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## GIS-applications in landscape design and research

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# **BRIDGING THE GAP** **PROCEEDINGS** **OF THE ECLAS CONFERENCE**

Paul Bauer, Maria Collender, Michael Jakob, Lea Ketterer Bonnelame,  
Peter Petschek, Dominik Siegrist, Christian Tschumi (Eds.)

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# GIS-Applications in Landscape Design and Research

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GIS | landscape design research | composition |  
digital media | design knowledge

There is evidence that the potential of GIS is still underutilized in landscape design and research due to a lack of awareness and prejudice. This paper explores some concepts of GIS-based analysis which link to the very heart of landscape design in a natural and intuitive way. Hence the possibility to break down barriers of using GIS in landscape architecture this paper aims to put forward some characteristic principles of study and practice that can be made operational via GIS while cultivating spatial intelligence in landscape design through exploiting its powerful integrating, analytical and graphical capacities. In this respect educational and research institutions must take the lead in knowledge acquisition on GIS-applications and passing it on, contributing to the academic underpinning and development of a digital culture in landscape architecture.

## Introduction

Despite its widespread availability there is evidence that Geographical Information Systems (GIS) are underused in the realm of landscape design. Though recognized as a useful tool for mapping and planning, the potential of GIS in landscape design is often still underutilized due to a lack of awareness and prejudice. Knowledge development and dissemination of GIS-applications in landscape design are important in raising the awareness of the potential of GIS and an important basic condition for implementation in design research, education and practice. This paper explores some concepts that can bridge the gap between geo-information technology and landscape design by using the design perspective as point of departure. Hence the possibility to break down barriers of using GIS this paper aims to put forward some typical ways of understanding landscape design that can serve as gateways to GIS-aided knowledge acquisition and practical applications.

## Landscape Design Research

Landscape design is next to landscape planning and management, an important object of knowledge in landscape architecture. The basic premises is that design can be considered research or a culture of thinking. Here landscape design is defined as a form of practical research aimed at the systematic acquisition of knowledge directed to specific practical objectives. This requires a multi-layered understanding of landscape. Hence, over time a repertoire of principles of study and practice typical for landscape design has been developed to understand landscapes as four-dimensional constructions, as history, as scale-continuum and as process. Particularly the products of design – landscape architectonic compositions – embody a great wealth of design knowledge regarding the application of these principles and their interplay. These compositions carry knowledge about how to satisfy certain requirements, how to perform tasks, and it is a form

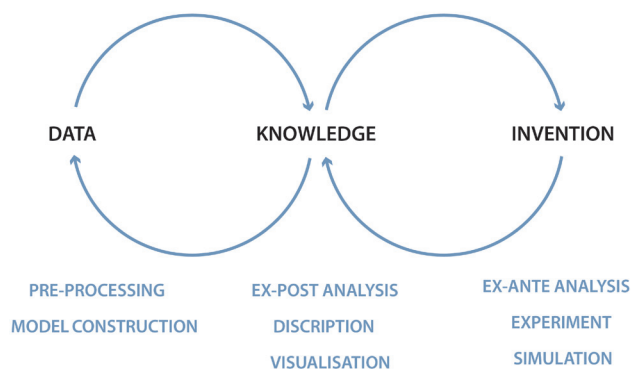


FIGURE 1. GIS as a facilitator and mediator in the knowledge formation-cycle and design generation-cycle: an iterative process from data to knowledge, from knowledge to invention. (Source: S. Nijhuis 2015)

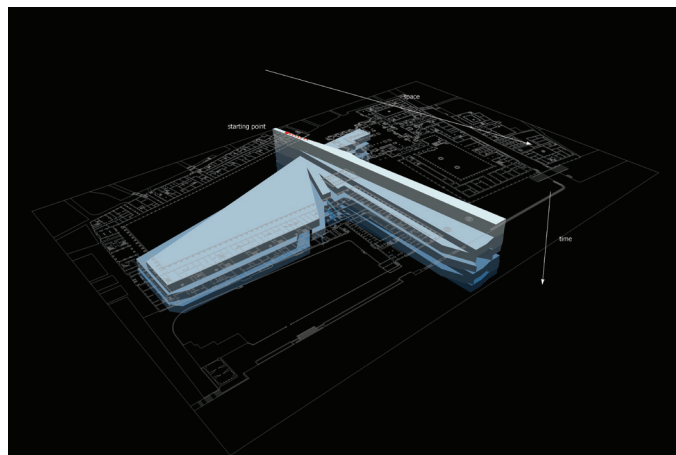


FIGURE 2. GIS-based visibility analysis in which successive fields of vision are calculated from the entrance to Piazza San Marco, Venice (Italy). Known as a Minkowski model, it shows from top to bottom how the square 'unfolds' – from a tightly framed view of the water to a view of the entire square. (Source: S. Nijhuis 2015)

of knowledge that is available to everyone (cf. Cross 2006). By studying landscape architectonic compositions landscape architects can acquire knowledge of the possible relationships between conceptual thinking and the three-dimensional aspect (Steenbergen & Reh 2003). Landscape design research is a vehicle to acquire knowledge of spatial composition via architectonic plan analysis. It is a matter of developing spatial intelligence, the architectural capacity or skill to think and design in space and time. In short: understanding is the basis for intervention. This implies that landscape design research is at the core of landscape architecture.

### GIS-Applications in Landscape Design Research

There are at least three operations in which GIS could be useful for landscape design research (Nijhuis 2015):

- GIS-modelling: description of existing and future landscape architectonic compositions in digital form;
- GIS-analysis: exploration, analysis, and synthesis of landscape architectonic compositions to reveal new or latent architectonic relationships, while utilizing the processing capacities and possibilities of computers for ex-ante and ex-post simulation and evaluation;
- GIS-visualization: visual representation of landscape architectonic compositions in space and time in order to retrieve and communicate information and knowledge of landscape design.

These operations have a great potential for measurement, simulation and experimentation of landscape architectonic compositions at different scale levels and offer alternative ways of understanding them. In this respect GIS can be used as a vehicle to explore the relation and interaction between data, knowledge and invention (Figure 1). In particular while using the typical principles of study as a point of departure for computer-aided design analysis a 'toolbox' emerges for GIS-applications in landscape design research. This toolbox consist of a set of GIS-based analysis methods and techniques stratified according the typical principles of landscape design. In that way concepts of GIS-based analysis can be linked and deployed in accordance with the experience of landscape architects.

### (I) Understanding Landscape Architectonic Compositions as Four-Dimensional Construction

This principle focuses on GIS-applications for exploring the composition 'from the inside out', as it could be experienced by an observer moving through space using concepts of GIS-based visibility analysis (e.g. viewsheds, isovists) and virtual 3D-landscapes. GIS is employed to explore the visual manifestation of open spaces, surfaces, screens and volumes, and their structural organisation and ordering principles. The basic premise is that the shape of space, plasticity and appearance of spatial elements in the composition determine the relation between design and perception. GIS-based landscape design research addresses the form and functioning of the three-dimensional landscape space, with routes as important operative structures that mediate or facilitate its use and reception. GIS is employed to study the framing of a landscape or urban panorama, or the construction of a spatial sequence along a route (Figure 2).

### (II) Understanding Landscape Architectonic Compositions as History

GIS-applications focus on 'reading' the landscape as a biography, as a palimpsest that evidences all of the activities that contributed to the shaping of that landscape. The composition is regarded as a layered entity where traces that time has laid over can reinforce or contradict each other. Knowledge of these layers is the starting point for new transformations, or adding a new design layer. This principle involves the evolution of the composition over time and investigates operations of 'erasing' and 'writing' history. Here GIS is employed to get to know the historical situation and the development of the composition. Via the construction of GIS-based virtual historical landscapes of a certain time-slice snapshot or comparisons of several of them the dynamics and change over time can be explored (Figure 3).

### (III) Understanding Landscape Architectonic Compositions as Scale-Continuum

In this principle the focus is on GIS-applications addressing the composition as being part of a scale-continuum. The level of

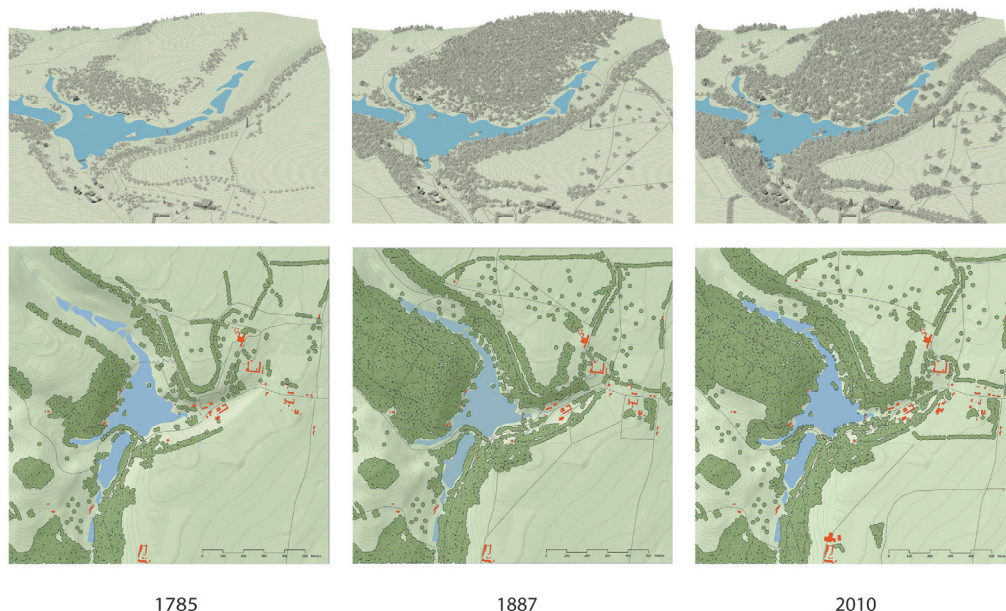


FIGURE 3. GIS-based reconstructions of Stourhead landscape garden (Wiltshire, UK) in different time stages of its development represented as virtual 3D landscapes and maps. (Source: S. Nijhuis 2015)

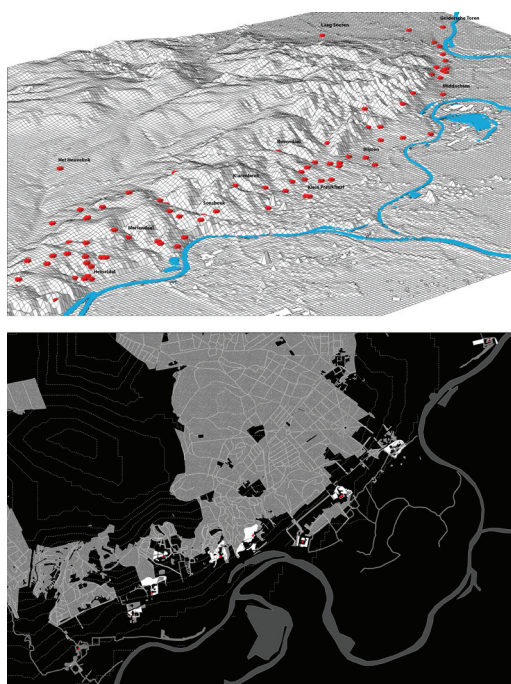


FIGURE 4. GIS-based spatial association analysis of the distribution and allocation of historical estates of Guelders Arcadia (near Arnhem, Netherlands) in the natural landscape dominated by the ice-pushed ridges of the Veluwe-East (top) and analysis landscape architectural compositions of selected individual estates that show a remarkable sensitivity towards natural conditions. (Source: S. Nijhuis)

scale of a composition under study is important, because any size larger than that of the study area supposes a 'larger context'. The composition is considered to be a relational structure connecting scales and spatial, ecological, functional and social entities. GIS-applications focus on exploring topological (vertical) and chorological (horizontal) relationships, the embedment of a specific site or location into the broader

context at different scale levels. Here spatial patterns are studied by map dissection as a basis for spatial association analysis, which explores the relation between different patterns. Here GIS is employed to explore for instance the position of the designed landscape in its natural, cultural or urban context on multiple scale levels. (Figure 4)

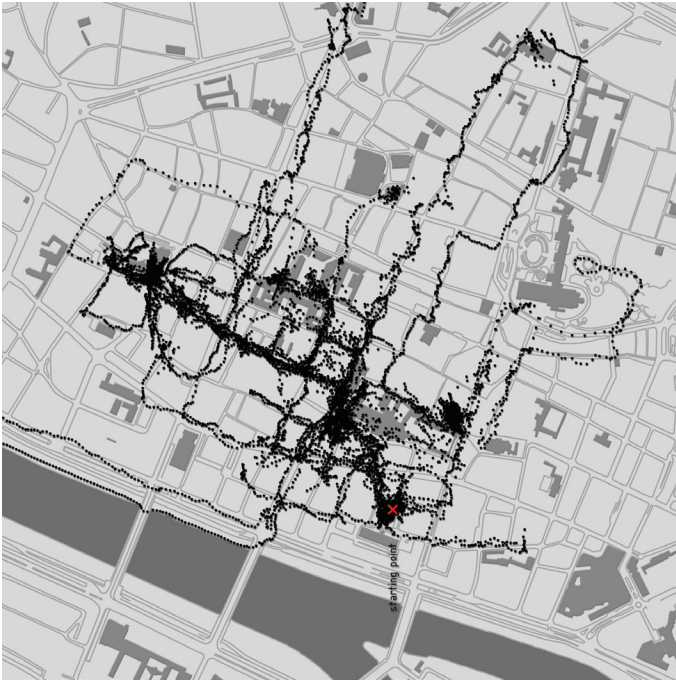


FIGURE 4. GPS-monitoring of pedestrian movement by tourists in Rouen (France). In order to reveal their movement behaviour several dozens of tourists were asked to carry GPS-devices while visiting the town centre, here represented as a map. (Source: S. Nijhuis 2015)

#### (IV) Understanding Landscape Architectonic Compositions as Process

GIS-applications focus on the interaction between landscape processes and typo-morphological aspects and address aesthetic, functional, social and ecological relationships between natural and human systems. The composition is regarded to be part of a holistic and dynamic system of systems as an expression of the interplay between formal aspects and interaction between ecological, social and economic processes. The landscape is considered as an ongoing process rather than as a result. Natural and social processes constantly change compositions, making the dynamics of the transformation a key issue in research and design. Here GIS is employed to understand the landscape as a system employing ecological process models investigating the spatial development and expression ecosystems, or exploring pedestrian movement patterns using GPS-devices (Figure 5).

#### In Conclusion

The briefly discussed principles for GIS-based landscape design research are not about presenting new GIS-analysis methods and techniques. It rather re-presents useful GIS-concepts from the perspective of landscape design. Hence, this toolbox embodies a way of thinking typical for landscape design and offers the possibility to link concepts of GIS-based analysis to the very heart of landscape architecture in a natural and intuitive way in the hope to break down barriers of using GIS in design study and practice. The typical principles of landscape design can also serve as a basis for cultivating spatial intelligence by means of geo-information technology while raising awareness and take away prejudice. It can serve as a basis for the academic underpinning and the development of a digital culture in landscape architecture exploiting GIS its powerful integrating, analytical and graphical capacities. Educational and

research institutions have an important part to play, they must take the lead in inspiring students and practitioners, building up their knowledge and passing it on, and adding new tools to the traditional craftsman's toolbox.

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