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EXPLORING THE VISUAL LANDSCAPE

INTRODUCTION

1.1 INTRODUCTION

The European Landscape Convention (ELC) defines landscape as “an area, as perceived by people, which character is the result of the action and interaction of natural and/or human factors” (Council of Europe, 2000). Thus, the ELC clearly emphasises the sensory relationship between the observer and the landscape. The major question here is how do we know and understand the landscape through perception?

Although ‘perceived by people’ refers to a holistic experience with all senses, very often it is reduced to the visual aspects. This has clearly to do with the ‘range’ of our senses. Already Granö (1929) [1] made the distinction between the ‘*Nahsicht*’ and ‘*Fernsicht*’. The *Nahsicht* or proximity is the environment we can experience with all our senses, the *Fernsicht* he called also landscape and is the part of our environment we mainly experience by vision. As Harris and Fairchild Ruggles (2007) put it: “For most human beings, the primary way of knowing the material world is through vision; the simple act of opening ones eyes and looking at an object, a scene, a horizon. The physiological processes engaged when the lid retracts from the eye are, when not impeded by pathologies, universal among humans. Because vision is an embodied experience, it is altered by the infinite range of the possibilities presented by corporeal performance. The body moves in space – quickly or slowly, the head still or moving side to side, up or down – the eyes view a scene, and a cognitive process begins in which particles of light are assembled by the brain to create an ordered image". This quote exemplifies that the identifying character of rural and urban environments is, to a large extent, built upon visual perception, which is a key factor in behaviour and preference, and thus important for landscape protection, monitoring, planning and management and design.

But how can we comprehend the 'face of the landscape' and its perception? And how can we make this applicable to landscape planning, design and management? Although these questions are not new [2], we believe that the long tradition and current advances in the field of visual landscape research in the Netherlands offer interesting clues for further development in theory, methodology and application.

1.1.1 Visual landscape research

Visual landscape research is the central theme, and throughout the book you will find also terms like *landscape physiognomy* and *physiognomic landscape research*. In this book we consider rural, urban and infrastructural landscapes as *types of landscape*.

According to the Oxford dictionary (2011a) *landscape physiognomy* refers to the appearance of the landscape and is derived from the Greek *physiognōmonía* meaning 'judging of man's nature (by his features)' based on *gnōmōn* 'a judge, interpreter'. Initially, it refers to the human face as in the French '*visage*', and its meaning has extended to the appearance of features such as landscape (French '*paysage*'). In the late 1970s scholars like De Veer and Burrough (1978) adopted this term and introduced the comparable Dutch terms *landschapsfysiognomie* (physiognomic landscape), *visueel landschap* (visual landscape) and *landschapsbeeld* (landscape scenery) to refer to the visual landscape consisting of the visible properties of all the landscape phenomena and their structure (De Veer and Burrough, 1978). We use the initial term landscape physiognomy (or physiognomic landscape) and the more actual term visual landscape as synonyms.

Physiognomic landscape research refers to visual landscape research that is concerned with mapping the visual landscape. Physiognomic landscape mapping or visual landscape mapping (*landschapsbeeldkartering*) comprises of a wide range of theories, methods and techniques for analysis and visualisation, and which reflect different approaches to landscape as described for example by Sevenant (2010).

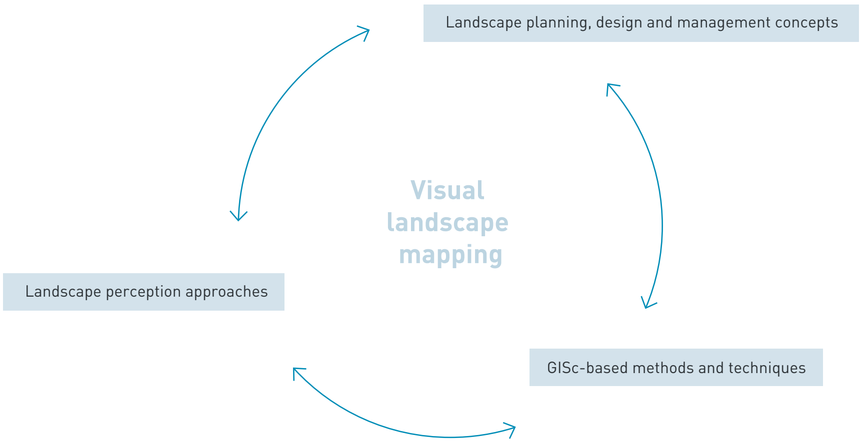


Figure 1
Visual landscape research is characterised by visual landscape mapping and determined by the integration of landscape planning, design and management, landscape perception and GISc-based methods and techniques

1.1.2 Landscape planning, perception and Geographic Information Science

Visual landscape research is an interdisciplinary approach important for landscape planning. It involves disciplines such as (landscape) architecture and urban planning and design, psychology and sociology, environmental ethics, and (humanistic) geography, all of which use data and tools offered by *Geographic Information Science* (GISc) such as computer mapping, spatial analysis, geomatics and (virtual) visualisation. The contributions in this book express this interdisciplinarity and reflect different perspectives on visual landscape research by their theoretical elaborations, research approaches and practical applications. However, the core of this book is the integration of (1) *landscape planning, design and management concepts*, (2) *landscape perception approaches*, and (3) *GISc-based methods and techniques* in order to map the visual landscape (see figure 1).

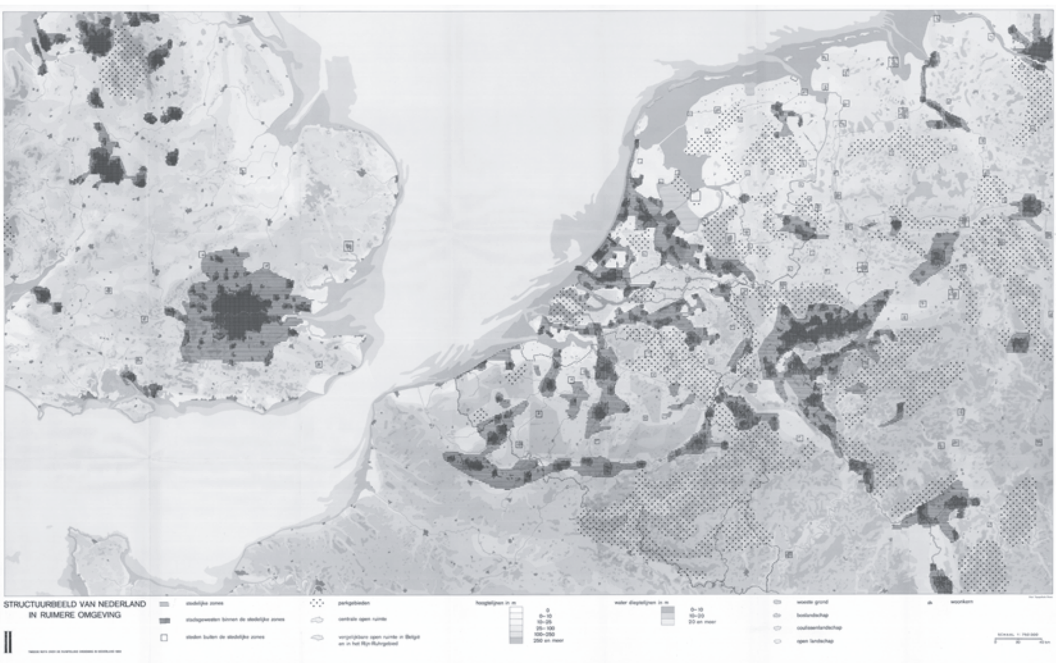
1.2 VISUAL RESEARCH IN LANDSCAPE PLANNING, DESIGN AND MANAGEMENT

In the Netherlands there is a long tradition of visual landscape research starting in the 1960s, which has had an important influence on Flemish work as well. Its origins are to be found on one hand in the widely acknowledged Dutch system of spatial planning, and on the other, in the academic interest in landscape perception influenced by parallel developments in the United States. Nowadays, this rich tradition of visual landscape research continues to develop and find its way in landscape perception research, planning and design oriented landscape research and its implementation in landscape policy. The contributions in this book showcase the latest developments in the field.

1.2.1 Visual research as policy-demand

The publication of a map called The landscape of the Netherlands and bordering regions (*Het landschap van Nederland met aangrenzende gebieden*) in the Second National Memorandum on Spatial Planning (*Tweede Nota over de ruimtelijke ordening van Nederland*) (RijksPlanologische Dienst, 1966) [3] represents an important step in visual research. This map presented the 'open' Dutch rural landscape as different 'complexes of open spaces' (figure 2) and addressed the visual landscape as an important issue for landscape planning and policy in the Netherlands for the first time. Inspired by this more detailed interest in the Dutch landscape, several scholars,

Figure 2
The landscape of the Netherlands and bordering regions showing complexes of open spaces (source: RijksPlanologische Dienst, 1966)



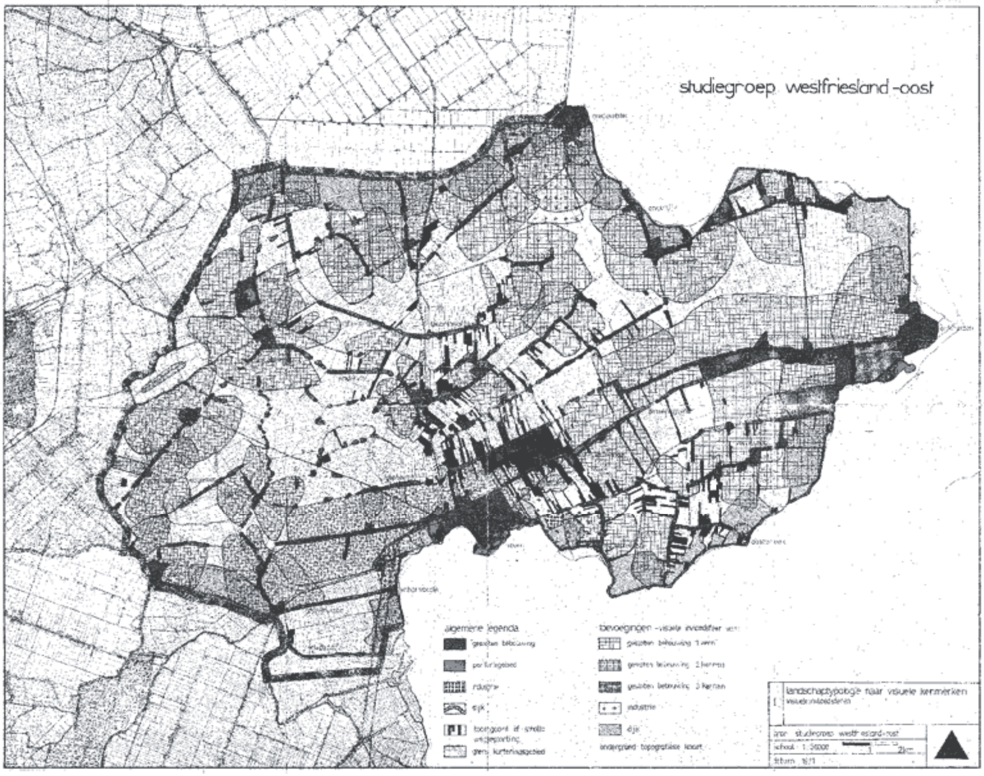


Figure 3
Landscape typology based on visual attributes (source: Van der Ham and Iding, 1971)

from different Dutch universities and related research institutes, took the opportunity to develop visual landscape concepts for the purpose of landscape planning, design and management, exemplified by the work of Van der Ham et al. (1970, 1971), Nicolai (1971), Koster and De Veer (1972), Kerkstra et al. (1974), and De Veer (1977) (see figures 3 and 4). The first overview of developed methods for visual landscape mapping and its applications appeared in De Veer et al. (1977), followed by an academic article by De Veer and Burrough (1978). This article remained until now the only English-language overview of the Dutch visual landscape research (including the Flemish studies).

From the 1980s onwards we see applications of computational methods and techniques in visual landscape mapping appear, exemplified by the work of Burrough et al. (1982), Van den Berg et al. (1985), and Dijkstra (1985). From the late 1980s, early 1990s a vast amount of visual landscape studies appear, boosted by policy demands and stimulated by Dutch perception

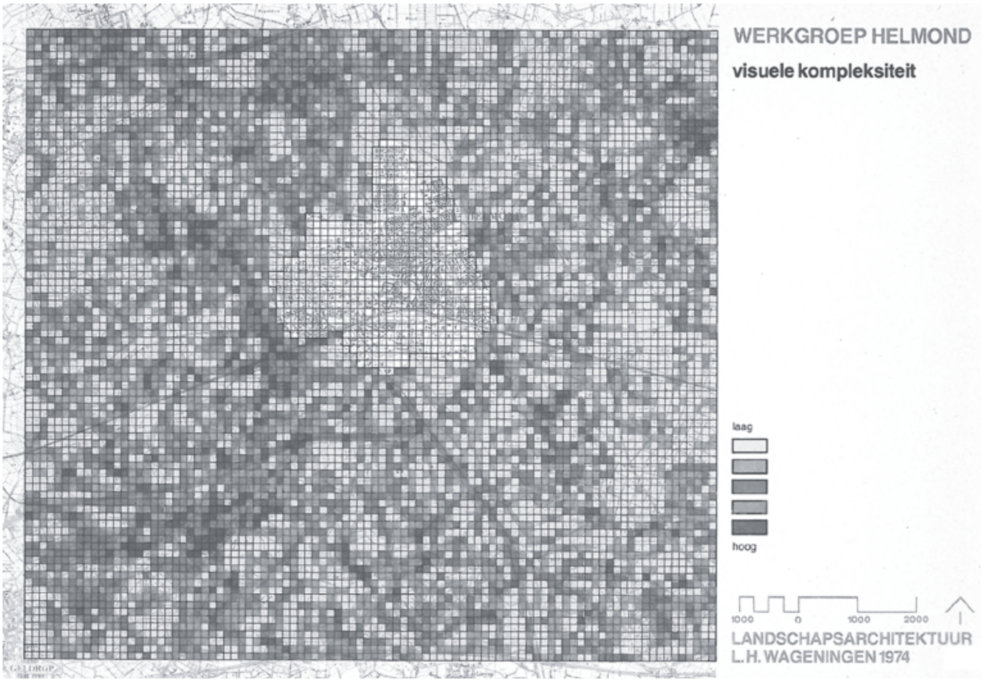


Figure 4
Visual complexity (source: Kerkstra et al., 1974)

studies of e.g. De Boer (1979), Boerwinkel (1986), Coeterier (1987, 1994, 1996), Van den Berg (1999), influenced by the work of Berlyne (1971), Appleton (1975), Ulrich (1981) and Kaplan and Kaplan (1989). Simultaneously advances in GISc in landscape research appeared too, as by Buitenhuis et al. (1986), Piket et al. (1987), Alphen et al. (1994), Palmer (1996), Palmer and Roos-Klein Lankhorst (1998) and Dijkstra and Van Lith-Kranendonk (2000). Most of these studies cover the rural types of landscape.

1.2.2 Visual research as academic interest

Parallel to this there was a growing interest for visual research in Dutch universities and research institutes involving disciplines such as architecture in urban and landscape domains. These developments are characterised by visual perception research in the urban realm. The studies of Wentholt (1968), Steffen and Van der Voordt (1978) and Korthals Altes and Steffen (1988) are important examples with respect to urbanism and are highly influenced by the work of Lynch (1960) *cum suis* (see figure 5). The use of the *enthescoop* (camera with periscopic

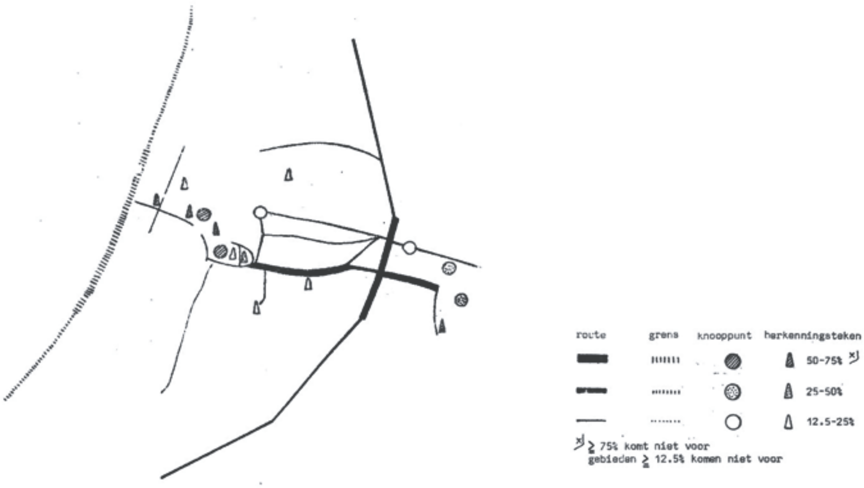


Figure 5

Collective image of the city Antwerp (source: Steffen and Van der Voordt, 1978)

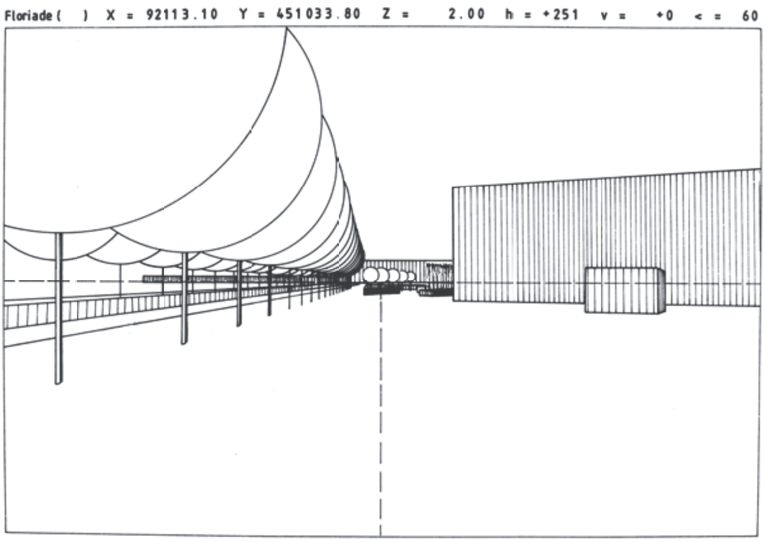


Figure 6

Computational visualisation of the Floriade by M. den Ruijter, 1984 (source: personal archive Den Ruijter)

lens) for means of urban analysis by Bouwman (1979) was also influential. For architecture the work of Prak (1979), Steffen (1981) and Hoogstad (1990) are good examples, and with regard to landscape architecture the influential works of Bijhouwer (1954), Warnau (1979, 1990), Steenbergen (1985, 1990) and Reh (1995). However, it is striking to notice that computational methods and techniques hardly found their way in this type of research. Early exceptions are to be found in the pioneering work of Den Ruijter (1978, 1984) and Roos-Klein Lankhorst (1987, 1989) (see figure 6). The increasing amount of (inter)national publications, inclusion in academic research programmes and educational curricula of the last decade exemplify the ongoing academic interest in visual research.

1.3 RESEARCH ON VISUAL LANDSCAPE AND PERCEPTION

According to Bell (1996), perception refers to “the activity carried out by the brain by which we interpret what the senses receive. It is not merely a factual reporting, but tends to be referenced to associations and expectations already in the mind of the beholder” and is derived from the Latin *perceptio*, from the verb *percipere* ‘seize, understand’ (Oxford dictionary, 2011b). Although we use all our senses to analyse the surroundings, mainly vision stands out, because it covers 87% of the sensory perception. So, vision provides the most information, and it is the sense in which we ‘imagine’ and ‘think’ (Bell, 1999; Snowden et al., 2006). As all senses work together, they add different dimensions to visual perception and can reinforce or confirm the information. The term visual, derived from the Latin *visualis* and *visus* ‘sight’, from *videre* ‘to see’, is used as adjective relating to perception by seeing or sight: *visual perception* (Oxford dictionary, 2011c).

1.3.1 Physiology of perception vs. psychology of perception

In (visual) perception studies there is a crucial difference between the *physiology of perception* (the ‘senses’) and the *psychology of perception* (the ‘brain’) (Jacobs, 2006; Bell, 1999). Physiology of visual perception refers to the processes of sensation and the mechanisms of sight, the structure of the eye, how it receives light, and its limitations. All aspects of physiological perception can be measured in an objective way (Sevenant, 2010; Jacobs, 2006; Bell, 1999). Although it is not the scope of this introductory chapter to elaborate on this, it is useful to mention the *field of vision,* which is an important aspect as it determines the visibility of the elements and their visual properties. Humans have an almost 120 degrees forward-facing horizontal, binocular field of vision, allowing depth perception (see figure 7). Also, the ability to perceive shape (pattern recognition), motion and colour varies across the field of vision. Pattern recognition concentrates in the centre of the field of vision and covers about 20-60 degrees of the binocular view (Panero and Zelnik, 1979; Snowden et al., 2006) (for applications see chapter 5). There are also some physiological restrictions to the *range of vision*, which is the distance from the observer to an object, depth plan, or skyline. The range of vision depends on the position of the observer (altitude, proximity and angular size of the objects), viewing direction and atmospheric conditions (e.g. contrast threshold) (Duntley, 1948; Nicolai, 1971; Antrop, 2007). 1200-1400 metres is a critical distance, further away it is not possible to distinguish optical depth; individual (common) objects are hardly recognizable and merge with their background (Nicolai, 1971; Antrop, 2007). Also, for the recognition of characteristic elements of the landscape, the limiting distance of 500 metres is used (Van der Ham and Iding, 1971) and is a common step in the changing structural density (Antrop, 2007) (for applications see chapters 12 and 13).

The psychology of perception refers to two different processes: (1) the basically unconscious processing sensory information, and (2) the more or less conscious experience of analysing and interpreting this information (Jacobs, 2006). These two processes are complex and include pattern recognition (shape, size, spatial arrangement) and colour discrimination, and are the basis for the identification of objects and their relationships. It also comprises of assigning meaning, defining relations, classifying information and memorization. These processes integrate new

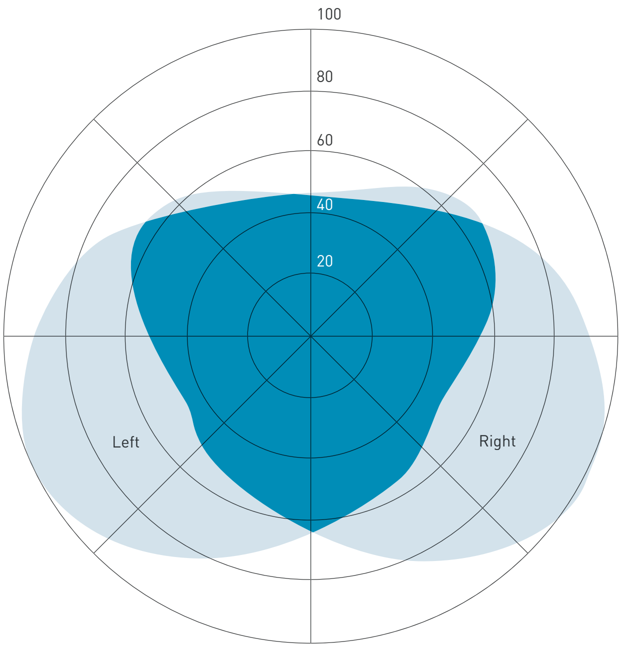


Figure 7
The field of vision for a person looking straight ahead. The irregular boundaries of the left and right fields are caused by facial features such as the nose. The darker area shows the region of binocular overlap (source: Ware, 2004)

information with existing knowledge and experience, combining it with personal symbolic and cultural elements. This whole psychological process is individual and thus essentially subjective and determines the experience of the landscape (Jacobs, 2006; Bell, 1999; Coeterier, 1987). Finally, this will affect our behaviour and actions (Sevenant and Antrop, 2010)(see chapter 2 and 3 for elaborations on this topic).

1.3.2 Paradigms in landscape perception research

In the field of landscape perception research there is a vast amount of theories, methods and applications available. Valuable overviews are given by Daniel and Vining (1983), Zube et al. (1982) and Arthur et al. (1977) as well as the more recent overviews of Sevenant (2010), Scott and Benson (2002), Lothian (1999) and Dijkstra (1991). As found in these studies the existing approaches to landscape perception can be divided in four paradigms and two types of models:

(i) Expert models

- *Expert-approach:* evaluation of the visual landscape by experts and trained observers (e.g. landscape architects, geographers), characterised by heuristic methods and the use of systematic descriptive inventories, visual management systems, etc. Most of the early Dutch studies on the visual landscape can be labelled as expert-approaches (see section 1.2). For recent examples see section 1.4. However, the works of Boogert and Schalk (1995), Wassink (1999) and Hendriks and Stobbelaar (2003) are worthwhile mentioning here. International references include the classic works of Lynch (1960), Cullen (1961), Appleyard et al. (1964), Ashihara (1983), Smardon et al. (1986) and Higuchi (1988). Furthermore, the works of e.g. Bell (1996), Thiel (1997), Dee (2001) and The Landscape Institute (2003) are good examples of this type of approach;

(ii) Public preference models

- *Psychophysical-approach:* testing general public or selected populations' evaluations of landscape aesthetics/properties by, for example, environmental psychologists, landscape architects, characterised by the use of photo questionnaires. In these studies the behavioural approach is the dominant methodology. Exemplary Dutch studies are Van de Wardt and Staats (1988) and Staats and Van de Wardt (1990). International references include Appleton (1975) and Daniel (2001);
- *Psychological-approach:* search for human meaning associated with landscape or landscape properties by environmental psychologists, characterised by mapping landscape experience. As in the psychophysical-approach, the behavioural approach is dominant [4]. Korthals Altes and Steffen (1988) and Coeterier (1987) are Dutch examples. Important international references include Kaplan and Kaplan (1989), Bell et al. (2001) and Nasar (2008);

- *Phenomenological-approach:* research on subjective experience of the landscape (e.g. phenomenologists, psychologists, humanistic geographers), characterised by the interpretation of paintings, poetry, etc. These studies show a humanistic approach. The work of Lemaire (1970) is a good Dutch example. International examples include: Tuan (1974), Boyer (1994) and Olwig (2002).

Throughout the book these different approaches are present, although most chapters reflect typical expert-approaches. The literature guide after the last chapter gives further readings on the different approaches.

1.4 VISUAL LANDSCAPE RESEARCH AND GEOGRAPHIC INFORMATION SCIENCE

The term Geographic Information Science was introduced by Goodchild (1992) and is defined as: “an information science focussing on the collection, modelling, management, display, and interpretation of geographic data. It is an integrative field, combining concepts, theories, and techniques from a wide range of disciplines, allowing new insights and innovative synergies for an increased understanding of our world. By incorporating spatial location as an essential characteristic of what we seek to understand in the natural and built environment, Geographic Information Science (GISc) and Systems (GIS) provide the conceptual foundation and synergetic tools to [explore visual landscapes]” (Kemp, 2008). For the full breadth of GISc and the background to it see e.g. Goodchild (1992) and Wilson and Fotheringham (2008).

Geographic Information Systems (GIS) are computer systems for capturing, storing, querying, analysing, and displaying geodata. GIS developed from the integration of four different computer applications: *image processing* (raster-based), *computer aided design* (CAD) (vector-based), *mapping/cartography* and *database management* (Kraak and Ormeling, 2010). Introductory works to GIS include Longley and Batty (2003), Chang (2010) and Longley et al. (2011). Useful accounts on geo-visualisation are Dodge et al. (2008) and Kraak and Ormeling (2010).

The terms *geomatics* or *geomatic engineering* or *geospatial technology* all refer to techniques for the acquisition, storage and processing of spatially referenced information of any kind. It combines tools used in geodesy, photogrammetry, cartography, land surveying, geography, remote sensing, GIS and GPS. Thus geomatics refers to a scientific approach focussed on the fundamental aspects of geo-information and is elaborated in chapter 4 (Longley et al., 2011).

An essential aspect of geomatics for visual landscape research is the elaboration of *Digital Elevation Models* (DEM, the generic term), *Digital Terrain Models* (DTM) and *Digital Landscape*

Models (DLM) describing the earth's topographical surface. Basically two types of DEMs can be recognised:

- *DTM:* Digital Terrain Models only representing the bare ground surface;
- *DLM:* Digital Landscape Models also referred to as 'envelope models' representing the earth's surface including all objects on it ('obstacles' such as buildings, infrastructures and land uses).

DEMs can be acquired by different means such as interpolation from elevation points, digitising contour lines or direct measurements using stereo-photogrammetry or LiDAR (Light Detection And Ranging). They exist in different formats, as raster or vector (TIN: Triangular Irregular Network) data. A TIN dataset is also referred to as a primary or measured DEM, whereas a raster DEM is referred to as a secondary or computed DEM. All these factors define the accuracy, precision and uncertainty (fuzziness) of the DEM dataset, which are important conditions for the analyses and the quality of the results.

1.4.1 Trends in GISc

During the last forty years visual landscape research has been constrained by computer technology and availability of digital data. The first decennia in using geo-information technology was characterised by problems to acquire useful digital data in appropriate formats and the development of system specific software standards. Today, the power of PCs allow complex GIS-applications, there is a multitude of geodata available from many providers and there is a lot of user's friendly 'of the shelf GIS-software' widely available, offering 'common' functions and tools for mapping the visual landscape. This will be exemplified by a brief bibliometric survey on the use of GISc in visual landscape research (see figure 8).

Influenced by national (NCG, 2010; VROM, 2008) and international initiatives supporting GISc and its applications in interdisciplinary approaches, GISc is likely to continue developing. The following trends can be recognised (Craglia et al., 2008):

- from *practice* to *theory*;
- from geo-information *application* to geo-information *infrastructure*;
- from spatial data *structuring* to meaningful spatial data *integration*;
- from *mapping* to *dynamic real-time spatial data collection and visualisation*;
- from *technological* to *socio-technical*;
- from a *few application areas* to *many disciplines in society*.

This list represents a rich research agenda and includes applications in space and place, description and classification and temporality. Alternative models of space and time (dynamics,

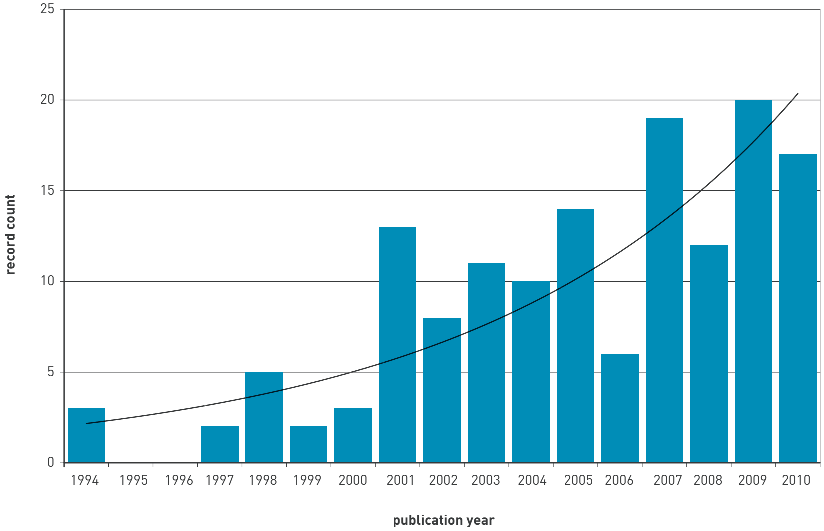


Figure 8
The diagram is based on a brief Web of Science literature research (1994-2010) using the key terms 'visual landscape' and 'GIS'. 145 references published in this period were found (source: Web of Science, 2011, 7th of July)

movement) will be explored and corresponding specific visualisation tools, and languages are being created (Fisher and Unwin, 2005). Especially with regards to visual landscape research the development of a *body-centred geography* in GISc offers interesting clues for addressing the perceptual space (Batty et al., 2005).

The trends mentioned before are also found in (academic) education, as can be seen in many recent BSc and MSc programmes, where learning goals aim to link academic knowledge and skills in information technology. For example, the List of relevant European teaching subjects in the studies of landscape architecture (EU-Teach, 2011) proposed by the European Council of Landscape Architecture Schools (ECLAS), the European Federation of Landscape Architecture (EFLA) and others, promote learning outcomes in information technology, including GIS and three-dimensional visualisation, besides basic learning outcomes of theory and methodology in landscape architecture and participation.

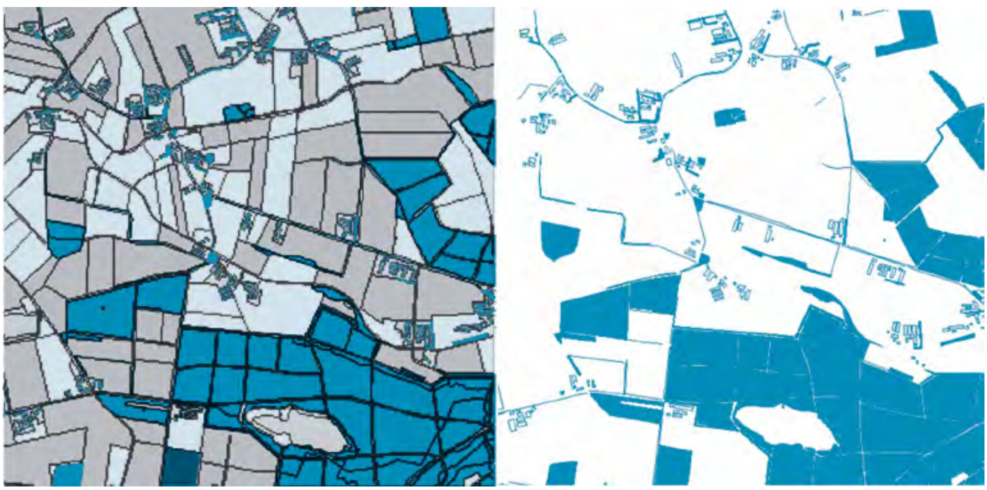
1.4.2 Specific methods and techniques based on GIScience

De Veer and Burrough (1978) suggested that the core of visual landscape mapping is about distinguishing between *space* and *mass* (see figure 9). A *space* is defined as an area of the earth's surface, bordered by linear or mass/volume elements higher than the eye level of a standing observer, within which all points are mutually visible. *Mass or volumes* are space-defining elements and can consist of vegetation (forest) or buildings or infrastructure (De Veer and Burrough, 1978). Later the concepts of screens and transparency were added (Buitenhuis et al., 1979; De Veer, 1981; Piessens, 1985).

Based on these definitions, De Veer and Burrough (1978) defined three approaches to map the visible landscape: the *compartment*, the *field of view* and the *grid cell* approach (see figure 10). These differ mainly by the way they define space and mass and how these can be determined using topographic maps or aerial photographs. The compartment approach considers the visible landscape as a set of concave compartments that can be characterised by size or shape, the type of border and their content. The field of view approach is based on measurements of fields of view and mapping sightlines from the observer's position in the landscape. The grid cell approach samples the landscape by a tessellation of (mostly square) grid cells, for which one or more variables are measured and used to classify the cell density and complexity or to assign a type to it (De Veer and Burrough, 1978; Palmer and Roos-Klein Lankhorst, 1998).

Methods for operationalising these approaches using geodata are given in studies like Burrough et al. (1982) and Buitenhuis et al. (1986). The last decennia, the number of processing methods and techniques to map the visual landscape increased, new algorithms were developed allowing the determination of new indicators for the visual landscape. Important are stereometric three-dimensional (3D) analyses that complement the planimetric two-dimen-

Figure 9
Space and mass. Original map (l) and derived space (white) – mass (black) map



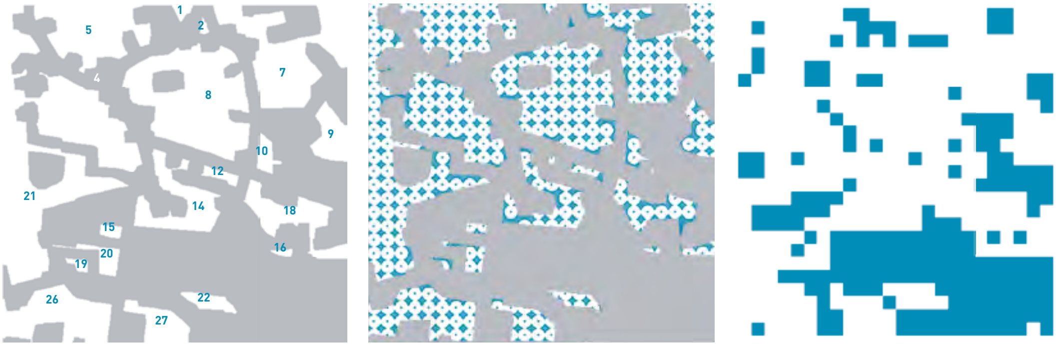


Figure 10
Three important approaches in landscape mapping: compartment (l); field of view (m); grid cell (r)

sional (2D) ones. Referring to the Dutch academic context, the following groups of methods and techniques can be recognised:

- *Grid cell analysis:* the landscape is subdivided into spatial features that are represented by raster cells or grid-shaped polygons. Each feature is described by one of more variables and can be integrated in each cell as integrated indicators, such density or complexity. The origins and background of this 'raster analysis' go back to the work of Tomlinson et al. (1976) and Tomlin (1983, 1991). The Map Analysis Package (MAP) by Tomlin was the first raster based GIS and a milestone in the GIS development (see e.g. Blom et al., 1985; Van den Berg et al., 1985; Van Lammeren, 1985) (see figure 11). Regarding visual landscape assessment using this approach, recent examples are given by Dijkstra and Van Lith-Kranendonk (2000), Palmer and Roos-Klein Lankhorst (1998) and Roos-Klein Lankhorst et al. (2002). In the international context these studies are comparable with the ones of Bishop and Hulse (1994) and Dramstadt et al. (2006). Raster analysis is also used for landscape characterisation at different scale levels (see e.g. Van Eetvelde and Antrop, 2009). The research of Bishop et al. (2000) showcases an application in the vertical plane;
- *Landscape metrics:* were originally developed for spatial analysis of land use patches in landscape ecology. Landscapes are modelled into patches, corridors, matrix and mosaics. Landscape metrics are also used to describe the composition and spatial configuration of these elements (Turner and Gardner, 1991; Li and Wu, 2007). The software FRAGSTATS (McGarigal and Marks, 1995) had a important impact on the broad introduction of landscape metrics in landscape research. For Dutch applications in visual landscape studies see Antrop and Van Eetvelde (2000) and Van Lammeren and Kamps (2001). Palmer (2004) and Uuema et al. (2009) gave examples of visual landscape studies that use landscape metrics. Li and Wu (2004) point at the misuse of the landscape metrics because of conceptual flaws regarding spatial pattern concepts. Landscape metrics are two-dimensional and can be applied both on raster and vector data;

- *Viewsheds:* areas that can be seen from a given position. Viewshed-analysis is basically a three-dimensional visibility calculation based on raster data (surface analysis). Tandy (1967) introduced the term viewshed by analogy to the watershed. The computer program VIEWIT (Amidon and Elsner, 1968) was an important stimulant in viewshed-analysis, in particular as promulgated by the US Forest Service in the 1970s and used by many natural resource planners, landscape architects and engineers (Ervin and Steinitz, 2003). See De Floriani and Magillo (2003), Fisher (1991, 1992, 1993, 1995 and 1995) and Riggs and Dean (2007) for technical backgrounds. Interesting Dutch applications in visual landscape assessment are Sevenant and Antrop (2006), Kerkstra et al. (2007), Piek et al. (2007) and Nijhuis (2010) (see figure 12). International references are Wheatley (1995), Llobera (1996, 2003), Germino et al. (2001), Bishop (2003), Rød and Van der Meer (2009);
- *Isovists:* sight field polygons or limit-of-vision plottings are the vector-based counterpart of viewsheds and address only the horizontal plane. Tandy (1967) suggested the application of isovists to "convey the spatial composition from an observers point of view". Later, Benedikt connected Gibson's (1979) concept of the ambient optic array to isovists and isovist fields for means of architectonic research (Benedikt, 1979, 1981). Computational generation of isovists are found in Depthmap (Turner, 2001) and Isovist Analyst Extension (Rana, 2002). For technical backgrounds and interesting parameters see Batty (2001) and Turner et al. (2001). In the Netherlands this topic can be found in Van Bilsen and Stolk (2007), Nijhuis (2009) and Weitkamp (2010). Recently the so-called 3D-isovists became of interest e.g. Fisher-Gewirtzman et al. (2003, 2005), Morello and Ratti (2009) and Van Bilsen (2008). "A '3D-isovist' defines the three-dimensional field of view, which can be seen from a vantage point with a circular rotation of 360 degrees and from the ground to the sky. In comparison to the definition of a 2D-isovist, which considers a plan parallel to the ground, this new definition refers to the real perceived volumes in a stereometric reference. Adding the vertical dimension helps to better simulate the physical environment observed from the vantage point" (Morello and Ratti, 2009);
- *Virtual 3D-landscapes:* current GIS are generally limited to the horizontal two dimensions but utilise three-dimensional visualisation and analysis. GIS support *3D-display of terrain models* (DEMs), *interactive navigation, 3D-symbols/geometries* (including: custom 3D modelling, importing GIS data, importing 3D-data, 3D laser scanning), *surface analysis* (i.e. viewsheds and isovists) and *viewpoint and path creation* (i.e. fly-through animations) (Kemp, 2008; Raper, 1989, 2000). However, the embedding of 3D topology and, consequently, 3D analysis tools to be become true 3D-GIS is still under development. See e.g. Batty (2008, 2000) and Abdul-Rahman et al. (2006) on this matter. Three-dimensional visualisation (GIS-based) offers a wide range of possibilities for means of visual landscape research. For an elaboration see Ervin (2001), Ervin and Hasbrouck (2001) and Bishop and Lange (2005). Degree of reality is an important topic that has to be addressed (Lange, 2001). Dutch examples of virtual 3D landscapes in visual landscape research include

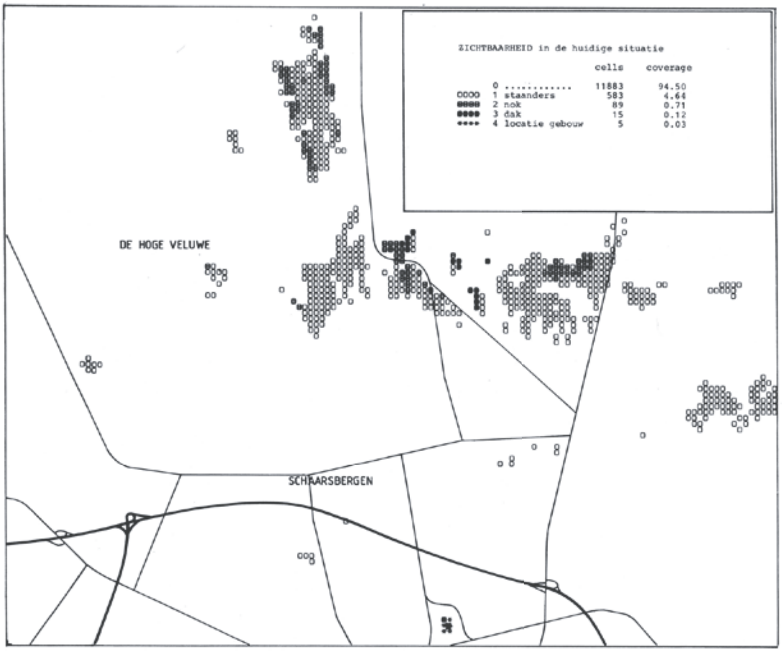


Figure 11
Visibility analysis using MAP2, an early GIS developed by Dutch scholars and based on Tomlin's MAP software (source: Van den Berg et al., 1985)

Alkhoven (1993) and Van Lammeren et al. (2003). International examples are Ribe et al. (2002), Hudson-Smith and Evans, (2003), Paar (2003), Rekitte and Paar (2006) and Hudson-Smith (2008).

Throughout the book the reader will find theoretical and practical applications of these methods and techniques, in particular in part two and three. More backgrounds on GISc in relation to visual landscape research can be found in chapter 4.

1.5 THREE PARTS, TWELVE CHAPTERS

This book is built up of twelve chapters, plus this introduction. The chapters are organised around three themes: (1) theory, (2) landscape research and design, and (3) landscape policy. This practical grouping in parts is derived from the content of the chapters and reflects the scope and direction of visual landscape research in the Dutch academic context. The chapters offer important clues for theory, methodology and application in research and development of landscapes all over the world, exemplified by their particular perspectives on the topic.

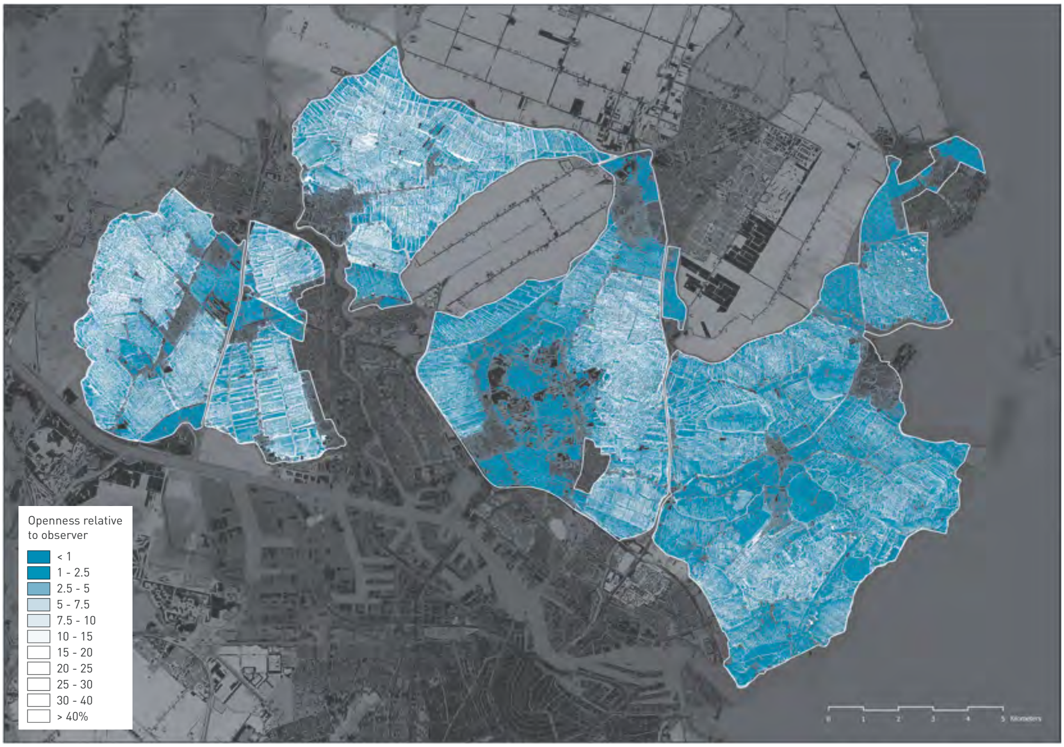


Figure 12
Analysis of landscape openness relative to the observer by means of viewsheds (by S. Nijhuis)

1.5.1 Part one: theory

This part comprises of theoretical elaborations on the psychology and phenomenology of the visual landscape and showcases recent developments in the field of environmental psychology. Furthermore it elaborates a perspective on GISc with regard to physiognomic landscape research from a typical geomatics point of view.

Psychology of the visual landscape (chapter 2) by Jacobs introduces the key concepts of psychological perception of the landscape. The chapter introduces biological, cultural and individual factors that determine the mental processes involved in landscape perception. It presents a comprehensive overview of disciplinary approaches to the study of psychological responses to the visual landscape and links it to GIS. *The phenomenological experience of the visual landscape* (chapter 3) by Moya Pellitero explores how phenomenological approaches can inform landscape planning, design and policy. This chapter elaborates how the qualitative and intangible nature of landscape can be incorporated into the analyses and monitoring typically performed through GIS. It proposes a participative methodology to elaborate new ways of mapping the social phenomenological experience of landscape. *Geomatics in physiognomic landscape research* (chapter 4) by Van Lammeren introduces the key concepts of geomatics in relation to visual landscape research. It addresses the constituent elements of geomatics: *geodata*, *geodata processing* and *geodata visualisation*. Furthermore, the chapter reflects experiences in the Netherlands in the use of GISc in visual landscape research and embeds it in an international context.

1.5.2 Part two: landscape research and design

This part presents visual landscape research methods and techniques for landscape planning, design and management and comprises of examples in the urban and rural realm. It showcases recent examples of multi-disciplinary approaches in landscape architecture, environmental psychology, urban design, information science and landscape heritage management.

Visual research in landscape architecture (chapter 5) by Nijhuis explores visual landscape research for means of landscape architectonic design. It is about analysis of the visible form of a landscape architectonic composition as it is encountered by an individual within it, moving through it, making use of GIS-based isovists and viewsheds. It addresses the basic concepts of visual perception, the role of movement and showcases how GIS can reveal the particularities of the perceived landscape architectonic space by computational analysis and its representation. *Mapping landscape attractiveness* (chapter 6) by Roos-Klein Lankhorst et al. introduces a validated model that predicts the attractiveness of the landscape: the GIS-based Landscape Appreciation Model (GLAM). The authors elaborate on the theoretical background to GLAM, the attributes in the current version of the model, the final steps in calibrating the model, as well as its validation. The chapter concludes with a discussion on the usefulness of GLAM for spatial policy. *The one- and two-dimensional isovists analyses in Space Syntax* (chapter 7) by Van Nes elaborates on axial lines and isovists as constituent elements of the Space Syntax method for means of visibility analyses. It showcases how spatial properties derived from these analyses indicate degrees of street life, safety and economic attractiveness in urban areas. *Virtual historical landscapes* (chapter 8) by De Boer et al. is about realistic 3D virtual reconstructions of historical landscapes using GIS-technology. These virtual historical landscapes let users experience the historical landscape from different viewpoints by browsing and navigating through 3D virtual environments. These virtual environments provide a global, visual context for a detailed presentation of historical and archaeological research data for management of landscape heritage and edutainment projects. *Mapping landscape openness with isovists* (chapter 9) by Weitkamp describes a procedure to get a grip on landscape openness using GIS-based isovists. It is about the concept of landscape openness as an important aspect of the visual landscape, it describes a method to model landscape openness and a procedure to use this model for policy making purposes. Furthermore, it discusses the evaluation of the results of the procedure with policy makers.

1.5.3 Part three: landscape policy

Landscape character assessment is a key element in landscape management, planning and monitoring and serves as an important basis for landscape policy. This part consists of applications of visual landscape research in the context of policymaking in the urban and rural realm. Important themes are landscape openness, the visual influence of high-rise buildings and panoramic views along motorways.

Landscape policy and visual landscape assessment (chapter 10) by Nijhuis and Reitsma elaborates a landscape planning and design-oriented approach to visual landscape indicators, involving GISc-based methods. It focuses on landscape character assessment addressing visual attributes such as spaciousness, degree of openness and visibility. The Province of Noord-Holland (the Netherlands) serves as a case study of how regional authorities can include visual landscape character assessment in landscape policy. *Preserving panoramic views along motorways through policy* (chapter 11) by Piek et al. introduces a practical approach towards motorway panoramas, it provides a definition and elaborates a GIS-based method to get a grip on views along motorways. The described approach fitted in well with policy discussions of the Dutch government about preventing spatial clutter across the landscape and preserving landscape openness. The research, to some degree, was used to formulate policy on motorway environments. *Hi Rise, I can see you!* (chapter 12) by Van der Hoeven and Nijhuis presents a framework for analysing high building development and the visual impact of high buildings on the surrounding landscape, with the city of Rotterdam as a Western European showcase. Architectural height, year of completion, location and functional use, as well as atmospheric circumstances and vertical size are constituent elements of the analysis comparing existing buildings with the urban policies that are in place. *Visions of Belle van Zuylen* (chapter 13) by Lörzing demonstrates that visual landscape assessment can have some tangible impact on a political decision-making process. As pointed out in the case of the proposed (and controversial) Belle van Zuylen skyscraper, a study into the tower's visual effects played an important role in the decision process of policy makers such as the Chief Government Architect, providing a solid basis for discussion on this issue of national importance.

NOTES

[1] Recently republished and translated in English: see Granö and Paasi (1997).
[2] The quest of apprehension, representation and realisation of the perceived space started already in Ancient Greece and took a big step in development in Renaissance Italy by the invention, description and application of linear perspective.
[3] For backgrounds to this see Maas and Reh (1968).
[4] The differences between the psychophysical and psychological approaches are gradual and hard to distinguish.

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