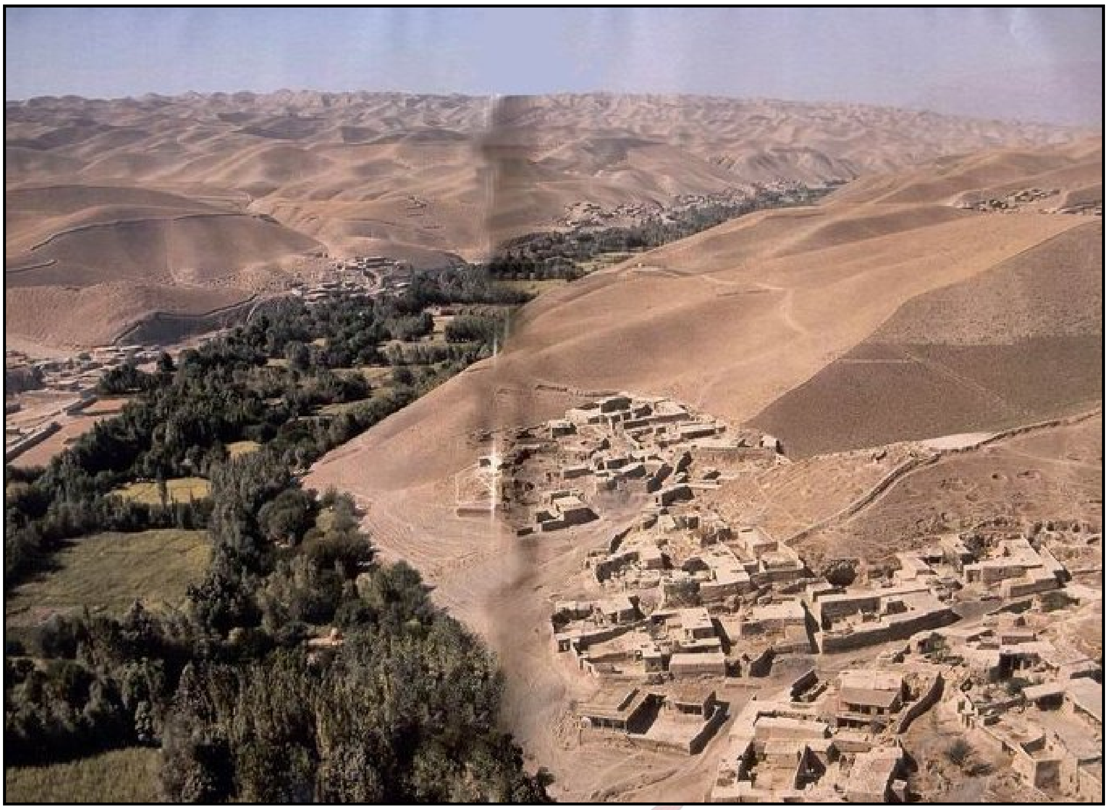


Figure 3.8: A calm Afghan landscape, with sinuously flowing dunes and homogeneous vegetation

Source: Edwards 2001: 28-29

Figure 3.9: An exciting landscape in Oregon, USA, with unevenly distributed mountains

Source: Mitchell 2001: 21

3.4.2 Simplicity and complexity, creating order or chaos

Shape, colour and texture variety produce sensations of simplicity and/or complexity in a landscape, and by implication, order or chaos. Simplicity in variety (producing order) enhances calmness and detracts from excitement, and complexity (producing chaos) enhances excitement, but detracts from calmness. For the purposes of this study, simplicity was evaluated according to element shape, colour and texture, and the variety of shape, colour and texture in the landscape. Little variety was taken to be an indication of simplicity in the landscape. Large variety was taken to be an indication of complexity in a landscape.

According to Stanton (1996) simplicity refers to the ease with which a landscape may be understood: it tends to portray a very clear, strong image, which appears reassuring in its predictability. Simplicity and complexity in a landscape are the result of the variety of elements with contrasting characteristics that can be seen in the landscape. Great variety results in constant visual surprise and interest. This can be visually demanding — the eye tends to keep moving in search for those properties, which provide resolution (Stanton 1996). A variety of shape, colour and texture will produce a complex aesthetic experience, thereby enhancing excitement. Similarity in shape, colour and texture will produce a simple aesthetic experience, thereby enhancing calmness in a landscape.

Beer (1998) states that complexity and diversity, mystery, legibility and coherence have been identified as important characteristics in the way in which the place affects the senses. Complexity involves people in a landscape and keeps them interested. It therefore has to have coherence and structure so that the parts make a whole, so that the landscape becomes understandable and not threatening. Diversity, variation and complexity in a landscape entail, firstly, an area's degree of vividness and, secondly, the quality of interaction among elements (Litton & Tetlow 1974, as quoted in Misgav 2000). "Vividness is, most simply, the presence of contrasting things seen together" (Litton 1982: 103).

Gericke (2002 Pers Com) states that texture, shape and colour are very important in a landscape. Shape, colour and texture add to variety in the aesthetic experience of landscape. Colour can range from warm reds, orange and yellows, to cold blues, greens and purples. Colour can also be evaluated according to lightness or darkness, in other words intensity. A variety of light and dark colours enhances excitement. Motloch (1991) describes light colours as having an airy, light feeling, and dark, intense colours as being somber and mysterious.

The texture of elements is defined by the material nature of the individual element: man-made features and static water features generally have a smooth texture, whereas undisturbed tree clumps have a rough texture. Colvin (1970) and Gericke (2002 Pers Com) explain that fine texture creates the illusion of it being farther away and a coarse texture of it being closer, thus the illusion of distance and depth is created.

Shape is the outward form of an element produced by its outline (Stanton 1996). Simple shapes have a structure that is easily comprehended by the eye, with a clear order of parts, angles and directions, easily remembered. Diagonal shapes have the appearance of being in motion, or being of a temporary nature. Conflicting shapes result in visual confusion. Geometric shapes are complex, being mostly man-made, whereas natural, flowing shapes are more readily understandable and simple. Curved or free-flowing lines are sometimes described as smooth, graceful or gentle and create a relaxing and natural feeling (Ingram 1991).

3.4.3 The role of landform in producing order or chaos

The repetition of similar elements, evenly spaced across a landscape, enhances unity. For example, hills evenly located on expansive plains are ordered and balanced. A variety of landform elements, on the other hand, unevenly scattered, clustered and fragmented, produce an exciting diversity resulting in a complex, imbalanced and chaotic aesthetic experience (Karjalainen & Komulainen 1998).

Level landforms contribute to unity because there is a much greater sense of unity within a pattern on this level land – various parts can all be related to the whole (Booth 1983).

3.4.4 The role of vegetation in producing order or chaos

Vegetation can function as a unifier: large patches of homogeneous plant material can serve as a common thread, because of their consistency, visually tying together all the different components of a landscape. It is the one element that stays the same while the other elements vary (Booth 1983). In a landscape, unity is enhanced by the continuation of some element of design (Motloch 1991). On the one hand, the continuation of colour and texture of vegetation would increase unity, enhancing calmness in a landscape. On the other hand, uneven distribution of homogeneous vegetation patches would produce an impression of fragmentation and chaos, thereby enhancing excitement in the landscape.

The variety of variables associated with vegetation (shape, colour, texture) enables vegetation elements to add a great variety and diversity to a landscape. Distribution of these elements could be even or uneven, either enhancing calmness and detracting from excitement, or vice versa.

3.4.5 The role of water in producing order or chaos

Variables applicable to the water component elements are colour and shape. Texture was not considered because of the scale of the test region and the difficulty in identifying texture from the orthophoto images. A variety of colours and shapes and an uneven distribution of elements will add to a situation of chaos, imbalance and complexity, thereby enhancing an exciting aesthetic experience. Similarity and even distribution of water elements will lead to a sensation of unity, producing order and balance, thereby enhancing a calm aesthetic experience.

Water elements can have either natural or geometric shapes (borders), mostly depending on the amount of human control. Natural shapes are simple, sinuous and calming, and geometric shapes are complex and angular, creating a perception of energy (Motloch 1991). The colour of a water element indicates depth and purity: dark water indicates deep, unpolluted water, whereas shallow water has a light colour.

3.4.6 The role of man-made features in producing order or chaos

A continuous and even distribution of elements in a landscape enhances a calm aesthetic experience. Little variety in the shape and texture of man-made elements, a repetition of similar elements and an even distribution across the landscape will produce a sense of unity and simplicity, thereby enhancing calmness and detracting from excitement in a landscape. Variety and an uneven distribution will produce a sense of fragmentation and complexity, thereby enhancing excitement and detracting from calmness in a landscape.

The elements described in this chapter will be analysed in the next chapter according to the subtypes of aesthetic experiences, based on the variables applicable to these elements.

CHAPTER 4: GIS-GRID ANALYTICAL METHODOLOGY

This chapter offers a complete description of the methodology applied as the theoretical model created in the previous chapters was put into practice using a GIS. This chapter firstly entails an overview of the nature of the test region according to the four coverages that were created and on which analysis was performed. Data capture was described in Section 1.4. Secondly, an explanation of the method of aesthetic value analysis is given. An extensive description of the calculation of attribute data, the analysis of the elements in producing aesthetic experiences, and the analysis performed with the use of a GIS follow in the remainder of the chapter.

4.1 BASIC LANDSCAPE STRUCTURE

The study area has a variety of landscape elements: landform consisting of plains, hills and mountains; vegetation consisting of trees, wetlands and riparian vegetation, natural undisturbed fynbos vegetation (the background matrix) and natural but disturbed recovered vegetation in built-up areas; water features consisting of dams and rivers; and man-made features consisting of built-up areas, four different types of roads and cultivated fields.

The following four figures illustrate the spatial extent of landscape elements in the basic coverages before any aesthetic analysis. Figure 4.1 is the resulting landform map, Figure 4.2 is the resulting vegetation map, Figure 4.3 is the resulting water features map and Figure 4.4 is the resulting man-made features map. Figure 4.1 illustrates the landform elements that were used in analysis. In the west can be seen the only mountain range by definition, with an absolute height of between 1600m and 1690m. In the north-northwest and south two hill ranges can be seen. The rest of the landscape consists of an extensive plain, with a slope below 10º. Figure 4.2 illustrates the vegetation elements that were used in analysis. Tree clumps are prominent in the north and south. Wetland and riparian vegetation can be seen along watercourses. The background undisturbed fynbos vegetation matrix covers most of the landscape. Natural but disturbed vegetation and cleared areas are mostly located in close proximity to built-up areas and cultivated land. Figure 4.3 illustrates the water elements that were used in analysis. A large number of irrigation dams can be seen, including the Loch Lynne Dam, the Rocklands Groot Dam and the Rocklands Berg Dam, as well as two prominent rivers. Figure 4.4 illustrates the man-made elements that were used in analysis. A large number of cultivated lands (mainly orchards) and small clusters of built-up areas, distributed over the landscape can be seen in this map. One highway, the R303, and a large number of gravel roads and tracks can also be seen.

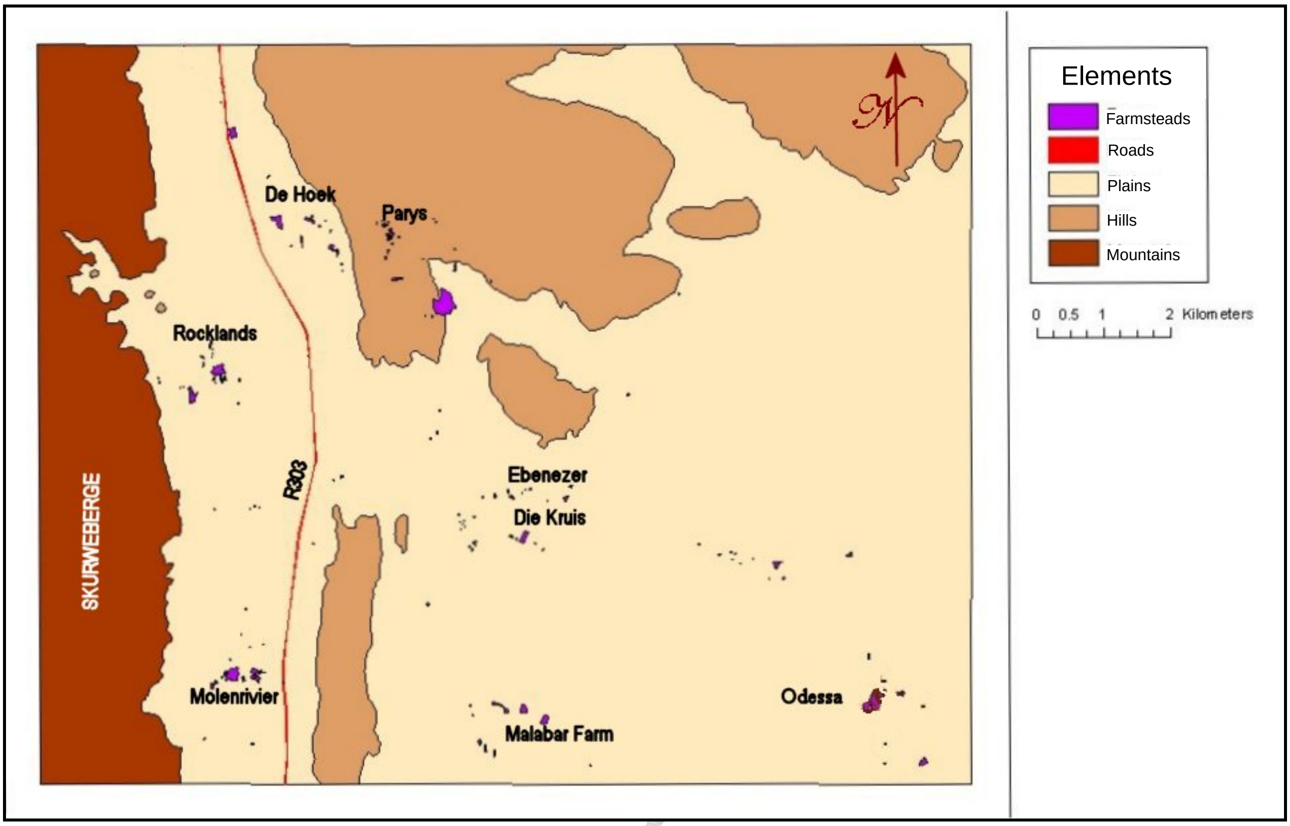


Figure 4.1: The landform component with elements

Figure 4.2: The vegetation component with elements

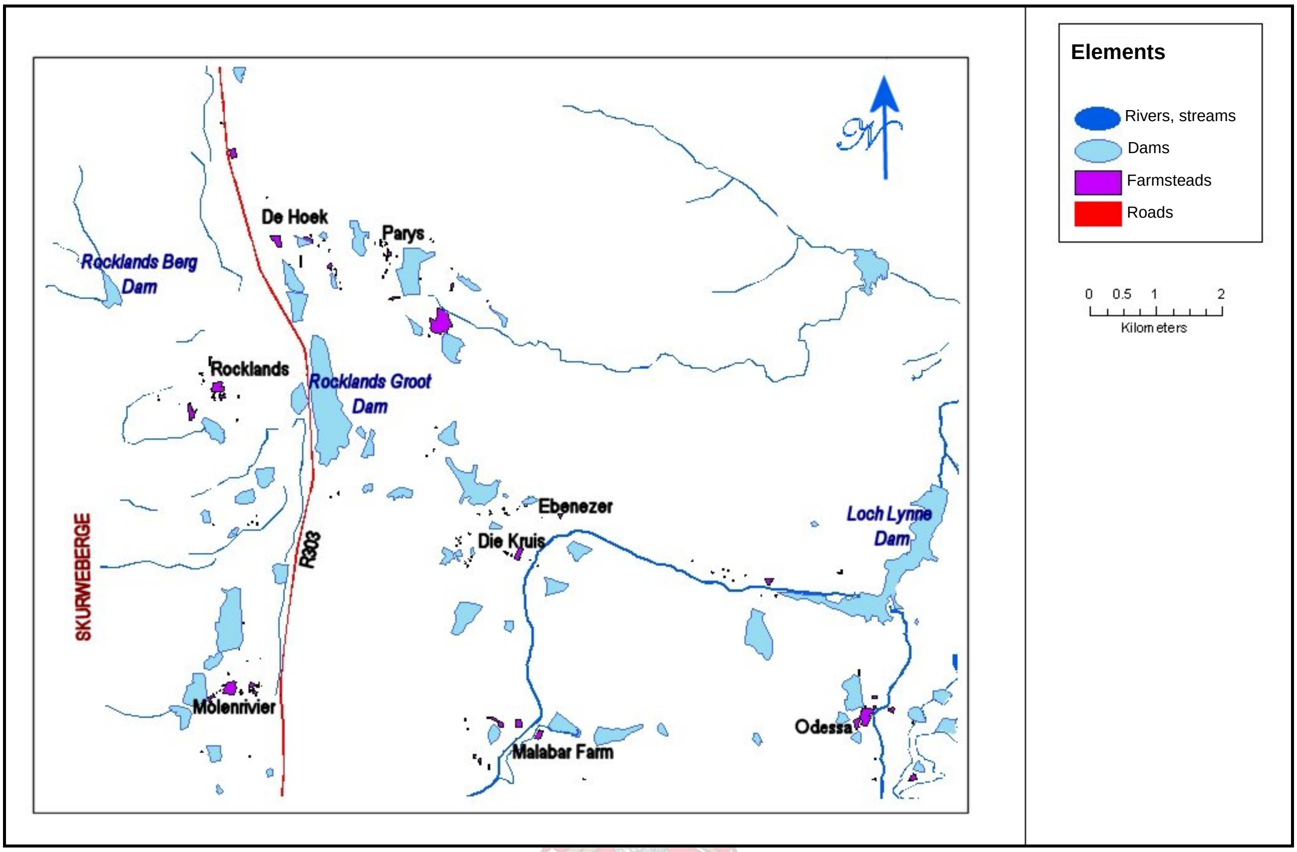


Figure 4.3: The water feature component with elements

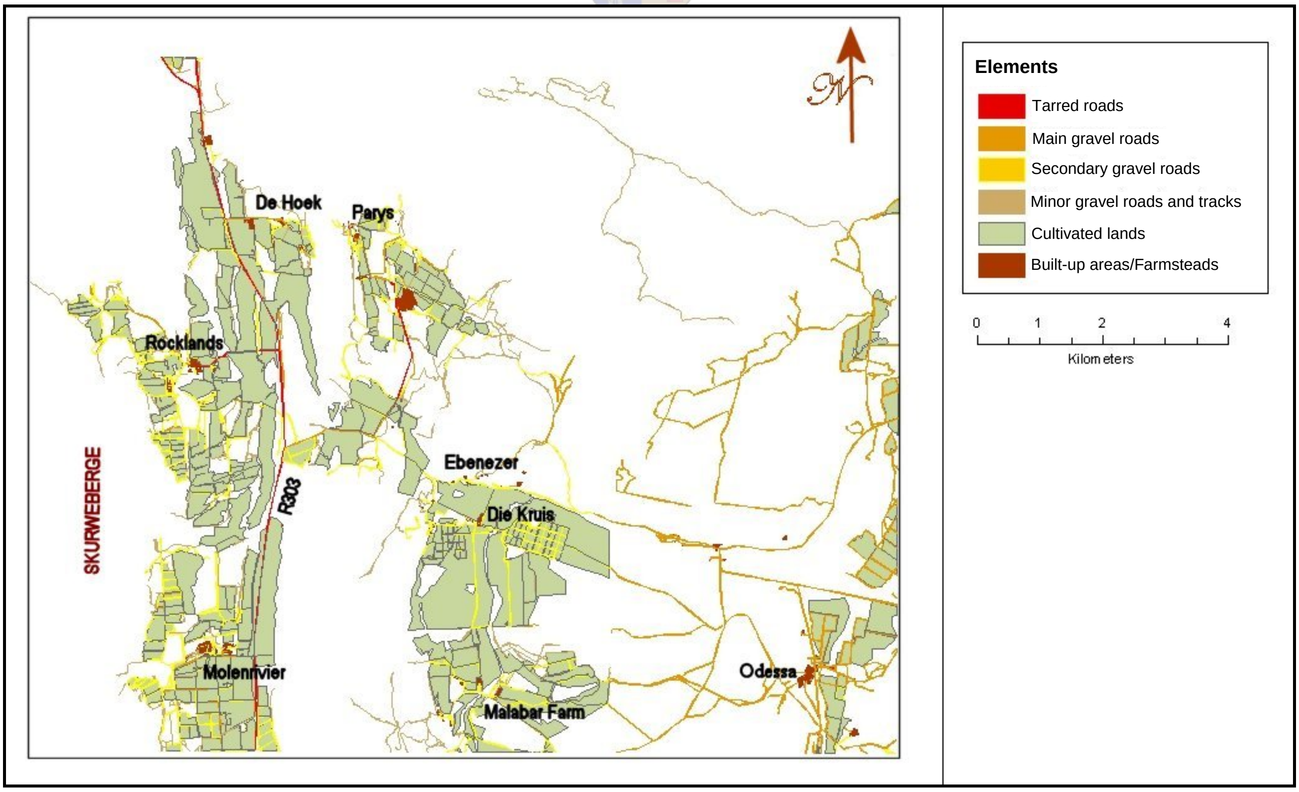


Figure 4.4: The man-made feature component with elements

4.2 RATING LANDSCAPE AESTHETIC EXPERIENCE

This section is an overview of the steps that were followed in the analysis of landscape elements based on the theory developed and described in the previous chapters. The general process consisted of converting vector layers to raster layers to be used in Arc/Info GRID overlay analysis.

Each attribute of each element was assigned a value rating according to the role it plays in enhancing either calmness or excitement, or detracting from either calmness or excitement. Two separate raster layers (or grids) were created for each element attribute: one grid containing values enhancing excitement, and one grid containing values enhancing calmness. A cell size of 5m x 5m was decided upon, giving an image size of 7 840 000 cells. This resolution ensured the desirable level of detail necessary to represent elements with a small surface area, for example, streams or channels with a 5m width. The values attributed to the cells reflect the aesthetic value of the element variables the raster layer was created from. A value scale from 1-5 was decided upon, with 1 representing very low, 2 low, 3 medium, 4 high and 5 representing very high.

These grids were then used in Arc/Info GRID overlay analysis, adding the values in corresponding cells. Grid layers of attributes enhancing calmness where overlaid in order to derive a map depicting the total calmness value of the landscape. The same was done with attribute grids enhancing excitement, deriving a map depicting the total excitement value of the landscape. A comparison of these two maps indicated which aesthetic experience was dominant. A combination of these two experience rasters (through overlay in GRID, adding cell values) resulted in the complete aesthetic experience map, providing a summary index of aesthetic experience.

4.3 INFLUENCE OF THE LANDFORM COMPONENT

Landform elements enhance or detract from aesthetic experiences through their position and distribution in the landscape, the role they play in creating movement through axial-focal interaction, and through creating either safe or threatening enclosures. Table 4.1 is a summary of the influence of position and distribution, and elongation. Enclosure is discussed separately in more detail in Section 4.7.2. The columns contain short descriptions of the influence of attributes, and are separated by rows into enhancing or detracting from calmness and excitement. The + sign indicates enhancing, and the – sign indicates detracting from the aesthetic experience. The structure of this table is similar to the tables containing summaries of the vegetation, water and man-made component elements (Tables 4.5, 4.14 and 4.19).

Table 4.1: The influence of landform elements in enhancing calmness or excitement, or detracting from calmness or excitement

	Variable:	
Aesthetic experience:	Position and distribution	Elongation
CALM	Scattered = - Evenly spaced = + More, larger plains = + More, larger mountains = - Plain surrounded by hills/mountains in safe enclosure = +	Axial elements leading to focal elements = -
EXCITING	Scattered = + Evenly spaced = - More, larger plains = - More, larger mountains = + Plain surrounded by hills/mountains in threatening enclosure = +	Axial elements leading to focal elements = +

4.3.1 Contribution from the position variable

The presence or absence of landform elements in a landscape can enhance or detract from an aesthetic effect, depending on the context and the type of aesthetic experience. Vertical landforms are dynamic, aggressive, exciting, implying power and strength in defiance of gravity and creating a feeling of reverence (Booth 1983). Mountains thus enhance excitement but detract from calmness in a landscape. Level landforms are static, nonmoving and in balance with the earth's gravitational forces. Plains thus have a calming effect on a landscape, therefore enhancing calmness and detracting from excitement in a landscape (Booth 1983). The aesthetic impact of hills is not quite as dramatic as that of mountains and not quite as pacifying as that of plains. Hills could therefore enhance or detract from either calmness or excitement, depending on the distribution. Conclusively, the aesthetic impact of hills averages between that of plains and mountains.

All landform elements were assigned two ratings according to this aesthetic influence: one enhancing calmness and the other enhancing excitement. These rating values were stored separately as two attribute fields of the landform coverage, eventually converted to two grid overlays using these attributes. Table 4.2 contains the value ratings that were assigned to the landform elements according to their contribution to the aesthetic experience of the landscape. The two aesthetic impact columns represent the values assigned to the two attribute fields.

Table 4.2: The contribution of landform elements to the aesthetic experience of a landscape

		Aesthetic impact	
		Enhancing calmness	Enhancing excitement
Landform element	Plains	5	1
	Hills	3	3
	Mountains	1	5

4.3.2 Contribution from the distribution pattern variable

Distribution of landform elements could enhance or detract from the aesthetic value of a landscape, depending on the aesthetic experience. Even distribution enhances unity and order and has a calming effect. Uneven distribution disrupts unity, creating an exciting and dynamic effect. These contributions were discussed in Section 3.4.1.

The method followed in analysis was based on the assumption that if a grid with large cells were to be placed over the landscape, the specific landform element should be present in each cell to be considered evenly distributed. The cell size of this grid was specified as 1400m x 1400m – a tenth of the width of the study area. The resulting landscape of the study area consisted of a total of 80 cells.

The analysis proceeded as follows: two separate value ratings were assigned to the landscape as a whole (i.e. to each cell in the grid overlay) according to the distribution aesthetic influence: one enhancing calmness and the other enhancing excitement. These rating values were stored separately as two attribute fields of the landform coverage, eventually converted to two grid overlays using these attributes. The following steps were taken in calculating the contribution of landform element distribution:

- Step One: The elements of the landform component were separated into three separate coverages – plains, hills and mountains. Three grid overlays with a cell size of 1400m x 1400m were created. Using Arc/Info weight tables, the highest value was assigned to the specific landform element (plain, hill or mountain) where present and the lowest value to zero or nodata cells.
- Step Two: The resulting rasters gave an indication of distribution and were not used for any further Arc/Info grid overlay analysis. The cell count was used to indicate distribution. Percentages were calculated for each grid as follows: 40 cells out of a possible total of 80 cells meant the element could be found in 50% of the landscape. If less than 40% of cells

contained the specified element, the element was considered to be unevenly distributed; if 40% - 60% of cells contained the specified element, the element was considered to have an average distribution; if more than 60% of cells contained the specified element, the element was considered to be evenly distributed. These percentages do not indicate the surface area extent of the element – it is an indication of distribution across the total image.

- Step Three: Rating values were stored as attributes of all cells in the landform coverage. These values were derived from the percentage of distribution, and assigned according to the type of aesthetic experience. An even distribution (>60%) enhances calmness but detracts from excitement. An uneven distribution (<40%) enhances excitement but detracts from calmness. An average distribution (40%-60%) neither enhances nor detracts from either calmness or excitement. Table 4.3 lists the rating values to be assigned according to distribution percentage.

Table 4.3: The contribution of distribution to the aesthetic experience of a landscape

		Aesthetic impact	
		Enhancing calmness	Enhancing excitement
Distribution	Even distribution (>60%)	5	1
	Uneven distribution (<40%)	1	5
	Average distribution (40%-60%)	3	3

- Step Four: Percentage of distribution was calculated for the three landform types separately, and two value ratings were assigned – one enhancing calmness and the other enhancing excitement. Table 4.4 contains the actual values that were assigned according to the percentage of distribution. Mountains, for example, can be found in only 20% of the test region, and was therefore considered to have an uneven distribution. The two aesthetic impact columns represent the values assigned to the two attribute fields.

Table 4.4: Value ratings assigned according to the distribution percentage of landform elements

		Distribution percentage	**Aesthetic impact**	
			Enhancing calmness	Enhancing excitement
Landform element	Plains	87,5% (in 70 of the 80 cells)	5	1
	Hills	45% (in 36 of the 80 cells)	3	3
	Mountains	20% (in 16 of the 80 cells)	1	5

- Step Five: The landform coverage was converted to six grid overlays, using both values assigned to the three landform element types. Two assignment approaches could be followed here. Firstly, the value ratings could be assigned to the landform elements only, for example, the value 5 could be assigned to all cells where plains can be found as its even distribution enhances calmness. The second approach was followed here. The assigned values were awarded to all cells in the raster, because the distribution of elements influences the landscape as a whole and not just the cells where the elements are to be found. These rating values were stored separately as two attribute fields of the landform coverage, eventually converted to two grid overlays using these attributes.

4.3.3 Contribution from the elongation variable

In the analysis of axial-focal interaction, it was necessary to define all elements of the components as either focal or axial. Locations of all focal elements from all components, in relation to all linear features from all components were analysed in the Section 4.7.1.

The definition and characteristics of an elongated feature were discussed in Section 3.2. This length-width ratio was used to define the landform elements as either focal or axial. A new attribute field was added to the landform coverage containing codenames defining all landform elements as either axial or focal. These attributes were calculated through the measurement of all landform elements except for plains. The plain element has an irregular shape and can therefore not be characterized as either focal or axial. No further analysis was done at this initial stage.

4.4 INFLUENCE OF THE VEGETATION COMPONENT

Vegetation elements enhance or detract from aesthetic experiences through their position and distribution in the landscape, in the simplicity or complexity of the shape, colour and texture, in the variety of shape, colour and texture they add to the landscape, and the role they play in creating movement through axial-focal interaction. Table 4.5 is a summary of the influence of position and distribution, variety of shape, colour and texture, and elongation.

Table 4.5: The influence of vegetation elements in enhancing calmness or excitement, or detracting from calmness or excitement

	Variable				
Aesthetic experience:	Position and Distribution	Shape, Variety	Colour, Variety	Texture, Variety	Elongation
CALM	Presence = + Scattered = - Evenly spaced = +	Unity enhanced by repetition: Little variety = + Smooth, sinuous, simple = +	Unity enhanced by repetition: Little variety = + Pale = + Bright = -	Unity enhanced by repetition: Little variety = + Fine = + Coarse = -	Axial elements leading to focal elements = -
EXCITING	Presence = + Scattered = + Evenly spaced = -	Geometric, complex = + High variety in shape = +	Variety = + Contrasting, bright colours = +	Variety = + Contrasting, coarse texture = +	Axial elements leading to focal elements = +

4.4.1 Contribution from the position variable

The presence of vegetation in a landscape enhances the aesthetic effect regardless of the type of aesthetic experience, although the different types of vegetation have varying positive effects. The same aesthetic values were therefore assigned to vegetation in both types of aesthetic experiences. Vegetation masses (see Section 2.4.2 for description of masses) with a greater vertical extent have a higher positive effect. Silvennoinen et al. (2001) found a strong preference for trees in a landscape. Wetlands and stream channel vegetation with a lower vertical extent were assigned a lower value than for trees. An average value was decided upon for the natural, undisturbed background vegetation, because even though large patches of homogeneous groundcover have a calming effect on a landscape, the effect is neutralising. It serves the purpose of a void rather than that of a mass (see Section 2.4.2 for description of voids). Disturbed vegetation in built-up areas was assigned a low value, because of the distinct unnatural appearance of these vegetation patches. Man's influence on these elements is clear. Cleared areas were selected and assigned a very low value. Nodata were automatically assigned a value of zero in the gridding process done in Arc/Info GRID.

All vegetation elements were assigned two ratings according to this aesthetic influence: one enhancing calmness and the other enhancing excitement. These rating values were stored separately as two attribute fields of the vegetation coverage, eventually converted to two grid overlays using these attributes. Table 4.6 contains the value ratings that were assigned to the vegetation elements according to their contribution to the aesthetic experience of the landscape. The two aesthetic impact columns represent the values assigned to the two attribute fields.

Table 4.6: The contribution of vegetation elements to the aesthetic experience of a landscape

		Aesthetic impact	
		Enhancing calmness	Enhancing excitement
Vegetation element	Trees	5	5
	Wetland and riparian vegetation	4	4
	Undisturbed, natural vegetation	3	3
	Disturbed vegetation	2	2
	Cleared areas	1	1

4.4.2 Contribution from the distribution pattern variable

Distribution of vegetation elements could enhance or detract from the aesthetic value of a landscape, depending on the aesthetic experience. The contributions of distribution were discussed in Section 3.4.1.

The same analysis principles and the steps taken in the analysis of landform distribution were applied in the analysis of vegetation distribution. Refer to Section 4.3.2 for an explanation and a description of the steps that were taken in analysis. Table 4.7 contains the actual values that were assigned according the percentage of distribution. The two aesthetic impact columns represent the values assigned to the two attribute fields.

Table 4.7: Value ratings assigned according to the distribution percentage of vegetation elements

		Distribution percentage	**Aesthetic impact**	
			Enhancing calmness	Enhancing excitement
Vegetation element	Trees	61.3% (in 49 of the 80 cells)	5	1
	Wetland and riparian vegetation	57.5% (in 46 of the 80 cells)	3	3
	Undisturbed, natural vegetation	100% (in 80 of the 80 cells)	5	1
	Disturbed vegetation	27.5% (in 22 of the 80 cells)	1	5
	Cleared areas	36.3% (in 29 of the 80 cells)	1	5

The vegetation coverage was converted to ten grid overlays, using both values assigned to the five vegetation element types. The assigned values were awarded to all cells in the raster. These rating values were stored separately as two attribute fields of the vegetation coverage, eventually converted to two grid overlays using these attributes.

4.4.3 Contribution from the shape variable

Edge shapes of vegetation elements influence the simplicity or complexity of a landscape. Shape is the outward form of an element produced by its outline or edge. Simple shapes have a structure that is easily comprehended by the eye, with a clear order of parts, angles and directions, and is easily remembered (Stanton 1996). Geometric shapes with sharp angles are more complex because of the man-made appearance of these shapes. Smooth, flowing, less geometric shapes are simpler and more natural. Geometric, complex shapes would therefore enhance excitement in a landscape, but detract from calmness. Simple, flowing lines would enhance calmness but detract from excitement in a landscape. Angular lines usually impart a feeling of energy, power, and boldness. On the other hand, a sinuous line evokes a sense of calmness, passivity, and restfulness (Booth 1983).

All vegetation elements were assigned two ratings according to the aesthetic influence of its edge shape: one enhancing calmness and the other enhancing excitement. These rating values were stored separately as two attribute fields of the vegetation coverage, eventually converted to two grid overlays using these attributes. Table 4.8 contains the value ratings that were assigned to the vegetation elements according to the contribution of their edge shape to the aesthetic experience of the landscape.

Table 4.8: Value ratings assigned to edge shape in enhancing or detracting from the aesthetic experience

		Aesthetic impact	
		Enhancing calmness	Enhancing excitement
Edge shape	All straight and angular	1	5
	More angular and straight than flowing	2	4
	Equal amount of angular and straight	3	3
	More flowing than angular and straight	4	2
	All flowing edges	5	1

Ratings values were assigned to vegetation elements according to the edge shape of the individual elements. Elements were where necessary individually selected according to the shape complexity. Table 4.9 contains the rating values that were assigned. The two aesthetic impact columns represent the values assigned to the two attribute fields. Figures A.1 and A.2 in Appendix A is a selection of images from the orthophoto images serving as examples of the vegetation elements evaluated in this section, illustrating the shapes, colours and textures.

Table 4.9: The contribution of vegetation edge shape in enhancing or detracting from the aesthetic experience

		Aesthetic impact	
		Enhancing calmness	Enhancing excitement
Vegetation element	Tree clumps with flowing and natural edge growth pattern	5	1
	Tree patches artificially controlled and cultivated with all straight or angular shapes	1	5
	Wetland, riparian vegetation	5	1
	Undisturbed, natural vegetation	5	1
	Disturbed vegetation in built-up areas - mostly angular, with some flowing edges	2	4
	Cleared areas: some natural edges and some artificial edges	3	3

The variety of shape also has an influence on the complexity or simplicity of a landscape. A wider variety enhances excitement but detracts from calmness in a landscape. A smaller variety enhances calmness but detracts from excitement in a landscape. The extent of variety in shapes and the aesthetic influence on a landscape according to value ratings is laid out in Table 4.10.

Table 4.10: The aesthetic influence of the variety of shapes in a landscape

		Aesthetic impact	
		Enhancing calmness	Enhancing excitement
Extent of variety	Five different values (very high variety)	1	5
	Four different values (high variety)	2	4
	Three different values (medium variety)	3	3
	Two different values (low variety)	4	2
	One value (very low variety)	5	1

All vegetation elements were assigned two ratings according to the aesthetic influence of its edge shape variety: one enhancing calmness and the other enhancing excitement. These rating values were stored separately as two attribute fields of the vegetation coverage, eventually converted to two grid overlays using these attributes. Analysis entailed a separate examination of the range of shape values awarded above for calm and exciting landscape analysis. Four different shape values were awarded to elements in the vegetation coverage (as listed in Table 4.9) influencing both calmness and excitement. Vegetation elements therefore have a high variety of shapes. A low value rating of 2 was assigned to all cells in the grid influencing calmness, as the high variety detracts from calmness. A high value rating of 4 was assigned to all cells in the second grid influencing excitement, as the high variety in shapes enhances excitement.

4.4.4 Contribution from the colour variable

Vegetation colour influences the simplicity or complexity of a landscape. Intensity and hue have different aesthetic influences depending on the specific aesthetic experience (calm or exciting). Pale and subdued colouring enhances calmness but detracts from excitement in a landscape. Dark and intense colouring enhances excitement but detracts from calmness in a landscape (Motloch 1991). Table 4.11 lists the value ratings assigned to vegetation colours in the test region as it either enhances or detracts from the aesthetic experience.

Table 4.11: Value ratings assigned to colour in enhancing or detracting from the aesthetic experience

		Aesthetic impact	
		Enhancing calmness	Enhancing excitement
Colour	White and pale grey	5	1
	Pale brown or yellow	4	2
	Pale green, blue or red	3	3
	Dark or bright orange or green	2	4
	Dark or bright red or blue, black	1	5

All vegetation elements were assigned two ratings according to the aesthetic influence of its colour: one enhancing calmness and the other enhancing excitement. These rating values were stored separately as two attribute fields of the vegetation coverage, eventually converted to two grid overlays using these attributes. Value ratings were assigned to the elements of the vegetation coverage, based on the above guidelines (Table 4.11), using the colour orthophoto images and evaluating elements individually. The value ratings assigned are laid out in Table 4.12. The two aesthetic impact columns represent the values assigned to the two attribute fields. Figures A.1 and A.2 in Appendix A is a selection of images from the orthophoto images serving as examples of the vegetation elements evaluated in this section, illustrating the shapes, colours and textures.

Table 4.12: The contribution of vegetation colour in enhancing or detracting from the aesthetic experience

		Aesthetic impact	
		Enhancing calmness	Enhancing excitement
Vegetation colour	Trees	2	4
	Wetland and riparian vegetation	2	4
	Undisturbed, natural vegetation	3	3
	Disturbed vegetation	4	2
	Cleared areas	5	1

The variety of colour also has an influence on the complexity or simplicity of a landscape. A wider variety enhances excitement but detracts from calmness in a landscape. A smaller variety enhances calmness but detracts from excitement in a landscape. The extent of variety in colour and the aesthetic influence on a landscape according to value ratings is similar to that of shape variety, and is laid out in Table 4.10.

All vegetation elements were assigned two ratings according to the aesthetic influence of its colour variety: one enhancing calmness and the other enhancing excitement. These rating values were stored separately as two attribute fields of the vegetation coverage, eventually converted to two grid overlays using these attributes. Analysis entailed a separate examination of the range of colour values awarded above for calm and exciting landscape analysis. Four different colour values were awarded to elements in the vegetation coverage (as listed in Table 4.12) influencing both calmness and excitement. Vegetation elements therefore have a high variety of colours. A low value rating of 2 was assigned to all cells in the grid influencing calmness, as the high variety detracts from calmness. A high value rating of 4 was assigned to all cells in the second grid influencing excitement, as the high variety in colours enhances excitement.

4.4.5 Contribution from the texture variable

Texture influences the simplicity or complexity of a landscape. Texture can be rated from fine to coarse, and will have a positive or negative effect depending on the aesthetic experience. Fine textures contribute to a sense of calm and coarse textures to excitement (Colvin 1970; Gericke 2002 Pers Com). Fine textures therefore enhances calmness but detracts from excitement in a landscape. Coarse textures enhance excitement but detract from calmness in a landscape. Booth (1983) describes coarse textures as those created by large leaves, thick massive branches and a loose or open habit of growth. Medium textures result from medium sized leaves and branches, and a moderately dense habit of growth. Fine textures are the result of many small leaves, tiny and thin branches and twigs and a tight or dense habit of growth.

All vegetation elements were assigned two ratings according to the aesthetic influence of its texture: one enhancing calmness and the other enhancing excitement. These rating values were stored separately as two attribute fields of the vegetation coverage, eventually converted to two grid overlays using these attributes. Value ratings were assigned to the elements of the vegetation coverage, based on the above guidelines, with the use of the colour orthophoto images. The value ratings assigned are laid out in Table 4.13. The two aesthetic impact columns represent the values assigned to the two attribute fields. Figures A.1 and A.2 in Appendix A is a selection of images from the orthophoto images serving as examples of the vegetation elements evaluated in this section, illustrating the shapes, colours and textures.

Table 4.13: Value ratings assigned to vegetation elements as texture enhances or detracts from the aesthetic experience

		Aesthetic impact	
		Enhancing calmness	Enhancing excitement
Vegetation texture	Trees: very coarse	1	5
	Wetland, riparian vegetation: coarse	2	4
	Undisturbed, natural vegetation: medium	3	3
	Disturbed vegetation: fine	4	2
	Cleared areas: very fine	5	1

The variety of texture also has an influence on the complexity or simplicity of a landscape. A wider variety enhances excitement but detracts from calmness in a landscape. A smaller variety enhances calmness but detracts from excitement in a landscape. The extent of variety in texture and the aesthetic influence on a landscape according to value ratings is similar to that of shape variety, and is laid out in Table 4.10.

All vegetation elements were assigned two ratings according to the aesthetic influence of its texture variety: one enhancing calmness and the other enhancing excitement. These rating values were stored separately as two attribute fields of the vegetation coverage, eventually converted to two grid overlays using these attributes. Analysis entailed a separate examination of the range of texture values awarded above for calm and exciting landscape analysis. Five different texture values were awarded to elements in the vegetation coverage (as listed in Table 4.13) influencing both calmness and excitement. Vegetation elements therefore have a very high variety of texture. A very low value rating of 1 was assigned to all cells in the grid influencing calmness, as the very high variety detracts from calmness. A very high value rating of 5 was assigned to all cells in the second grid influencing excitement, as the very high variety in colours enhances excitement.

4.4.6 Contribution from the elongation variable

In the analysis of axial-focal interaction, it was necessary to define all elements of the components as either focal or axial. Locations of all focal elements from all components, in relation to all linear features from all components, were analysed in Section 4.7.1.

The definition and characteristics of an elongated feature were discussed in Section 3.2. This length-width ratio was used to define the vegetation elements as either focal or axial. A new attribute field was added to the vegetation coverage containing codenames defining all vegetation elements as either axial or focal. No further analysis was done at this initial stage. These attributes were calculated as follows:

- Tree clumps with a geometric edge shape (already assigned in Section 4.4.3), e.g. a row of trees between agricultural lands, were classified as axial.
- The remaining tree clumps with natural edge shapes were classified as focal.
- Wetland vegetation patches can be found alongside rivers and stream channels, and in elongated wetland areas. These features were classified as axial.
- Undisturbed, natural vegetation (background matrix) functions as a void, and was therefore not classified as either focal or axial.
- Disturbed, natural vegetation, found dispersed in built-up areas, does not stand out by itself and has no function as an axis or a focal feature.
- Cleared areas were individually evaluated and classified as focal or axial where appropriate.

4.5 INFLUENCE OF THE WATER FEATURE COMPONENT

Water elements enhance or detract from aesthetic experiences through their position and distribution in the landscape, the variety of shape and colour they add to the landscape, and the role they play in creating movement through axial-focal interaction. Table 4.14 is a summary of the influence of position and distribution, variety of shape and colour, and elongation.

Table 4.14: The influence of water elements in enhancing calmness or excitement, or detracting from calmness or excitement

	Variable			
Aesthetic experience:	Position and Distribution	Shape, Variety	Colour, Variety	Elongation
CALM	Presence = + Scattered = -; Evenly spaced = + Static water = +; Dynamic water = -	Unity enhanced by repetition: Little variety = + Smooth, sinuous, simple = +	Unity enhanced by repetition: Little variety = + Pure = +	Axial elements leading to focal elements = -
EXCITING	Presence = + Scattered = +; Evenly spaced = - Static water = -; Dynamic water = +	Geometric, complex = +; High variety in shape = +	Variety = + Contrasting, bright colours = +	Axial elements leading to focal elements = +

4.5.1 Contribution from the position variable

The presence of water in a landscape has a positive aesthetic effect, regardless of the type of aesthetic experience, although the two types of water features have varying positive effects. Dams enhance calmness to a greater extent than rivers because of the calming effect of static water. Rivers enhance excitement to a greater extent than dams because of the exciting effect of dynamic water (Motloch 1991; Gericke 2002 Pers Com). All water elements were assigned two ratings according to this aesthetic influence: one enhancing calmness and the other enhancing excitement. These rating values were stored separately as two attribute fields of the water coverage, eventually converted to two grid overlays using these attributes. Nodata was automatically assigned the value of zero in the gridding process done in Arc/Info GRID. Table 4.15 contains the value ratings that were assigned to the water elements according to their contribution to the aesthetic experience of the landscape. The two aesthetic impact columns represent the values assigned to the two attribute fields.

Table 4.15: The contribution of water elements to the aesthetic experience of a landscape

		Aesthetic impact	
		Enhancing calmness	Enhancing excitement
Water element	Dams	5	4
	Rivers, streams, channels	4	5

4.5.2 Contribution from the distribution pattern variable

Distribution of vegetation elements could enhance or detract from the aesthetic value of a landscape, depending on the aesthetic experience. The contributions of distribution to the aesthetic experience were discussed in Section 3.4.1.

The same analysis principles and the steps taken in the analysis of landform distribution were applied in the analysis of water feature distribution. Refer to Section 4.3.2 for an explanation and a description of the steps that were taken in analysis. Table 4.16 contains the actual values that were assigned according the percentage of distribution. The two aesthetic impact columns represent the values assigned to the two attribute fields. These rating values were stored separately as two attribute fields of the water coverage, eventually converted to two grid overlays using these attributes.

Table 4.16: Value ratings assigned according to the distribution percentage of water elements

		Distribution percentage	**Aesthetic impact**	
			Enhancing calmness	Enhancing excitement
Water element	Dams	100% (in 80 of the 80 cells)	5	1
	Rivers/streams/channels	57.5% (in 46 of the 80 cells)	3	3

The water coverage was converted to four grid overlays, using both values assigned to the two water element types. The assigned values were awarded to all cells in the raster.

4.5.3 Contribution from the shape variable

Geometric shapes with sharp angles are more complex because of the man-made appearance of these shapes. Smooth, flowing, less geometric shapes are simpler and more natural. Geometric, complex shapes would therefore enhance excitement in a landscape, but detracts from calmness. Simple, flowing lines would enhance calmness but detract from excitement in a landscape (See Section 4.4.3 for a more detailed discussion on the contribution of shape).

All water elements were assigned two ratings according to the aesthetic influence of its edge shape: one enhancing calmness and the other enhancing excitement. These rating values were stored separately as two attribute fields of the water coverage, eventually converted to two grid overlays using these attributes. Table 4.8 contains the value ratings that were assigned to the vegetation elements according to the contribution of their edge shape to the aesthetic experience of the landscape. The same values are applicable to water element edge shape.

Ratings values were assigned to water elements according to the edge shape of the individual elements. Elements were individually selected and values were assigned using the colour orthophoto images. Table 4.17 contains the rating values that were assigned. The two aesthetic impact columns represent the values assigned to the two attribute fields. Figure A.3 in Appendix A is a selection of images from the orthophoto images serving as examples of dams evaluated in this section, illustrating the shapes and colours.

Table 4.17: The contribution of water edge shape in enhancing or detracting from the aesthetic experience

		Aesthetic impact	
		Enhancing calmness	Enhancing excitement
Water element	Dams: with natural shapes	5	1
	Dams: with artificial dam walls	4	2
	Rivers/streams/channels	5	1

The variety of shape also has an influence on the complexity or simplicity of a landscape. A wider variety enhances excitement but detracts from calmness in a landscape. A smaller variety enhances calmness but detracts from excitement in a landscape. The extent of variety in shape of water elements and the aesthetic influence on a landscape according to value ratings is similar to that of vegetation shape variety, and is laid out in Table 4.10.

All water elements were assigned two ratings according to the aesthetic influence of its shape variety: one enhancing calmness and the other enhancing excitement. These rating values were stored separately as two attribute fields of the water coverage, eventually converted to two grid overlays using these attributes. Analysis entailed a separate examination of the range of shape values awarded above for calm and exciting landscape analysis. Two different shape values were awarded to elements in the water coverage (as listed in Table 4.17) influencing both calmness and excitement. Water elements therefore have a low variety of shapes. A high value rating of 4 was assigned to all cells in the grid influencing calmness, as the low variety enhances calmness. A low value rating of 2 was assigned to all cells in the second grid influencing excitement, as the low variety in shapes detracts from excitement.

4.5.4 Contribution from the colour variable

Water colour is an indication of water purity. This perception influences aesthetic quality: clear water, with a dark blue or black colour in coloured imagery is more natural, pristine, thereby having a positive influence wherever it occurs. Turbid water show in a light green, blue or brown in coloured imagery depending on the nature of suspended material (Motloch 1991; Beer 1998). Rating was done according to the value ratings assigned to colours in Table 4.11.

All water elements were assigned two ratings according to the aesthetic influence of its colour: one enhancing calmness and the other enhancing excitement. These rating values were stored separately as two attribute fields of the water coverage, eventually converted to two grid overlays using these attributes. Value ratings were assigned to the elements of the water coverage, based on the guidelines of Table 4.11, using the colour orthophoto images and evaluating elements individually. The value ratings assigned are laid out in Table 4.18. Figure A.3 in Appendix A is a selection of images from the orthophoto images serving as examples of dams evaluated in this section, illustrating the shapes and colours.

Table 4.18: The contribution of water colour in enhancing or detracting from the aesthetic experience

		Aesthetic impact	
		Enhancing calmness	Enhancing excitement
Water colour in imagery	Brown or white	1	1
	Light green or brown	2	2
	Green	3	3
	Light blue	4	4
	Dark blue or black	5	5

The variety of colour also has an influence on the complexity or simplicity of a landscape. A wider variety enhances excitement but detracts from calmness in a landscape. A smaller variety enhances calmness but detracts from excitement in a landscape. The extent of variety in colour and the aesthetic influence on a landscape according to value ratings is similar to that of shape variety, and is laid out in Table 4.10.

All water elements were assigned two ratings according to the aesthetic influence of its colour variety: one enhancing calmness and the other enhancing excitement. These rating values were stored separately as two attribute fields of the water coverage, eventually converted to two grid overlays using these attributes. Analysis entailed a separate examination of the range of colour values awarded above for calm and exciting landscape analysis. Two different colour values were awarded to elements in the water coverage influencing both calmness and excitement. Water elements therefore have a low variety of colours. A high value rating of 4 was assigned to all cells in the grid influencing calmness, as the low variety enhances calmness. A low value rating of 2 was assigned to all cells in the second grid influencing excitement, as the low variety in colours detracts from excitement.

4.5.5 Contribution from the elongation variable

In the analysis of axial-focal interaction, it was necessary to define all elements of the components as either focal or axial. Locations of all focal elements from all components, in relation to all linear features from all components were analysed in Section 4.7.1.

The definition and characteristics of an elongated feature were discussed in Section 3.2. This length-width ratio was used to define the vegetation elements as either focal or axial. A new attribute field was added to the vegetation coverage containing codenames defining all vegetation elements as either axial or focal. No further analysis was done at this initial stage. These attributes were calculated as follows: all rivers were classified as axial, and dams were individually measured and classified as either axial or focal.

4.6 INFLUENCE OF THE MAN-MADE FEATURE COMPONENT

Man-made elements enhance or detract from aesthetic experiences through their position and distribution in the landscape and the variety of shape they add to the landscape. Table 4.19 is a summary of the influence of position and distribution, variety of shape, and elongation.

Table 4.19: The influence of man-made elements in enhancing calmness or excitement, or detracting from calmness or excitement

	Variables	
Aesthetic experience:	Position and Distribution	Shape, Variety
CALM	Presence = - Scattered = - Evenly spaced = +	Unity enhanced by repetition: Little variety = + Smooth, sinuous, simple = +
EXCITING	Presence = - Scattered = + Evenly spaced = -	Geometric, complex = + High variety in shape = +

4.6.1 Contribution from the position variable

Elements in the man-made component have differing effects on the aesthetic quality of both calm and exciting landscapes. The effect depends on the material it is made from (artificial or natural) and the shape (geometric/man-made/artificial or natural) (Van den Berg & Vlek 1998; Kaltenborn & Bjerke 2002).

Built-up areas and tarred roads had the most negative effect, representing the greatest extent of human impact and intrusion. Shapes are highly geometric and building material completely artificial. Tarred roads also cover a high proportion of the surface (> 6m wide). Main gravel roads have a smaller negative effect than tarred roads because no artificial material was used to create the roads, but major dirt roads are nonetheless a manifestation of human intrusion into pristine natural areas. Main gravel roads also cover a high proportion of the surface (> 6m wide).

Cultivated lands and secondary gravel roads have an even less negative effect on the landscape, being closer to pristine natural landscape and not made of artificial materials. Gravel roads also cover a relatively small proportion of the surface (3-6m wide). Nonetheless, these two elements are still a manifestation of human intrusion – e.g. the geometric shape of cultivated farmlands. Minor gravel roads and tracks cover the smallest proportion of surface area of all the roads (< 3m wide), are less obvious and have a greater connection to recreation, but are still a manifestation of human intrusion – they were assigned a value of four.

All man-made elements were assigned two ratings according to this aesthetic influence: one enhancing calmness and the other enhancing excitement. These rating values were stored separately as two attribute fields of the man-made coverage, eventually converted to two grid overlays using these attributes. Nodata was automatically assigned the value of zero in the gridding process done in Arc/Info GRID. Table 4.20 contains the value ratings that were assigned to the man-made elements according to their contribution to the aesthetic experience of the landscape. The two aesthetic impact columns represent the values assigned to the two attribute fields.

Table 4.20: The contribution of man-made elements to the aesthetic experience of a landscape

		Aesthetic impact	
		Enhancing calmness	Enhancing excitement
Man-made element	Built-up areas	1	1
	Cultivated lands	3	3
	Tarred roads	1	1
	Main gravel roads	2	2
	Secondary gravel roads	3	3
	Minor gravel roads and tracks	4	4

4.6.2 Contribution from the distribution pattern variable

Distribution of man-made elements could enhance or detract from the aesthetic value of a landscape, depending on the aesthetic experience. The contributions of distribution to the aesthetic experience were discussed in Section 3.4.1.

The same analysis principles and the steps taken in the analysis of landform distribution were applied in the analysis of man-made feature distribution. Refer to Section 4.3.2 for an explanation and a description of the steps that were taken in analysis. Table 4.21 contains the actual values that were assigned according to the percentage of distribution. The two aesthetic impact columns represent the values assigned to the two attribute fields. These rating values were stored separately as two attribute fields of the man-made coverage, eventually converted to two grid overlays using these attributes.

Table 4.21: Value ratings assigned according to the distribution percentage of man-made elements

		Distribution percentage	**Aesthetic impact**	
			Enhancing calmness	Enhancing excitement
Man-made element	Built-up areas	38.75% (in 31 of the 80 cells)	1	5
	Roads	90% (in 72 of the 80 cells)	5	1
	Cultivated lands	61.2% (in 49 of the 80 cells)	5	1

The man-made coverage was converted to six grid overlays, using both values assigned to the three man-made element types. The assigned values were awarded to all cells in the raster.

4.7 COMPONENT INTERACTION ANALYSIS

The influences of a landscape element on the aesthetic experience of a landscape can be evaluated by itself or in interaction with other landscape elements. Thus far, this chapter consisted of a discussion of the first instance: the influence of individual landscape elements on the aesthetic experience of a landscape. This section entails a discussion of the influence of combined elements on the aesthetic experience of a landscape. In these instances the landscape had to be evaluated as a whole, with all the elements interacting with each other.

4.7.1 Axial-focal proximity analysis

The importance of axial-focal interaction in the creation of a sense of movement in a landscape was discussed in Section 3.2. The elements involved in this subtype of aesthetic experience are landform elements, vegetation elements and water elements. Man-made elements were not considered because they do not stand out as a visually dominant feature in the landscape, due to the large scale of the test region and because most man-made elements are located too close together in space to have either an elongated (axial) or a circular (focal) shape.

The following steps were followed in the analysis of movement in the test region, based on the interaction between the above-mentioned elements.

- Step One: Sections 4.3.3, 4.4.6 and 4.5.5 explained how elements of the landform, vegetation and water coverage were selected and codenamed axial or focal. In this first step, all axial and focal features from each of the four coverages were selected separately, i.e. landform elements with an elongated shape, landform elements with a circular shape, vegetation patches with an elongated shape, vegetation patches with a circular shape, water elements with an elongated shape and water elements with a circular shape. From these selected elements, new coverages were created in Arc/Map, by exporting these elements from the original coverages. All the elongated (axial) elements were combined to create one coverage, and all the circular (focal) elements were combined to create a separate coverage. The result was two coverages: one containing all the focal features — landform, vegetation and water, and the other containing all the axial features — landform, vegetation and water.
- Step Two: In this step, axial and focal features in line with each other and located close together in space had to be selected from both coverages. These would be the elements creating an impression of movement in the landscape (Section 3.2 explains the effect between axial and focal elements). A maximum distance of 150m was decided upon, because the human eye would have difficulty in visually connecting elements located farther than that from each other. The appropriate axial and focal elements were selected by using the SELECT BY LOCATION command in ArcMap. This was done as follows: all the axial elements were selected, then all the focal elements lying within a distance of 150m from these selected axial elements were selected. These focal elements were exported to create a new coverage of active focal elements, i.e. circular shaped elements involved in an axial-focal interaction. To remove axial elements not within 150m from focal elements, all the focal elements in the active focal element coverage were used in the SELECT BY LOCATION

command in ArcMap, selecting axial elements within 150m from these focal elements. These axial elements were also exported, creating a new coverage with active axial elements.

- Step Three: To be located closely in space is not the only prerequisite for the creation of a sense of movement in a landscape. The axial and focal elements have to be in line with each other – the eye of the viewer must be led along the elongated element towards the focal element. Therefore, all these active axial and focal elements were then evaluated individually as pairs, and only those elements in line with each other were selected and exported to a separate coverage.

All the elements in this final coverage were assigned two ratings according to this aesthetic influence: one enhancing calmness and the other enhancing excitement. A value rating of 1 was assigned to all the elements as they detract from calmness, and a value rating of 5 was assigned to all the elements as they enhance excitement. These rating values were stored separately as two attribute fields of this movement coverage, eventually converted to two grid overlays using these attributes. Nodata was automatically assigned the value of zero in the gridding process done in Arc/Info GRID.

4.7.2 Enclosure analysis

The importance and characteristics of enclosure as the result of the positions of landform elements were discussed in Section 3.3. The degree of enclosure or openness in a landscape contributes to an overall sense of safety or security. A safe landscape is considered to lead to a calm aesthetic experience, and a landscape, which is too exposed or too tightly enclosed to lead to an exciting aesthetic experience, being a threatening landscape.

Vertical extent was an important factor to consider, as well as the relative position of vertical landform elements to each other. Hills and mountains that surround an enclosed area on at least two sides were considered to be enclosing (Figure 3.4 illustrates an enclosure, with vertical elements on two sides of a horizontal element). The width of the enclosed space determines whether the enclosure creates a safe or threatening circumstance (this concept is discussed in more detail in Section 3.3). For the sake of analysis, a height to width or width to height ratio of 1:1 - 1:1.5 was decided upon. The following steps were followed in the analysis of enclosure in the test region, based on the interaction between landscape elements.

- Step One: The first step entailed selecting all enclosures, both safe and threatening. All landform elements with a vertical extent were selected, i.e. hills and mountains. Elements surrounding an enclosed horizontal area were reselected from this selection by individual evaluation of the selected elements, and exported to create a new active enclosure coverage.

- Step Two: The enclosed horizontal areas were measured to establish whether the enclosures created were safe or threatening. A ratio of more than 1:1.5 created a threatening enclosure, and a ratio of between 1:1 and 1:1.5 a safe enclosure.

All the elements in this final enclosure coverage were assigned two ratings according to this aesthetic influence: one enhancing calmness and the other enhancing excitement. The value ratings assigned are displayed in Table 4.22. The two aesthetic impact columns represent the values assigned to the two attribute fields.

Table 4.22: The value ratings assigned to the elements of the active enclosure coverage

		Aesthetic impact	
		Enhancing calmness	Enhancing excitement
Type of element	Safe enclosure	5	1
	Threatening enclosure	1	5

These rating values were stored separately as two attribute fields of this enclosure coverage, eventually converted to two grid overlays using these attributes. Nodata was automatically assigned the value of zero in the gridding process done in Arc/Info GRID.

4.8 CUMULATIVE OVERLAY ANALYSIS

The Arc/Info GRID module was used to overlay all the grid overlays created in the analysis process as described in this chapter – 31 grids in total for both the calm and the exciting experience, derived from a total of 22 variables listed in Table 4.23. A rating system was developed that assigned values between 1 and 5 (1 = very low, 2 = low, 3 = medium, 4 = high, 5 = very high) to each grid cell for each variable, based on the aesthetic guidelines isolated from the literature regarding the variables and the role that they play in affecting aesthetic quality. A simple cumulative addition or summing overlay function was used to add the values of the overlaid cells, producing the potential totals in the table. For the sake of simplicity, raster layers were first overlaid according to type of aesthetic experience and components. Figure 4.5 diagrammatically illustrates the overlay process. By way of explanation for the calmness aesthetic experience: Step one was to sum the five (5) primary grids containing landform variable value ratings enhancing calmness, in order to create a summary secondary grid of the contribution of landform towards enhancing calmness in the test region. This included the presence of landform elements, the distribution patterns of hills, mountains and plains and enclosure created by landform elements. Similarly, the primary grids for vegetation (12), water

(7), man-made features (4) and movement enhancement (3) variables were summed to complete the range of secondary grids denoting calmness in the landscape.

Table 4.23: The hypothetical maximum and minimum rating values derived from the overlay process.

Components (secondary grids)	Element variables (primary grids)	Calm		Exciting	
		Min	Max	Min	Max
LANDFORM	Variable 1: Position	1	5	1	5
	Variable 2: Distribution: Mountains	1	5	1	5
	Distribution: Hills	1	5	1	5
	Distribution: Plains	1	5	1	5
	Variable 3: Enclosure	1	5	1	5
VEGETATION	Variable 1: Position	1	5	1	5
	Variable 2: Distribution: Trees	1	5	1	5
	Distribution: Wetland and riparian vegetation	1	5	1	5
	Distribution: Undisturbed, natural vegetation	1	5	1	5
	Distribution: Disturbed vegetation	1	5	1	5
	Distribution: Cleared areas	1	5	1	5
	Variable 3: Shape	1	5	1	5
	Variable 4: Shape variety	1	5	1	5
	Variable 5: Colour	1	5	1	5
	Variable 6: Colour variety	1	5	1	5
	Variable 7: Texture	1	5	1	5
	Variable 8: Texture variety	1	5	1	5
WATER	Variable 1: Position	4	5	4	5
	Variable 2: Distribution: Dams	1	5	1	5
	Distribution: Rivers/streams/channels	1	5	1	5
	Variable 3: Shape	1	5	1	5
	Variable 4: Shape variety	1	5	1	5
	Variable 5: Colour	1	5	1	5
	Variable 6: Colour variety	1	5	1	5
MAN MADE	Variable 1: Position	1	4	1	4
	Variable 2: Distribution: Built-up areas	1	5	1	5
	Distribution: Roads	1	5	1	5
	Distribution: Cultivated lands	1	5	1	5
MOVEMENT	Variable 1: Landform elongation	1	5	1	5
	Variable 2: Vegetation elongation	1	5	1	5
	Variable 3: Water feature elongation	1	5	1	5
	TOTAL:	**34**	**154**	**34**	**154**

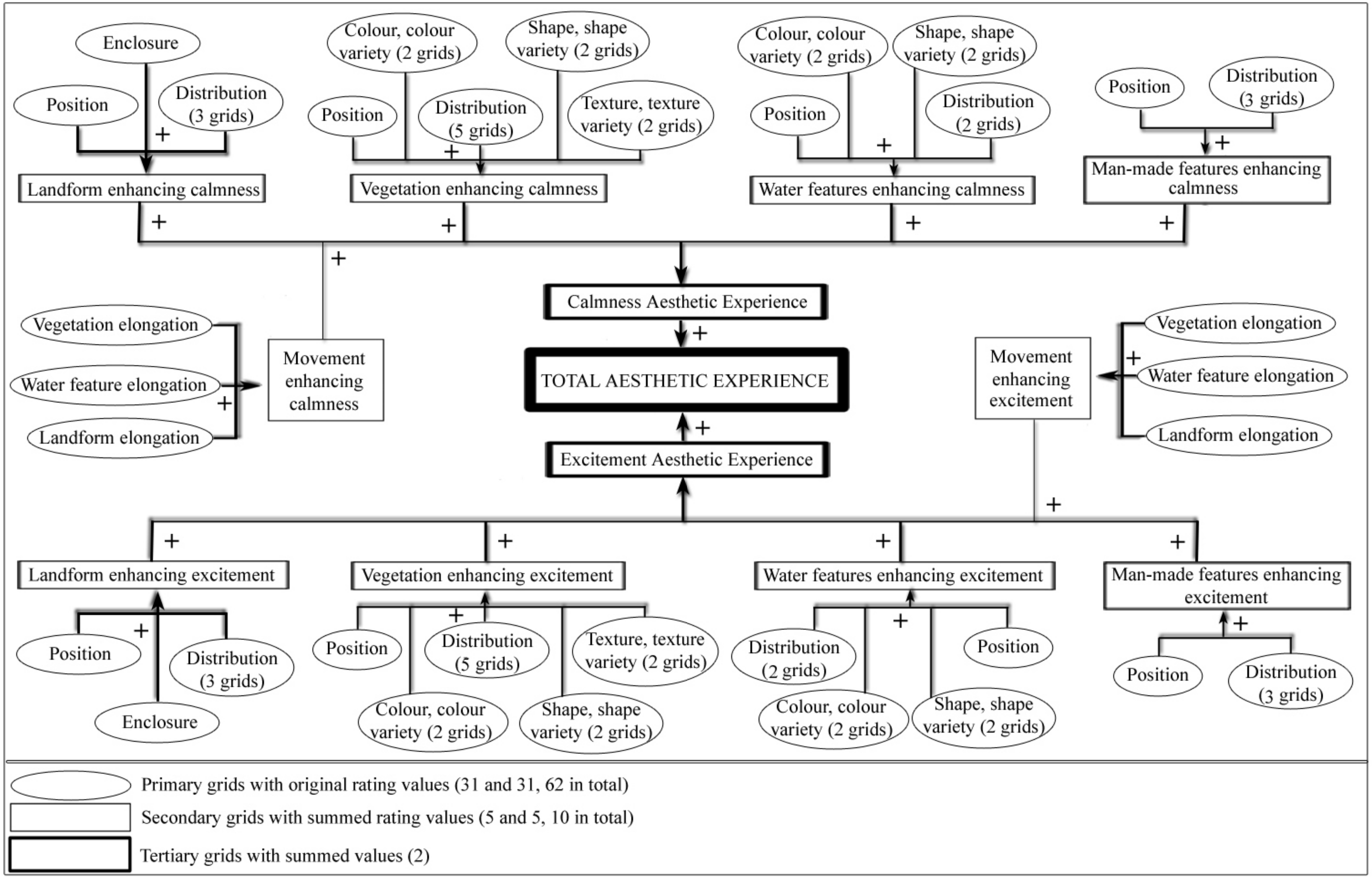


Figure 4.5: A diagrammatic illustration of the cumulative grid overlay process

Step two entailed the summing of these five secondary grids to generate one tertiary grid denoting an aggregate “Calmness aesthetic experience.” The same steps were repeated on excitement generating grids to produce the second tertiary grid denoting an aggregate “Excitement aesthetic experience.”

The two resulting aggregate grids (denoting calmness and excitement) are displayed in Figures 4.6 and 4.7 as a Calmness Aesthetic Experience (CAE) map and an Excitement Aesthetic Experience (EAE) map. The values and shading of the cells indicate the extent to which parts in the test region are experienced as either calm or exciting. Generally the pattern shows low aesthetic values for those areas dominated by human-made features (cultivated fields, buildings) on level land, medium values for naturally vegetated plains and high values for elevated land covered by natural vegetation as well as for most water features. The calmness experience dominates in the eastern sector of the test region, with (predictably) the exciting experience dominant towards the west-northwest.

The final step was to sum the values of the two aggregate tertiary grids, in order to create a grid denoting complete aesthetic experience of the landscape. This final grid is displayed in Figure 4.8 as a Total Aesthetic Experience map, with the cell values indicating the extent of the total aesthetic value of the parts of this study region.

The result confirms the expectation that water surfaces and elevated land harbour the dominant aesthetic experience value in this landscape. This chapter has covered the methodological description of all practical landscape analytical procedures and the mapped end result of the landscape aesthetic valuation. The next, and final, chapter serves to evaluate these results and to make recommendations for the use of the research outcomes.

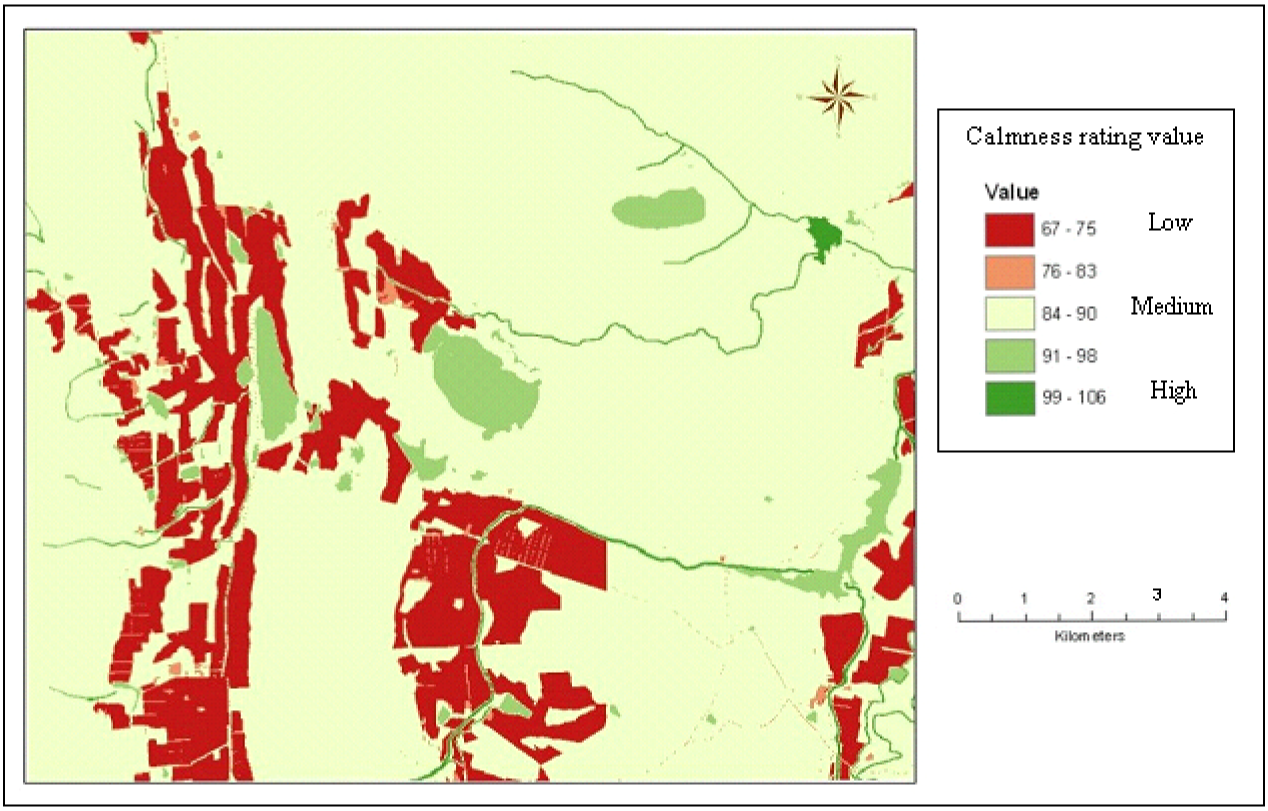


Figure 4.6: The Calmness Aesthetic Experience map

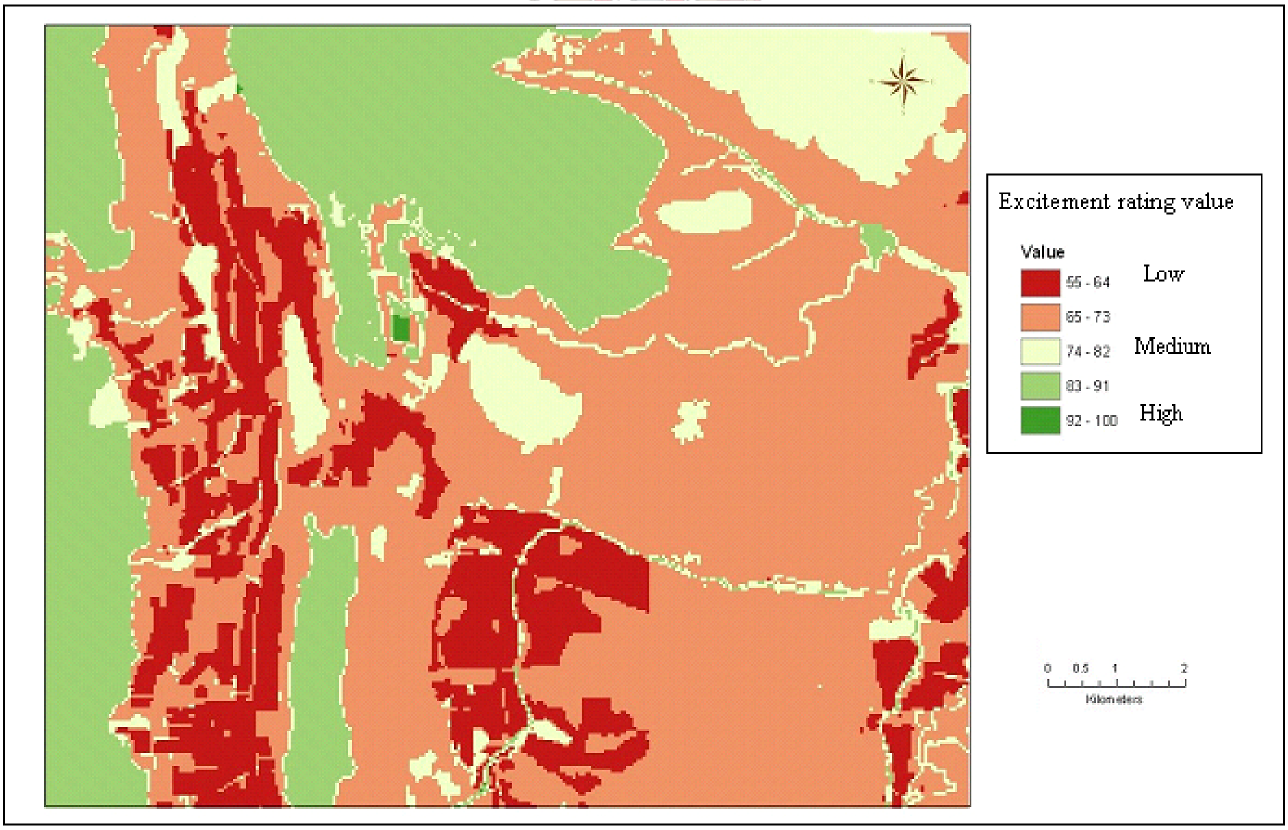


Figure 4.7: The Excitement Aesthetic Experience map

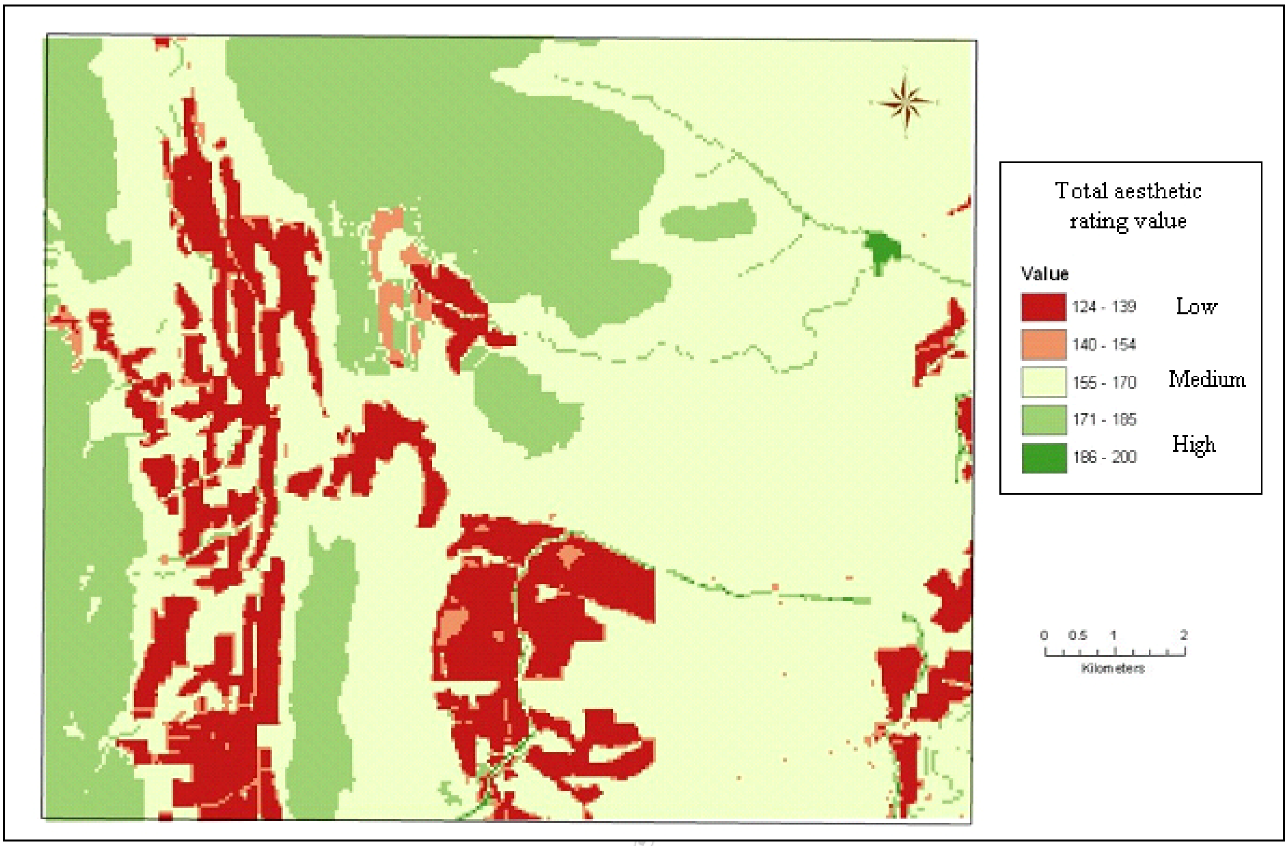


Figure 4.8: The Total Aesthetic Experience map

CHAPTER 5: EVALUATION AND CONCLUSION

The method of analysis and evaluation of landscape aesthetic quality results are evaluated in this chapter. This concluding chapter also contains a discussion on the usefulness of this study and recommendations for future applications.

5.1 SIGNIFICANCE OF RESULTS FOR THE EVALUATION OF LANDSCAPE AESTHETICS

The methodology developed and applied in Chapter 4 was based on the assumption that the greatest possible aesthetic quality, whether calm or exciting, is preferable in any landscape. Every step in the process was therefore focused on emphasizing the greatest positive contribution that all elements could make to the general aesthetic quality of a region, and specifically the test region.

All the element variables made their own contributions in enhancing both calm and exciting landscapes, thereby generating the 62 primary grids (31 for the calm experience and 31 for the exciting experience). The results were added together to end up with ten secondary grids, which were combined, in order to create two tertiary grids – the aesthetics maps showing both the calmness and the excitement generating qualities of the test region separately. These were finally combined to create the complete aesthetic experience of the landscape.

The combined aesthetics maps give a good indication of the overall, general aesthetic quality of the landscape. Another important result is the indication of the areas in this region with the highest aesthetic value. The most aesthetically pleasing part in this region is the northern and western sections, with very small low-value areas. Development in these areas should be avoided in order not to compromise its beauty. The owner(s) of this land could also consider putting these areas to recreational use or to increase recreational use, in order to extend economical activities. Other areas with a high aesthetic quality are located too close to areas with a low aesthetic quality, and are therefore compromised by this close proximity. The relative aesthetic value, compared to surrounding regions, can only be established after a similar study is done on surrounding areas. Although recommended, that is beyond the scope of this study.

5.2 EVALUATION OF METHODOLGY

As was stated initially, if scenic preferences can be associated consistently with the physical landscape features, the latter can be used as predictors of the former, and it was precisely this that was attempted in this research. A literature survey resulted in an extensive collection of scenic preferences indeed consistently associated with the physical landscape. The researcher found that these experiences of the aesthetic quality of a landscape could be organised and subdivided into two opposing, but similarly enjoyable, types of aesthetic experiences, namely calm landscape experiences and exciting landscape experiences. It was clear from the literature survey that a number of objective rules and guidelines could be consistently applied to these two types of landscape.

The literature survey also brought to light a consistency in the analysis of landscape structure, specifically in the subdivisions into landscape components. A common structure was applied in this study, which was both easily understandable and accessible and appropriate to the needs of the study.

The objective rules isolated from the literature were incorporated into the landscape structure so that it could be applied on the most detailed level of the structure. An example is that the rules that apply to rivers could be defined in enough detail to specify the exact role of rivers in a landscape. The roles of elements were therefore based on these rules, but also on the position of the elements in the greater landscape structure and the variables determining the precise nature of the elements. This enabled the successful development of an objective methodology with which these rules and, by association, sets of elements could be transformed into objective processes, interacting with each other using GIS functionality.

One possible criticism against the methodology could be the lack of preference control in the importance accorded the variables considered in the cumulative overlaying process. An improvement to alleviate this particular problem might be to apply the multi-criteria analysis technique available on the Idrisi platform. That would allow variable weighting to be assigned to variables in accordance with landscape preferences expressed by particular observers.

5.3 POSSIBLE APPLICATIONS OF THE STUDY RESULTS AND RECOMMENDATIONS

Considering the results of the research and the practical application developed in this study, possible uses of the study are as follows:

- Classification of regional scenery based on aesthetic quality. This was demonstrated with the test region.
- Evaluation of the tourism marketability of localities within regions, and stretches along routes for judging suitability of regional tourism packages. This was demonstrated in the discussion on the Total Aesthetic Experience Map (Figure 4.8).

- Zoning of landscape by local and provincial environmental managers and planners as guidelines for developers, in terms of projected impact prevention through land use and other developmental change. This requires that the methodology described in Chapter 4 be applied over larger planning areas.

The outcome of this research was a method of analysis and objective evaluation of a landscape, using a GIS for data creation, analysis and map construction. The resulting map is an indication of aesthetic value, showing the test region graded according to intrinsic aesthetic value. Colour grading was used (ranging from green to light green/beige, to red), with green indicating areas of outstanding beauty and high aesthetic value. This method is a tool, which could be used by developers and environmental managers in EIA studies: proposed development could be limited to areas with a lower aesthetic value. Alternatively, damage to areas with high aesthetic value can be predicted, were development to proceed. The method can be used to suggest how the damage can be lessened or avoided completely. If this is not possible, a different site for development must be found.

A number of extensions and improvements to the method are possible and could be attempted in a future continuation of the research. The theoretical model is not exhaustive, especially when applicable to different landscape types. Additional variables could be added to component elements, for example shape and slope analysis of landform. The quantitative analysis of the spatial research results could also be enhanced by calculation of the spatial extent of each aesthetic value class to create a bench mark against which landscape change could be measured in future. Similar calculation and comparison between the results for the excitement and calmness aspects separately might enable the formulation of an objective landscape characterization index.

5.4 CONCLUSION

A problem formulated in the introduction was that subjectivity would always be present to some extent in the evaluation of a subjective human experience such as landscape beauty. The use of common aesthetic rules enabled the development of an objective method of analysis, within which subjective rules were generalised in order to improve the objective quality of these rules. Aesthetic value applied to elements and variables were transformed from being qualitative to being quantitative, thereby also increasing the objective value of the method. Though not fully objective, a large degree of objectivity was obtained.

An important benefit of this study is that it can be applied to any study region – even in the absence of positive elements like water features in a desert region, the evaluation of sections in this region would still be relative to other sections in the same region. The area could then potentially have an overall aesthetic quality less than a neighbouring region with positive water features, but within the region itself, it would be possible to identify the most aesthetically pleasing and hence developmentally sensitive areas.

To summarise, a problem facing environmental impact assessment studies in South Africa is the lack of an objective method by which aesthetic value of a landscape can be evaluated. This study attempted to develop such a method. Applied in areas with outstanding natural beauty it could make a contribution towards the conservation of one of this country's most precious resources – its scenery.

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APPENDIX A: PHOTOGRAPHIC ILLUSTRATIONS OF VARIABLES

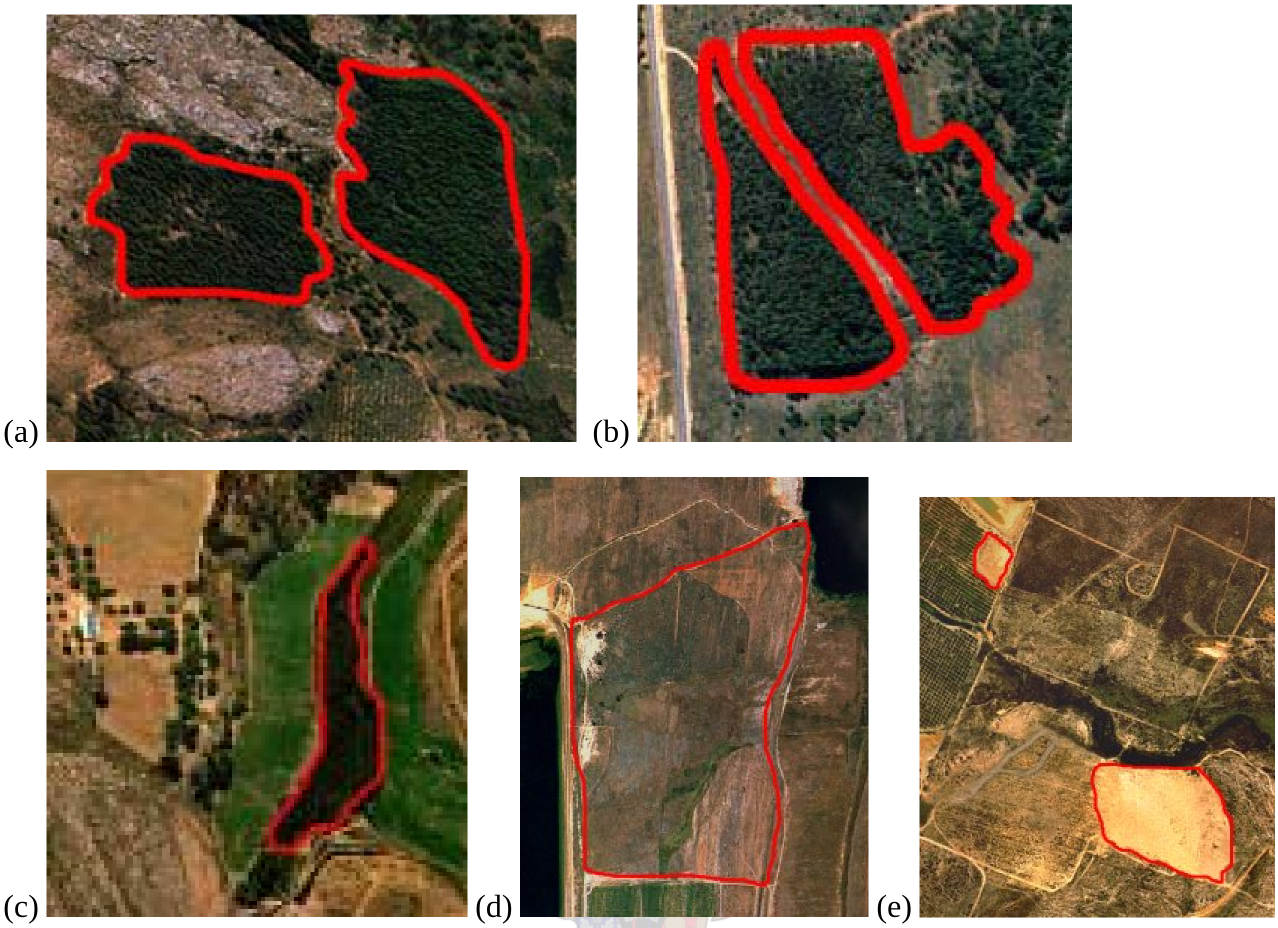

Figure A.1: Shapes, colours and textures of selected vegetation elements: (a) dark green tree clumps with natural growth pattern; (b) dark green tree clumps with unnatural growth pattern; (c) dark green riparian vegetation with natural growth pattern; (d) pale coloured disturbed vegetation; (e) pale coloured excavated area with partly natural and partly unnatural shape.

Figure A.2: A photograph illustrating the colour, texture and distribution of the natural undisturbed vegetation of the study region.

(a)  (b)  (c) 

Figure A.3: Shapes and colours of dams: (a) black with natural shape; (b) pale green with partly natural, partly unnatural shape; (c) pale yellow or brown with partly natural, partly unnatural shape.