3

GIS in Landscape Planning

Matthias Pietsch
Anhalt University of Applied Science
Germany

1. Introduction

Landscape planning supports sustainable development by creating planning prerequisites that will enable future generations to live in an ecological intact environment (Bfn, 2002). It breeds to a full-coverage strategy with the aim of maintaining landscape and nature as well as facilitating municipal and industrial development (von Haaren, 2004; BfN 2002). Contrary to the design approach (McHarg, 1969) it has been developed to an institutionalized planning system based on analytical processes (Schwarz- v. Raumer & Stokman, 2011). Objectives will be derived from scientifically based analysis and normative democratically legitimized goals (Riedel & Lange, 2001; Jessel & Tobias, 2002; von Haaren, 2004 a.o.).

Existing Geographic Information Systems (GIS) offer the needed capabilities concerning the whole planning cycle (Harms et al., 1993; Blaschke, 1997; von Haaren, 2004; Pietsch & Buhmann, 1999; Lang & Blaschke, 2007; a.o.). Data capturing for inventory purpose, scientific-based analysis, defining objectives, scenarios and alternative futures and planning measures can be carried out by using GIS (Schwarz-v. Raumer, 2011; Ervin, 2010; Steinitz, 2010; Flaxman, 2010). For the implementation and sometimes necessary updates environmental information systems can be developed for specific purpose (Zölitz-Möller, 1999; Lang & Blaschke, 2007). Nowadays required models (e.g. process, evaluation, decision) can be defined and interchanged for different scopes (Schaller & Mattos, 2010). The technical evolution of hard- and software enable planners and designers to improve participation processes and decision-making using visualization and WebGIS-technologies (Warren-Kretzschmar & Tiedtke, 2005; Paar, 2006; Lange, 1994; Wissen, 2009; Bishop et al., 2010; Buhmann & Pietsch, 2008a and b; Pietsch & Spitzer, 2011; Richter, 2009; Lipp, 2007). Transforming the existing planning process to a process-oriented one with new ways of interaction technical enhancements are necessary as well as a new planning and design style (Ervin, 2011). Therefore teaching methods must be changed to a more process- and workflow oriented thinking (Steinitz, 2010; Ervin, 2011) using the advantages of the different software tools like GIS, CAD, visualization and Building Information Models (BIM) (Flaxman, 2010). GeoDesign as a “new” term had been discussed the last years. While some planners contribute that they are doing this for years (Schwarz-v. Raumer & Stokman, 2011) requirements had been defined for a more collaborative and process-oriented planning (Francica, 2012; Ervin, 2011; Steinitz; 2010; Flaxman, 2010; Dangermond, 2009, 2010).

In this paper the different terms will be explained and the special German definition of landscape planning will be described. Based on this definition the use of GIS in the different working steps will be described and useful methods (e.g. habitat suitability analysis) will be explained. The needs for standardization and existing information management will be discussed and future improvements realizing the GeoDesign framework will be shown.

2. Definition

A lot of different terms are used in the context of spatial planning in the literature. Often spatial planning, physical planning, conservation planning, environmental planning, landscape planning, landscape design and a lot of other terms are used (Steinitz, 2010; Flaxman, 2010; Opdam et al., 2002; von Haaren, 2004; Jessel & Tobias, 2002; Kaule, 1991; Gontier, 2007; Weiers et al., 2004). But the common sense is the analyzing, evaluation, modeling, designing or the planning of measures (Opdam et al., 2002; Harms et al., 1993; Flaxman, 2010; Gontier et al., 2010) to achieve a more sustainable land management (McHarg, 1969; BfN, 2002). They deal with different scales (spatial, temporal) and pursue different goals (e.g. select conservation sites, design alternative futures, reduce environmental impact; improve urban development in a sustainable way). Therefore it's necessary to describe some of these terms that will be used in this article especially because some of them are specific German instruments. In all planning tasks you have to deal with spatial datasets (e.g. presence of species, habitats, soil types, land use, water bodies) and create in the planning process new datasets based on this information. Existing evaluation models will be used or new ones will be created using different scientific methods. New visions or alternative futures will be designed and have to be discussed with the public and explained to decision-makers using appropriate media and techniques. And at the end the results must be implemented (e.g. urban development plans, conservation agencies). Planning is not science, which means there are often different ways for the same direction. Scientific models and methods (e.g. landscape ecology) must be used to get the best results but in the end the decision is made by politicians in discussion with the public. Therefore it's necessary to work with as much as possible transparency (Steinitz, 2010; von Haaren, 2004) to produce convincing results with great acceptance (von Haaren, 2004). GIS tools and methods offer capabilities that are helpful in the whole planning process (Blaschke, 1997; Pietsch & Buhmann, 1999; Lang & Blaschke, 2007; a.o.).

2.1 Landscape design

Landscapes have been designed for thousands of years by human beings with impact from local to global scale (e.g. climate change, degradation). On the one hand intensive land use had and has a great environmental impact (e.g. fragmentation, biodiversity loss, soil erosion, water contamination) on the other hand specific land use types occurred that are now representative for specific regions (e.g. farmland in the Alps) and that are habitats for endangered species (plants and animals).

While societal and environmental issues are changing six basic questions must be asked in any situation of design (Steinitz, 1990, 2010) (see Fig. 1). Taking this framework into account the technology we are using might help to develop the necessary models and methodologies to manage landscapes in the complex world and to help the decision-makers in a confident way to design sustainable landscapes (Steinitz, 2010).

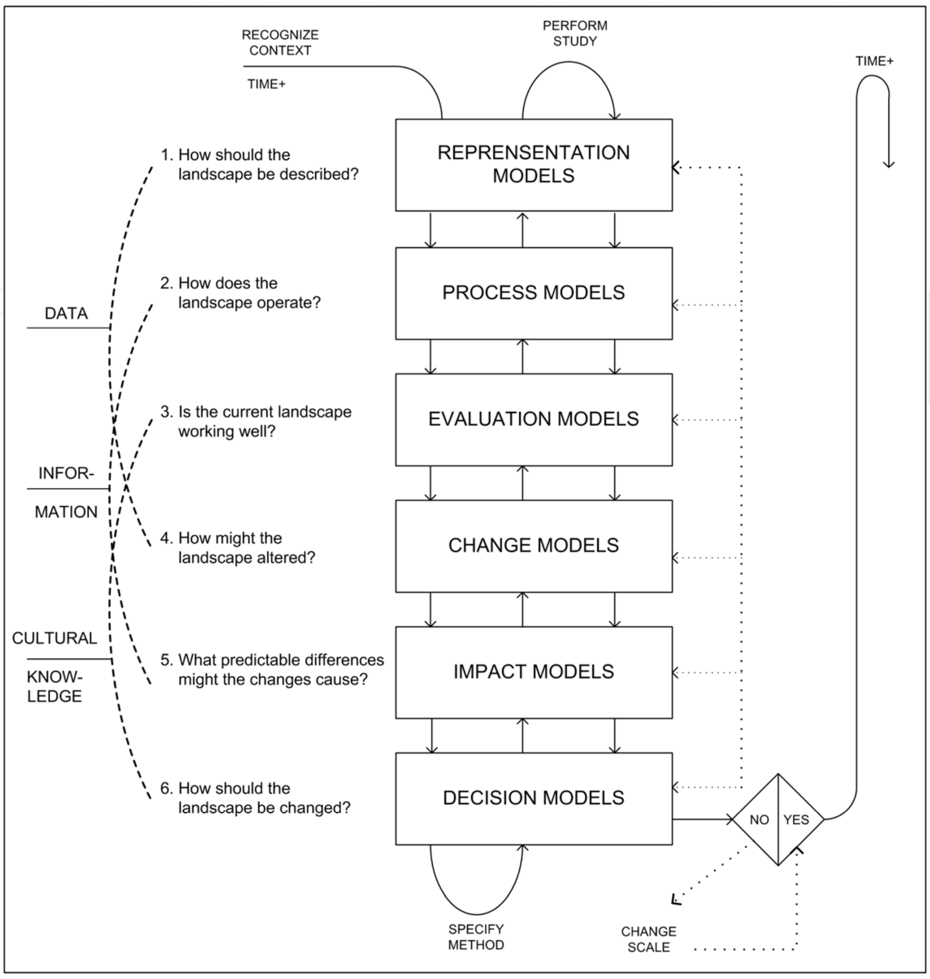


Fig. 1. „Steinitz Framework“ (Steinitz, 1990, 2010)

It is mentioned that there is not one answer which are the best models and what are the spatial-analytic needs for designers or planners (Ervin, 2011). It depends on scale and complexity. The more detailed the planning task is the simpler the models may be and the experience of the planner or designer may be sufficient. For a large scale, the complexity is increasing and appropriate methods must be decided. Two basic strategies exist. The first one is to design the future state and then ask: "By what scenario might it be achieved" (Steinitz, 2010). The second one is to design a scenario and then ask: "In what future might it result?" (Steinitz, 2010).

Steinitz (2010) defined seven basic ways of designing that can be adapted using GIS technologies (at least in part) but that are not dependent upon them. They are accepted and often used in a specific way or in various combinations. They are:

- anticipatory
- participatory
- sequential
- combinatorial
- constraining
- optimizing or
- agent-based.

But there is a great relationship between the factors scale, decision models, process models and the way of designing (Flaxman, 2010, Steinitz, 2010). It is a difference between doing a design at small scale or even larger and larger. Therefore increasingly research is needed focused around the following six themes:

- content-problem seen over varied scales and locations
- decision model and its implementation (e.g. public participation)
- comparative studies of landscape processes (pattern and functions) and its models
- design methods and its applications (e.g. decision support systems, agent-based modeling)
- representation of the results (e.g. visualization techniques, animations, simulations)
- new technologies and its applications (e.g. augmented-reality, mobile devices, GIS on demand, WebGIS) (Steinitz, 2010).

2.2 The "German" situation

In Germany environmental planning and landscape planning can be distinguished (von Haaren, 2004; Klöppel et al., 2004; Jessel & Tobias, 2002; Riedel & Lange, 2001). They are the fundamentals for sustainable planning and the basics for decision-makers to take landscape functions into consideration (BfN, 2002).

2.2.1 Environmental planning

There are a lot of policies influencing the landscape. These are e.g. the European Landscape Convention, the Environmental Impact Assessment Act, the Strategic Environmental Impact Assessment Act or the Habitat Directive (Köppel et al., 2004; Umweltbundesamt, 2008). This leads to the recognition of the value of landscapes in law and the requirement of public participation processes (Steinitz, 2010; von Haaren, 2004; a.o.).

In contrast to Environmental impact assessment (EIA) on the project level, Strategic Environmental Impact Assessment (SEA) covers a wider range of activities, a wider area or sometimes a longer time span and identifies and evaluates the environmental consequences of proposed policies, plans or programs to ensure that the consequences are addressed at the earliest possible stage of the decision-making process (European Commission Environment DG, 2001; Gontier, 2007; Köppel et. al., 2004; Gontier et al., 2010). For this reason the focus of implementing sustainability aspects into the decision-making process is more effective and more sustainable-driven than being reactive on the EIA-level.

There exist three combinations of SEA and planning process (see Fig. 2).

The objectives of the intervention and environmental impact assessment provisions are to ensure that individual projects, plans or programs are performed with as little impact on the environment and nature as possible. This does not entail a separate procedure in its own right but rather takes place as part of the regular planning, permit and approval procedures e.g. of a road planning project or the urban development planning process (Heins & Pietsch, 2010; Köppel et al., 2004). The intervention provisions require registration and assessment of the effects that the planned project or plan can be expected to have on the functional capacity of the ecosystem and appearance of landscapes. In addition, the EIA and SEA is also concerned with the effects that such measures can have on human health and on cultural heritage (Federal Ministry for the Environment, Nature Conservation and Nuclear Safety 1998; Riedel & Lange, 2001; Busse et al., 2005; Köppel et al., 2004; Georgi & Peters, 2003; Georgi, 2003; Umweltbundesamt, 2008; Höhn, 2008; Jessel et al., 2009; Hendler, 2009; Wiegleb, 2009). Therefore the fundamental components of an EIA and SEA although there are variations around the world are:

- Screening
- Scoping
- Assessment and evaluation of impacts and development of alternatives
- Reporting
- Review
- Decision-making
- Monitoring, compliance, enforcement and environmental auditing (Commission for Environmental Assessment, 2006; von Haaren, 2004; Riedel & Lange, 2001; Köppel et al., 2004).

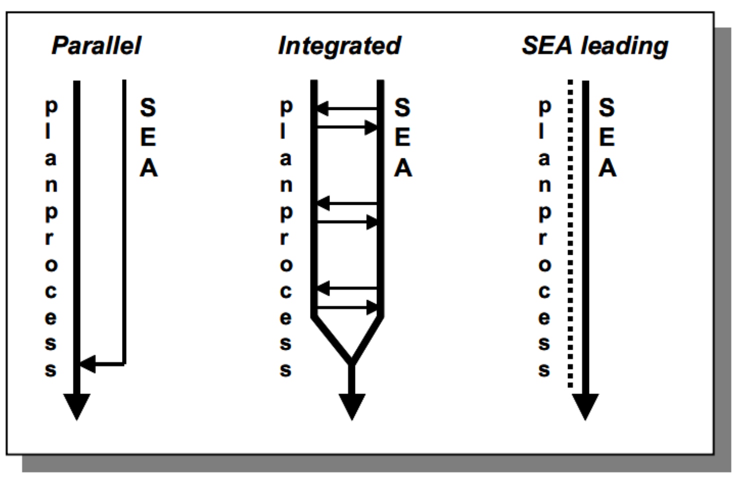


Fig. 2. Combinations of SEA and planning process (Commission for Environmental assessment, 2006)

In Germany mitigation and landscape envelope planning have a special role in the whole spectrum of environmental planning and nature conservancy. It is an instrument that is always tied in with the formal legal planning process such as e.g. road planning, zoning of areas for wind energy or solar panels (Riedel & Lange, 2001; Schultze & Buhmann, 2008; Köppel et al. 2004). Landscape envelope and mitigation planning is that instrument that optimizes the ecological balance of the overall project and to describe the compensation measures (BMV 1998). In the logical sequence of work steps Landscape envelope and mitigation planning uses the results of an EIA and is the legally binding part of the planning (Köppel et al., 2004; Schultze & Buhmann, 2008).

Based on the Habitats Directive and the Birds Directive sites had been selected according to EU standards to create the NATURA 2000 network. If any plan or project either itself or in combination with other plans or projects might have significance impact on a given site an impact assessment is required (Köppel et al., 2004; European Commission Environment DG, 2002).

The key issue to identify the significance impact is an assessment that covers:

- habitats listed in Annex I of the Habitats Directive, including their characteristic species.
- species listed in Annex I of the Habitats Directive and bird species listed in Annex I and Article 4 (2) of the Birds Directive, including their habitats and locations.
- biotic and abiotic locational factors, spatial and functional relationships, structures, and site-specific functions and features of importance to the above mentioned habitats and species (Bundesamt für Naturschutz, 2012).

The impact assessment should lead to alternative solutions, compensatory measures and to preserve the overall coherence of the NATURA 2000 network (European Commission, 2007). For specific information about the procedure, the exceptional circumstances when a plan or project might still be allowed to go ahead in spite of a negative assessment see European Commission Environment DG (2002).

2.2.2 Landscape planning

In Germany, landscape planning, based on the Federal Nature Conservation Act, is the planning instrument for nature conservation and landscape management as opposed to other planning instruments and administrative procedures (The Federal Ministry for the Environment, Nature Conservation and Nuclear Safety 1998; Bfn 2002). It makes important contributions to the conservation of natural resources at all levels (local, district or entire regional state) and for full-coverage, sustainable conservation and long-term development of nature and landscapes in the built and non-built environment (see Fig. 3).

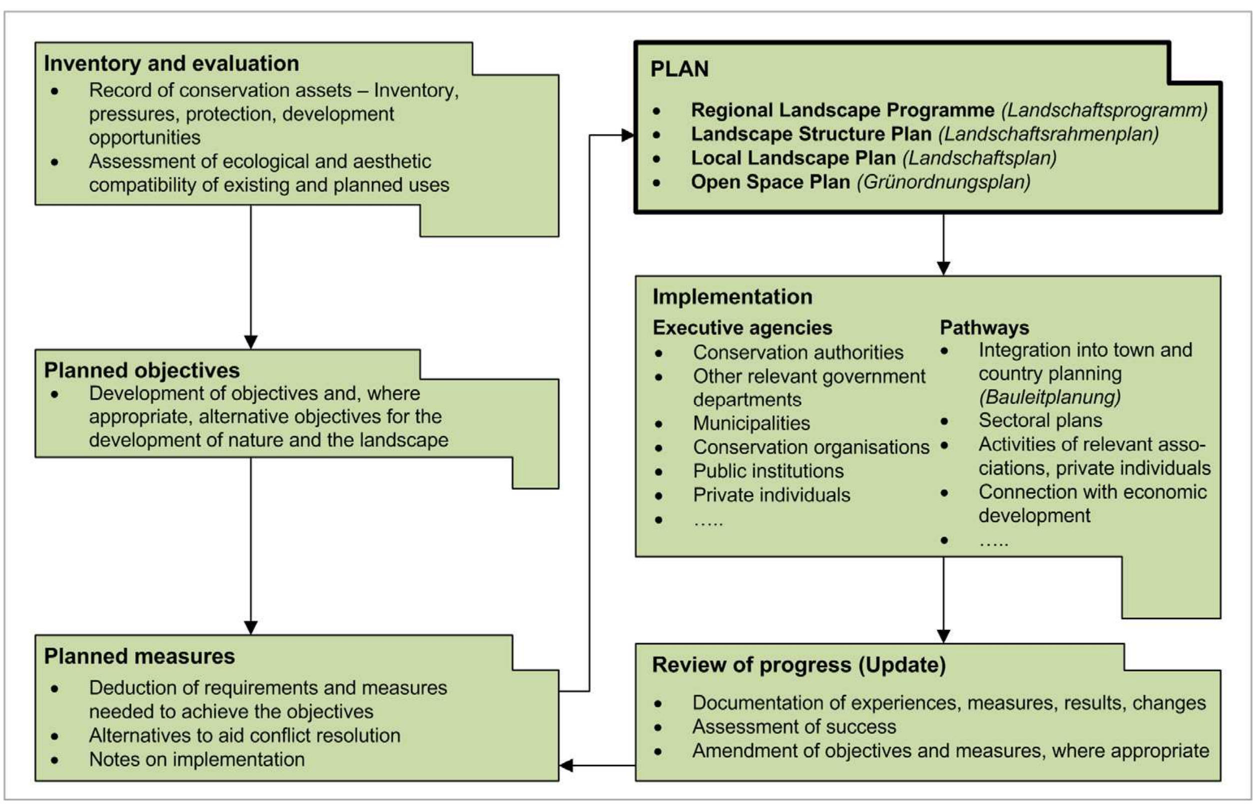


Fig. 3. Tasks and contents of landscape planning in logical sequence of work steps (BfN 2002)

In the different steps of the planning process a lot of information are needed to analyze and evaluate the current state of nature and the landscape, the functional capacity of the natural environment, the scenic qualities of the landscape, the development potential and the existing and foreseeable problems and conflicts with other uses (e.g. agriculture, traffic, housing) (Riedel & Lange, 2001; Jessel & Tobias, 2002; BfN, 2002; von Haaren, 2004;. a.o.). Based on that information a guiding vision and a set of objectives and measures have to be developed together with all stakeholders. Scenarios and visualizations are helpful to explain the details and the timescale for implementation (Lange, 1994; Ervin & Hasbrouck, 2001; Lange, 2002; Appleton & Lovett, 2003; Bishop & Lange, 2005; Paar, 2006; Warren-Kretzschmar & Tiedtke, 2005; Sheppard et al. 2008; Schroth, 2010; Schwarz-v. Raumer, 2011). At the end of the planning process the implementation and review (sometimes updates) are the most important tasks (BfN 2002).

2.3 Conclusions

Environmental and landscape planning in Germany differs in scope and aims. Landscape planning makes important contributions at all levels and full-coverage while environmental planning deals with specific scales (spatial and temporal) and territories (Köppel et al., 2004; Lambrecht et al., 2007; Riedel & Lange, 2001; von Haaren, 2004). The results of the landscape planning process can be used in the evaluation process of an EIA or SEA to analyze the negative effects caused by a project, plan or program. Otherwise the results of an SEA might be used in the following EIA or results of an EIA must be used in the following envelope and mitigation planning (Lambrecht et al., 2007; Schultze & Buhmann, 2008; Heins & Pietsch, 2010). That implies the necessity to realize an efficient information management and minimum standards to provide data and information in the right way at all work steps in the planning process (Pietsch & Heins, 2008; Heins & Pietsch, 2010; Schauerte-Lücke, 2008). Taking all frameworks in consideration information about the current state of nature and landscape, landscape functions, negative impacts or foreseeable conflicts must be evaluated and measures must be planned. Therefore different spatial information using scientific methods must be analyzed using e.g. GIS. Because the requirements are similar the following remarks will be limited to the landscape planning process while they may be assigned to the other planning tasks.

3. Capabilities of using GIS in landscape planning

Information technologies especially GIS can help to improve the landscape planning process and to capture the results in existing information systems for future use or as part of environmental information or decision support systems (Arnold et al., 2005; Pietsch & Buhmann, 1999; Blaschke, 1997; Lang & Blaschke, 2007; Gontier et al., 2007) (see Fig. 4).

GIS can be used in the different working steps of the landscape planning process. At the beginning data capturing in all planning tasks is necessary. This can be done by fieldwork, using existing thematic datasets (e.g. via Web Services) or by converting from existing databases or other monitoring systems (e.g. remote sensing). Checking the data quality is one of the most important tasks in the first step, to appreciate the necessity of data conversion, field work or usability of the existing material. After analyzing the existing situation for the defined scope the evaluation of potential of development, environmental functions, ecosystem services, scenic qualities, conflicts, previous and future impacts must be evaluated. Methods and tools analyzing datasets in different formats (raster and vector) or scales like spatial (resolution, grain, 2D, 3D) and temporal (historic, present, future conditions) are available. Some of them can be used for different purposes (e.g. evaluation, scenario and planning objectives) or they are only comfortable for a specific level or topic. Afterwards in landscape planning (e.g. local level) a guided vision or alternative futures should be planned and discussed (BfN, 2002; von Haaren, 2004). GIS can help to improve the participation process using visualization and multimedia techniques and Web GIS functionality. After the discussion process measurements should be planned and implemented in different ways. Monitoring of the landscape transformation must be done to check if it is really doing what it is expected to do (Opdam et al., 2002). Information management and a basic standardization are necessary to make sure that the life cycle works and in all work steps the right information in the right quality is available (Heins & Pietsch, 2010; Schauerte-Lücke, 2008; Opdam et al., 2002).

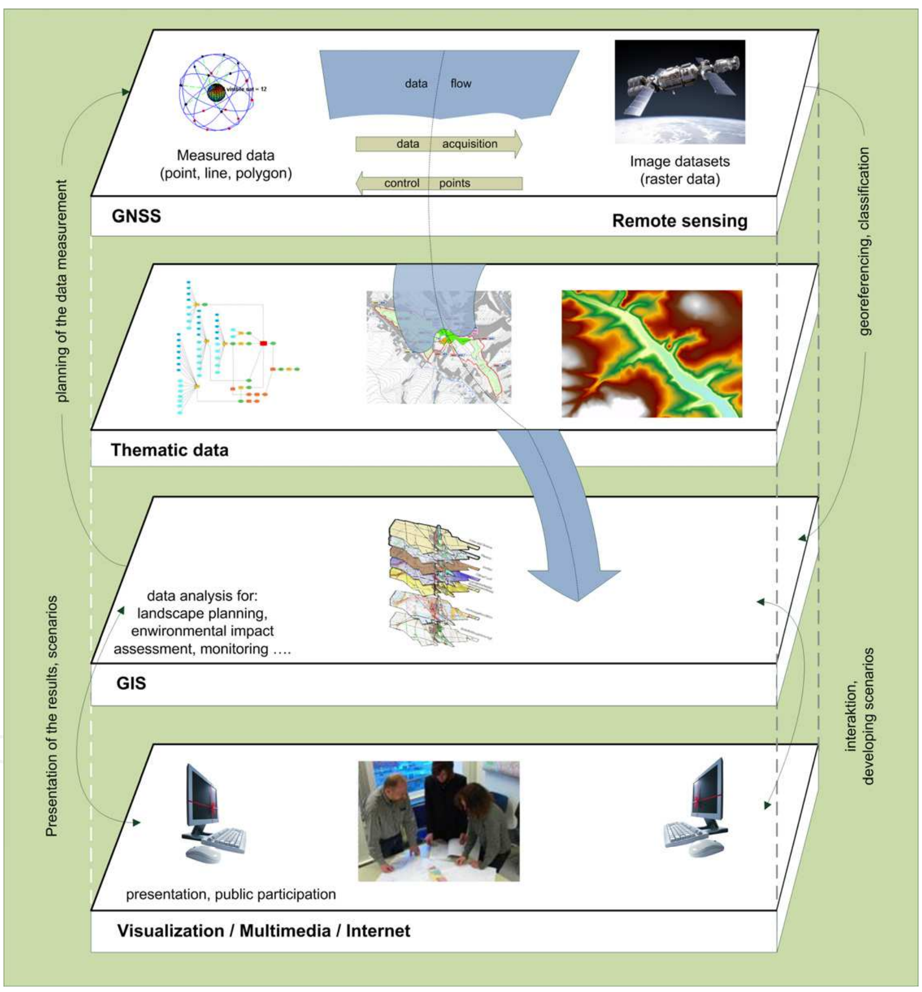


Fig. 4. Interaction of modern technologies in landscape planning (von Haaren, 2004)

3.1 Data capturing

Nowadays mobile devices are used for data capturing using Global Navigation Satellite Systems (GNSS) (e.g. GPS, GLONASS) in a standardized and formalized way (Dangermond, 2009; Brandt, 2007) to reduce effort in data conversion to implement and use the results in the planning process. They are used e.g. to create tree cadastre (Pietsch, 2007; Brandt, 2007; GALK-DST, 2006), to collect species presence datasets (Dangermond, 2009), to reduce time and costs capturing land use types or habitats and for monitoring (e.g. checking mitigation measures). Depending on the hardware capacity and performance and the receiver accuracy improvements in data collections are possible. Using UMTS or other online services datasets might be send to a server (e.g. in the office) on the fly without necessary active copying or basic datasets like aerial images, top maps, thematic layers (e.g. streets) or the datasets that have to be checked can be received via Web Services (e.g. WMS, WFS) to be used online in the field. Digital cameras with a GNNS module facilitate documenting the investigation area. Images with coordinates are stored and some cameras and applications are able to analyze the viewing direction automatically. Using techniques like that enable the planner to create automatically documentations based on the existing images to present them e.g. online via Google Earth or to use them in the planning process (e.g. visualization, sketches, participation).

3.2 Analyzing

In the landscape planning process landscape functions like regulation, carrier, production and information functions must be analyzed (Groot, 1992; Pietsch & Buhmann, 1999; Jessel & Tobias, 2002; von Haaren, 2004; Lang & Blaschke, 2007). For nature conservation the regulation function is the most relevant (Weiers et al., 2004). Therefore landscape ecology defined as a problem-oriented science can provide methods for the different planning steps. But to optimize the knowledge-transfer between landscape ecology and spatial planning landscape ecology must co-evolve (Opdam et al., 2002). “In decision-making on future landscapes, landscape planners, landscape managers and politicians are involved in a cycling process” (Opdam et al., 2002) (see Fig. 5)

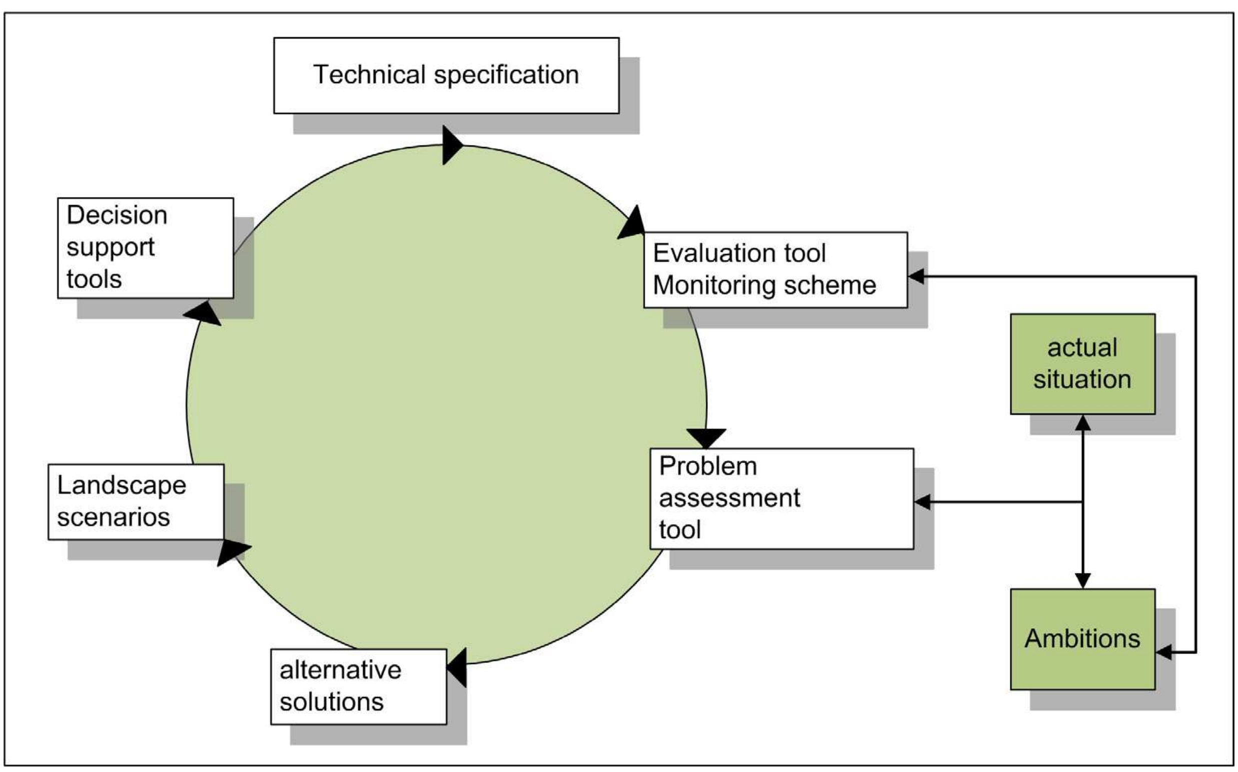


Fig. 5. Planning cycle (adapted from Harms et al., 1993)

That means that different models and methods are needed to integrate science in the planning process (Blaschke, 1997; Lang & Blaschke, 2007; Schwarz-v. Raumer & Stokman, 2011). Some examples will be given in the following chapters.

3.2.1 Multi-criteria evaluation (MCE)

Analyzing landscape functions (e.g. soil erosion) different information (e.g. land use, gradient, rainfall) must be taken in consideration. Using scientific-based methods the potential, risk or existing conflicts can be calculated. Depending on the selected methodology and the available information / datasets multi-criteria evaluation (MCE) is a very powerful tool. Therefore a reduction of complex environmental factors into a cohesive spatial concept is necessary. Overlay-functions (raster or vector-based) in combination with evaluation or impact models can be used to calculate e.g. suitable areas for farming or settlement or to perform impact analyses (see Fig. 6.)

Fig. 6. Overlay (example)

3.2.2 GIS-based habitat models

In conservation biology and conservation planning there is a great diversity of GIS-based species distribution, habitat or population models (Blaschke, 1997; Blaschke, 2003; Taeger, 2010; Guisan & Zimmermann, 2000; Gontier, 2007; Gontier et al., 2010; Pietsch et al., 2007; Amler et al., 1999). Habitat suitability models based on empirical data versus models based on expert knowledge can be distinguished. On the other hand the level of detail (e.g. individuals, populations, species occurrences or species communities) is another way to describe the different models (Gontier et al. 2010).

There has been a lot of discussion about the possibilities to implement habitat suitability analysis (HSI) in environmental and landscape planning (Kleyer et al., 1999/2000; Schröder, 2000; Blaschke, 1999 and 2003; Rudner et al., 2003). They are established in environmental- and bio-science but because of the data requirements and the time- and cost-consuming modeling used only in a few planning examples (Jooß, 2003 and 2005; Pietsch et al., 2007; Gontier, 2007; Rudner et al., 2004; Schröder, 2000).

GIS-based models based on expert knowledge normally use presence datasets of specific species. Using the knowledge about the habitat preferences it's possible to analyze the suitability. Actual land use maps or other thematic information about habitats and specific structures or qualities (e.g. hydrological situation, soils, water quality) are used to evaluate the actual situation (Blaschke, 1997; Jooß, 2003; Taeger 2010). In contrast to ecological models using statistical methods models based on expert knowledge have a great potential to be used in landscape planning (see table 1). They are not as precise as ecological models but easier to interprete and applicable in larger areas.

	ecological model	**"planning" model**
method	- statistical approach -	- expert knowledge - prediction model
datasets	- actual presence data (based on field work) - (knowledge about habitat preferences)	- knowledge about habitat preferences
criteria / habitat information	- very detailed - for a small area	- more general - based on existing planning information - depends on the expert knowledge
quality/validity	- precise models, but only usable for a small area - scientific models	- fuzzy models, but for larger areas
validation	Easy to validate	Validation based on control samples
usability	- precise model for one specific species - maximum quality	- much more general, but useful for planning tasks - cumulative models for several species - scoping for species research

Table 1. Types of habitat models (adapted from Jooß, 2003)

They can be used for several species using existing species information. Based on the prediction model future conditions and different scenarios can be simulated to evaluate the impact of land use changes in the planning process (Gontier et al., 2010; Taeger, 2010; Pietsch et al., 2007; Blaschke, 1997). The visualization of future habitat suitability is possible. GIS offers the capability to create models (Fig. 7) based on existing datasets (species, land use, previous impact, structures, qualities) to analyze the actual and future suitability.

It's possible to create evaluation models, to create scenarios to improve the situation for one specific or several species, to develop measures to reduce negative impacts or create new habitats (Hunger, 2002; Hennig & Bögel, 2004) and they are useful to evaluate the negative impact of a plan, project or program in the context of an SEA or EIA (Gontier, 2007; Pietsch et al, 2007; Lang & Blaschke, 2007; Blaschke, 1999). In combination with connectivity analysis (see chapter 3.2.3) physical and functional links in ecological networks can be examined.

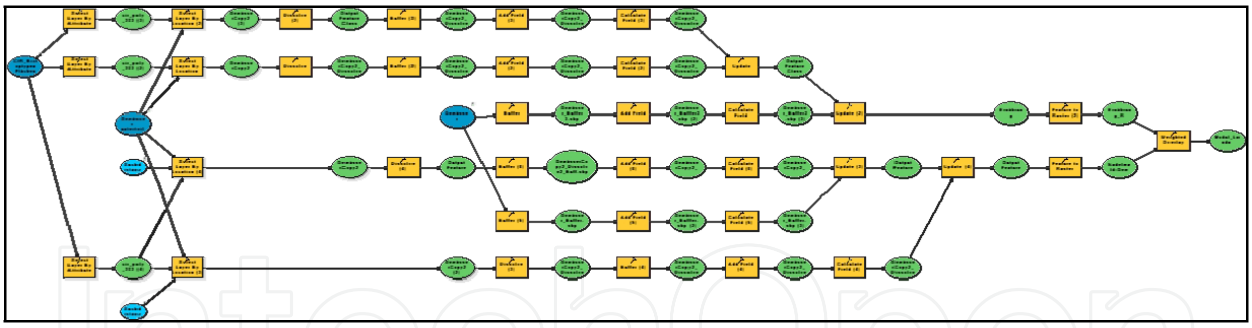


Fig. 7. Example for a habitat suitable model (Schmidt, 2007)

3.2.3 Connectivity analysis

Land use change and the physical and functional disconnection of ecological networks represent one of the driving forces of biodiversity loss (Zetterberg et al., 2010; Bundesamt für Naturschutz, 2004; Spangenberg, 2007; Reck et al., 2010). Beside a lot of different methodologies (see Fig. 8) network analysis and graph theory provide powerful tools and methods for analyzing ecological networks (Pietsch & Krämer, 2009; Urban et al., 2009; Zetterberg et al., 2010). There are three different types of connectivity analysis that can be classified according to the increasing data requirements and detail (Calabrese & Fagan, 2004).

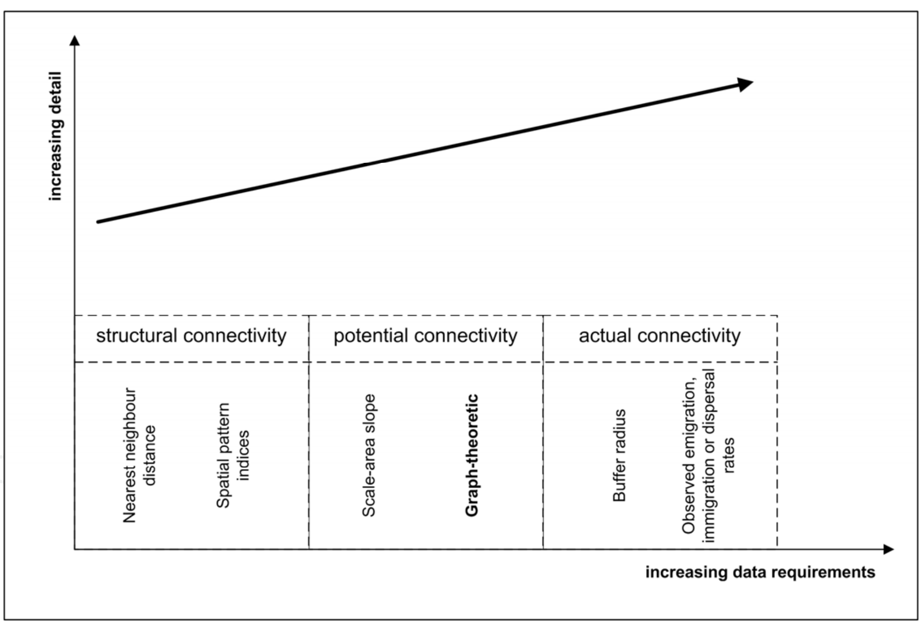


Fig. 8. Different types of quantitative connectivity analysis (adapted from Calabrese & Fagan, 2004; Wolfrum, 2006)

Graph-theory can be used as a method with very little data requirements, easy to use and not as sensitive as other methods against changes in scale (Urban et al., 2009; Bunn et al., 2000; Calabrese & Fagan, 2004; Urban & Keitt, 2001; Saura & Pascual-Hortal, 2007; Pascual-Hortal & Saura, 2006). Several graph-theoretic metrics related to classical network analysis problems had been developed and tested and ecologically interpreted (Bunn et al., 2000; Urban & Keitt, 2001; Wolfrum, 2006).

In graph-theory a graph is represented by nodes (e.g. habitats) and links (dispersal). A link connects node 1 and node 2 (see Fig. 9) (Tittmann, 2003; Urban & Keitt, 2001; Saura & Pascual-Hortal, 2007; Wolfrum, 2006). If the distance between two nodes is longer than the specific dispersal rate the link is missing, if the distance is in the dispersal range there is an existing link (Pietsch & Krämer, 2009; Zetterberg et al., 2010).

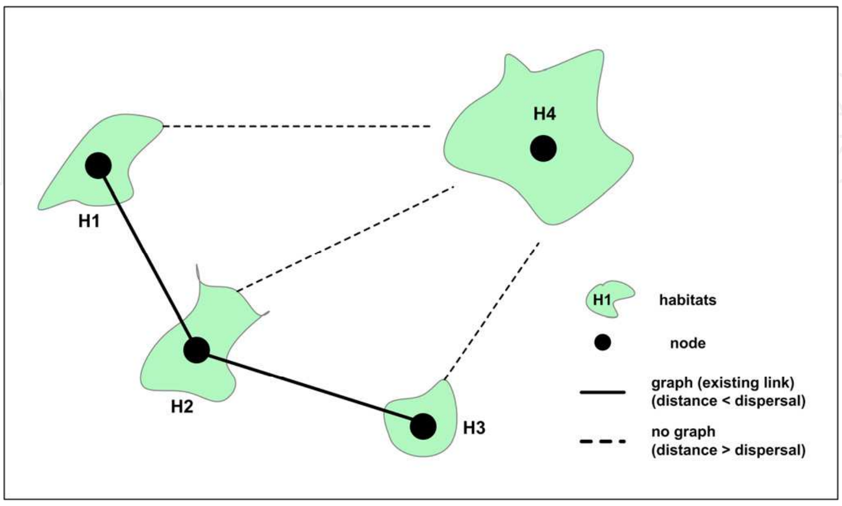


Fig. 9. Scheme of nodes and landscape graph representing habitats and connections (Pietsch & Krämer, 2009)

The graph-theory models can be distinguished in binary and probability models (Pascual-Hortal & Saura, 2006; Saura & Pascual –Hortal, 2007; Bunn et al., 2000; Urban & Keitt, 2001). Using binary models it's only possible to analyze if there is a link or not, while using probability models it's possible to analyze the existing situation (if there are links or not) and to evaluate each specific patch (habitat) (see Fig. 10) (Bunn et al., 2000; Urban & Keitt, 2001; Zetterberg et al., 2010). The distance between the nodes can be represented as edge-to-edge interpatch distance, as Euclidian distance or as least-cost path (Tischendorf & Fahrig, 2000; Ray et al., 2002; Adriaensen et al., 2003; Nikolakaki, 2004; Theobald, 2006, Zetterberg et al., 2010).

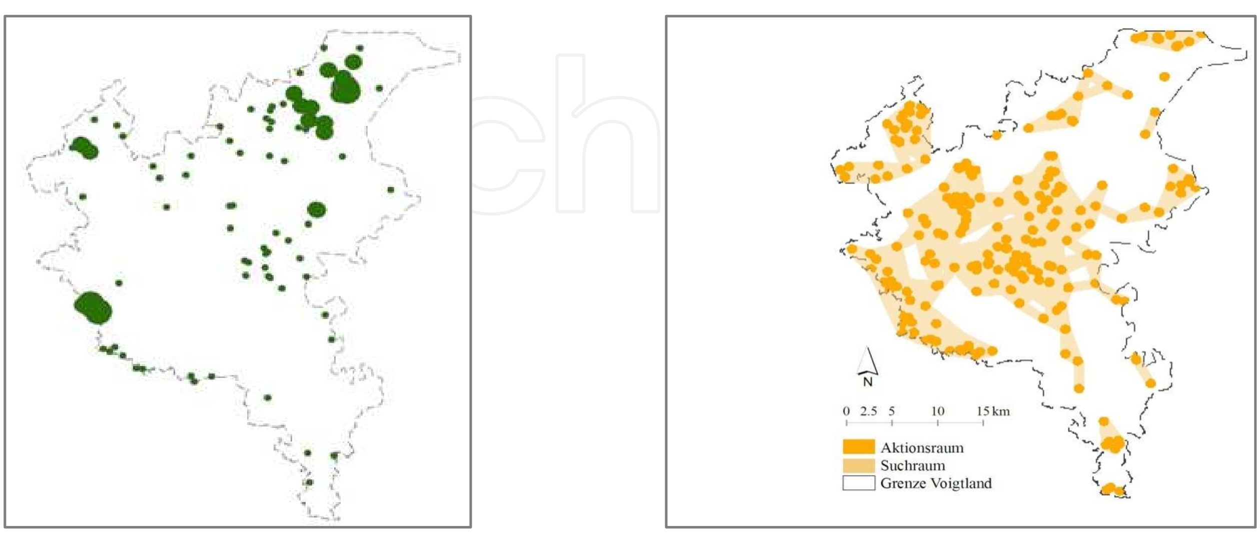


Fig. 10. Evaluation of specific habitats of Zootoca vivipara (example) (the bigger the more valuable) (left); patches and connectivity zones (right)

Using these techniques critical parts of a network can be identified e.g. through patch removal (Keitt et al., 1997; Zetterberg et al., 2010; Pietsch & Krämer, 2009), the different patches can be ranked according to their importance (Urban & Keitt, 2001) and natural and man-made barriers and breaks can be found (Zetterberg et al., 2010). They can be used as evaluation tools in the planning process or to analyze and visualize different possible scenarios for the participation process or to define areas that are most important for specific measures. In combination with cost-distance modeling (Adriaensen et al., 2003; Theobald, 2006; Zetterberg et al., 2010) and improved knowledge about species preferences and dispersal (Pietsch & Krämer, 2009) the tools are helpful to reduce negative ecological impact and find appropriate solutions in the landscape planning process.

3.3 Participation

The results of the landscape planning process are planned objectives or planned measures to be implemented into town and country planning, sectoral plans or executed by executive agencies (e.g. public institutions, conservation authorities, private individuals) (BfN, 2002; Riedel & Lange, 2001). Therefore landscape planning must be extended from an expert planning to a process-oriented planning where the participation process is one of the most important topics (Steinitz, 2010; von Haaren, 2004; Wissen, 2009). Based on the communication model of Norbert Wiener (Steinitz, 2010) the process has three elements: the message, the medium and the meaning. In landscape planning that means that the planner has a vision (a plan), the landscape is the medium and the viewer (public, stakeholder etc.) gains an impression of the changed landscape. In existing planning processes often the communication starts by the designer and ends by the viewer. But there must be a two-way alternate communication between the designer and the viewer to improve the results and the acceptance (Wissen 2009; Steinitz 2010; a.o.) (Fig. 11).

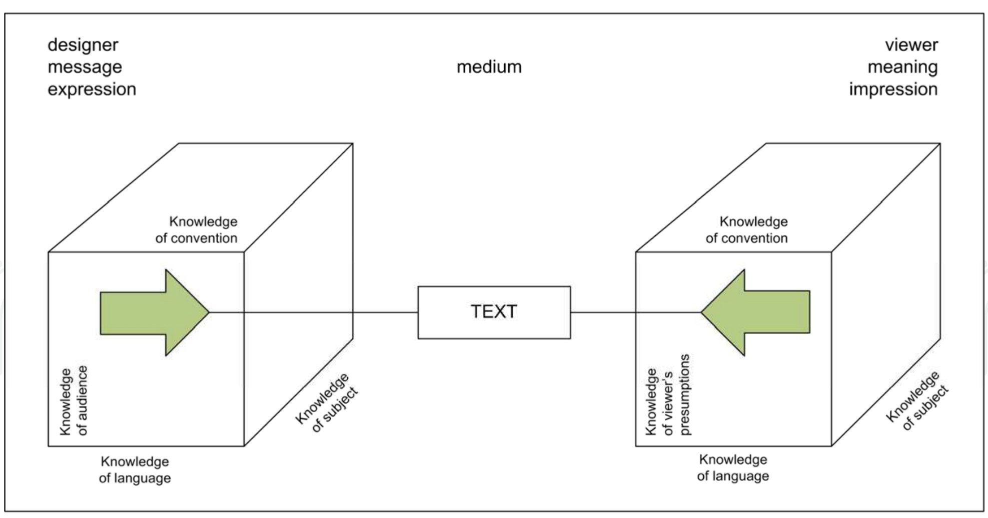


Fig. 11. Nobert Wiener's Communication Model (Steinitz, 2010)

Communication and information are the basic elements of participation (Warren-Kretzschmar & Tiedtke, 2005; Wissen, 2009). The advantages of computer-generated visualizations (plans, photomontages, 2D visualizations, 3D visualizations, real-time visualizations) in decision-making processes have been recognized for a long period (Lange 1994; Al-Kodmany 1999; Warren-Kretzschmar & Tiedtke 2005; Wissen 2009 a.o.). There are a lot of different media or visualization techniques that can be used for citizen participation (see table 2.). For non-experts it's often difficult to understand the planning ideas. On the other side it's necessary for the planner to express and communicate his thoughts in order to promote more sensitive landscape managing (Buhmann et al. 2010).

	Dynamic navigation	**Interactivity (of image)**	**Photorealistic**	**GIS-supported**	**Internet**
Interactive maps/ Aerial photos	+	-	-/+	++/-	++
Panorama photos	+	-	++	-	+
Photomontage	-	+	++	-	+
Sketches	-	++	-	-	-
Rendering of 3D-Model	-	+	+	++	+
VRML	++	-	+	+	++
Real-time	++	+	++	++	-

Legend: - unsuitable, + suitable, ++ very suitable

Table 2. Overview of visualization methods and their attributes (see Warren-Kretzschmar & Tiedtke, 2005)

But in all cases the questions remain:

- "Which characteristics of the visualizations are crucial for the support of citizen participation in the planning process?
- Which of the visualization methods are best suited for the different landscape planning tasks?
- How can visualization be successfully employed in citizen participation activities, both online and offline and which organizational aspects are important?" (Warren-Kretzschmar & Tiedtke, 2005).

Using appropriate techniques and media it's possible to explain complex environmental issues to layman. The combination of modeling techniques and GIS permit to open a "window to the future" to show scenarios, 3D- and 4D-simulations in different level of details and realism (Sheppard et al., 2008; Bishop & Lange, 2005; Paar & Malte, 2007; Säck-da Silva, 2007; Schroth, 2010; Pietsch & Spitzer, 2011).

A possibility to analyze relevant observation points for detailed visualizations are GIS based viewshed analysis. Digital Elevation Models (DEM) in combination with actual landform based on topography maps, orthophotos or thematic land use maps can be analyzed to select important vistas and areas from which a specific project might be visible or which area might be affected realizing a specific project (e.g. in the context of impact assessment for wind turbines) (see Fig. 12). After calculating the results they can be checked in the field and detailed visualizations of the before and after situation can be developed (Buhmann & Pietsch 2008a).

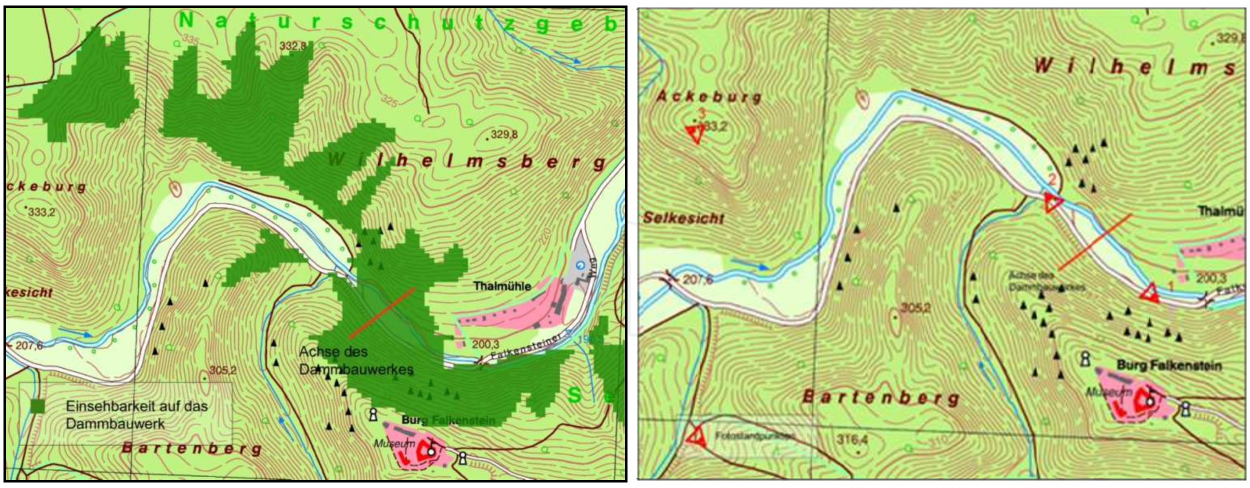


Fig. 12. Viewshed analysis (areas in green from which proposed dam in red is visible) (left); seleceted observation points for detailed visualization (right)
(Buhmann & Pietsch, 2008a)

Creating a 3D model of the investigation area enables to calculate scenarios and simulations through the integration of GIS data and generated 3D models (e.g. buildings, plants). Visual impact assessment or aesthetic analysis (Kretzler, 2003; Ozimek & Ozimek, 2008; Bishop et al., 2010) are possible as well as calculating affected settlements by different levels of flooding and evaluating different measurements to reduce the impact (see Fig. 13) (Buhmann & Pietsch, 2008a). Using these techniques different landscape ecological impacts can be spatially defined, evaluated and visualized.

Fig. 13. Simulation of affected areas (blue) and not affected areas (white) during a flood 1994 (right); simulation with planned dams (right) (Buhmann & Pietsch, 2008a)

In detailed scale seasonal changes can be presented and discussed and visual impact analysis based on temporal changes can be evaluated especially in sensitive (e.g. areas with a high touristic potential) areas (see Fig. 14).

For public participation processes planning results can be presented interactively in real-time for offline or online purpose (Paar, 2006; Paar & Malte, 2007; Buhmann & Pietsch 2008a and b; Warren-Kretzschmar & Tiedtke, 2005; Wissen, 2009; Kretzler, 2002; a.o.). Visualization using different media and specific level of detail is a useful methodology to explain the results of the different working steps as well as to explain complex ecological issues in a way everybody (experts, public, stakeholder, politicians) is able to understand. In the context of Wieners communication model visualization techniques are a possibility to improve the meaning and understanding of the planers vision (Wissen, 2009).

Fig. 14. Simulation of a dam (left: winter, right: summer) (created by Lenné3D GmbH) (Buhmann & Pietsch, 2008b)

To create a two-way alternate communication between planer/designer and viewer Web GIS-technologies can be used (Warren-Kretzschmar & Tiedtke, 2005; Lipp, 2007; Richter, 2009). Through Web GIS-technologies it's possible to present spatial information via the internet, combine them with other media (Dangermond, 2009) and offer GIS capabilities (e.g. zoom, pan, spatial analysis, upload and download, network-analysis, editing) to enhance the communication process. Thematic maps using WebMap- or WebFeature-Services can be presented via Internet (Richter 2009; Krause 2011). In the landscape planning context the thematic maps and the belonging text explaining the landscape functions, conflicts, the guiding vision and objectives and measures can be published. Users can be enabled to navigate through the whole documents and give feedback using drawing or editing tools to locate the response and the possibility for textual information (see Fig. 15). All these information can be stored in a database to analyze the results of the public participation process, to redesign the plan and if necessary to reply to each of the user.

In combination with visualization techniques the communication between planner/designer and viewer can be improved. In addition to town meetings or specific workshops much more people can be involved using these techniques. Especially for landscape planning projects on regional level or for the entire state it might be helpful to improve the participation process simultaneously reducing planning period and costs.

Fig. 15. Screenshot public participation server (Richter, 2009)

3.4 Objectives / vision / measures

Based on the inventory and evaluation process objectives and if necessary alternative objectives must be developed (Bfn 2002; von Haaren, 2004). A methodology to meet these requirements is to define for each landscape function (e.g. species/habitats/biotopes) two categories. All patches in the first category are most suitable for the defined function. All other land use types have no negative effect (e.g. habitats of endangered species). The second category involves patches with high relevance that has to be weighted with other functions (e.g. parks with relevance for endangered species and recreation). Defining all these categories and selecting the different patches might be very complex. GIS may help selecting the specific areas and create a summary of all demands. Based on these information using weighted overlay algorithms the vision and objectives can be defined (see Fig. 16).

Creating maps step-by-step in consideration of the defined criteria the discussion with decision-makers, public, stakeholders and experts can be improved. In town meeting or participation using internet technologies it's easier to understand the analysis and the requirements for each category and landscape function. During an interactive presentation different scenarios might be tested and the results can be visualized. Transparency can be increased and general agreement achieved.

Based on the defined objectives specific ad spatial concrete measures must be planned (Riedel & Lange, 2001; von Haaren, 2004; BfN, 2002). The results should be implemented in standardized environmental information systems to ensure the possibility for implementation, update and monitoring as well as publishing using Web services for other planning tasks or following working steps.

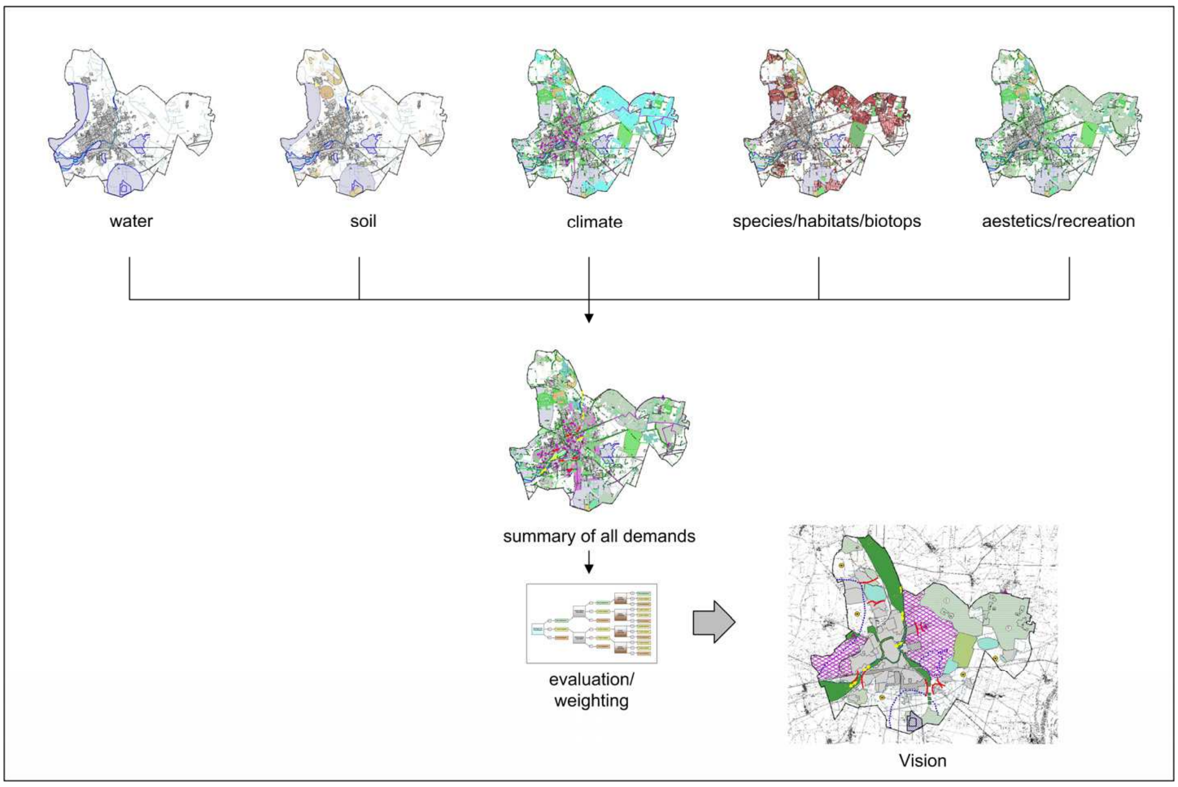


Fig. 16. Generating a vision based on weighted overlay of different plan concepts

4. Information management

In the past there had been a lot of problems exchanging information in horizontal and vertical ways between different planners and different landscape planning procedures (Krämer, 2008; Dembinsky, 2008; Arnold et al., 2005; Pietsch et al. 2010). In the context of environmental planning the whole planning process can be described as a life cycle of information (see Fig. 17).

To improve data exchange standardized, conceptual data models had been created e.g. for various areas of roads and transport (Hettwer, 2008) or regional, municipal land management and landscape planning in Germany (Benner et al. 2008; Benner & Krause, 2007). The purpose is to ensure a consistent object representation and a unified data exchange of graphic and geometric data (Ernstling & Portele, 1996; Hettwer, 2008; Pietsch et al., 2010; a.o.). The defined data models allow software developer to create specific application for landscape planning purposes and develop interface for data exchange.

For the representation guidelines and standard maps for different purposes had been developed to achieve a unified design in creating maps (Schultze & Buhmann, 2008). Taking the communication model of Norbert Wiener (Steinitz, 2010) in consideration defining and using data models lead to standardized communication without loss of information and meaning and improves data quality (Pietsch & Heins, 2009; Heins & Pietsch, 2010; Hettwer, 2008). Otherwise producing standardized datasets allows the implementation and development of Web GIS-applications for public participation or in monitoring / environmental information systems. Validation checks may be implemented to ensure data quality and to guarantee integrity. This allows to choose and develop scientific (process, evaluation, change, impact, decision) models for the planning process (Flaxman, 2010). Therefore existing data models must be extended using actual technical (e.g. OGC) and functional (e.g. guidelines, standard maps) standards. This might cause to a homogeneous terminology for planners and designers and a consistent presentation of results in the decision-making process. First steps had been done and some examples exist, but there is a lot of research to do to become these things reality.

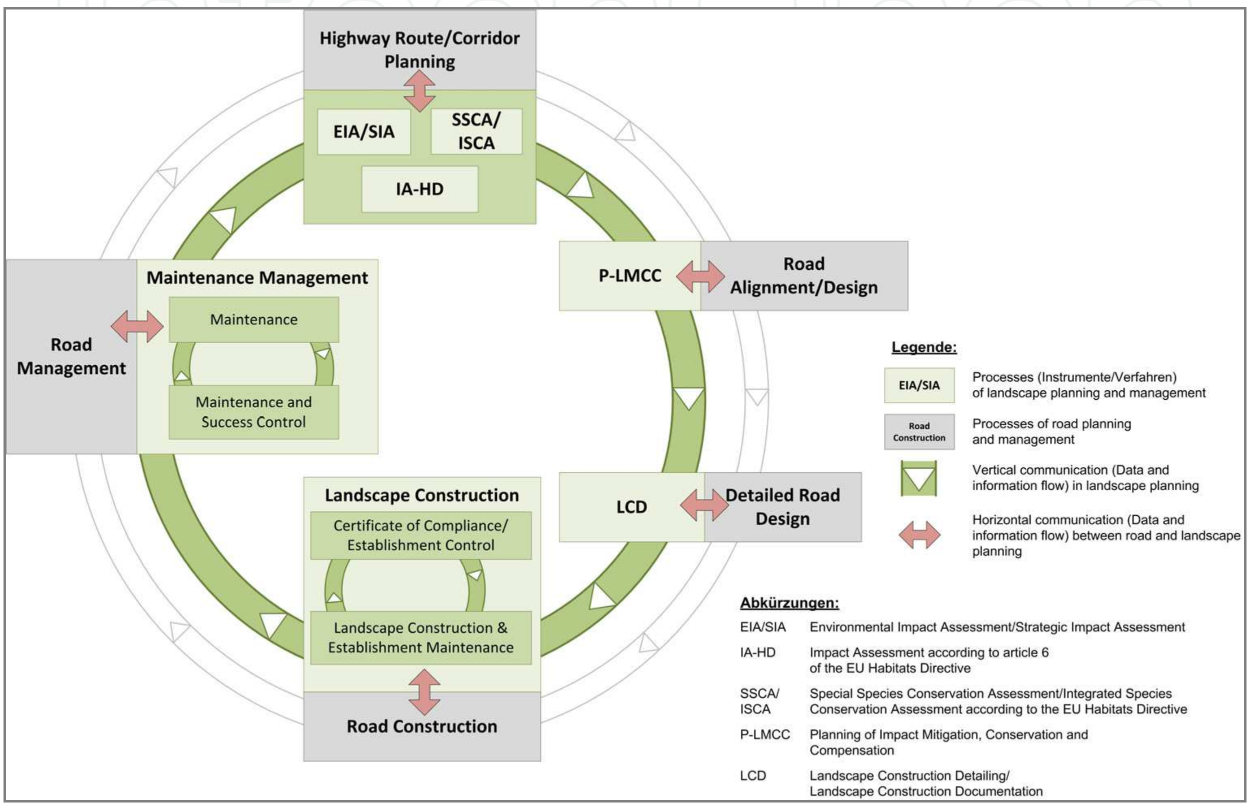


Fig. 17. Cycle of information in the context of landscape and road planning (Pietsch et al., 2010)

5. Geodesign - A new approach?

Since ESRI started the GeoDesign Summit in 2010 the term started his triumphal procession. But what is GeoDesign? According to MICHAEL FLAXMAN (2010) “GeoDesign is a design and planning method which tightly couples the creation of a design proposal with impact simulations informed by geographic context”. The idea is that the planner or designer receives at every working step real-time guidance using contextual geographic information. The design can be evaluated relative to the local conditions and continuous feedback on multiple aspects will be provided through the whole planning process instead of post-hoc evaluation (Flaxman, 2010). GeoDesign may improve the design and planning process combining the potentials of CAD, GIS, Building Information Models (BIM) and visualization tools (Dangermond, 2009 and 2010; Flaxman, 2010; Ervin, 2011) and improve interaction and collaboration in the planning process (Tomlin, 2011; Francica, 2012). In contrast to the specific GIS or CAD workflow a hypothetical one for the GeoDesign workflow will look like Fig. 18.

Design Instantiation

Pick a site or area of study
Pick suitable feature representations, based on standard or custom data models
Adjust visual portrayal (symbology) as desired
Select suitable evaluation models based on availability, project needs

Integrated Design/Sketch Evaluation

Sketch features (semantically rich and georeferenced by default)
Sketch evaluation tools give feedback without blocking drawing
Running selected models on design iterations is default and automatic

Full Impact Evaluation

Same technical structure as sketch models (simply take longer to run)
Models run as background tasks (typically as web geoprocessing services)
Models results streamed back to design client incrementally as computed
Evaluation models recognize design context in addition to input design data
Appropriate analysis context can vary by model

Fig. 18. GeoDesign Process-Flow (Flaxman, 2010)

But actual the full process remains hypothetically while aspects are already available in existing software tools (Dangermond, 2009, 2010; Flaxman, 2010). The concepts had been embedded in Decision Support Systems (Brail et al., 2008) or GIS-based planning tools (Flaxman, 2010). GeoDesign is not a new concept. It's a refinement and restatement of ideas that had been discussed in the past multiple times (Flaxman, 2010; Ervin, 2011; Schwarz-v. Raumer & Stokman, 2011). But thinking about context-sensitive impact evaluation leads to an evolving concept. While multi-criteria analysis are not new (Schwarz-v. Raumer & Stokman, 2011; von Haaren, 2004; Jessel & Tobias, 2002) using them in real-time is a very complex issue and only a few GIS systems are able to do so (Flaxman, 2010). Sharing and deploying a variety of models and indicators using web services will radically reduce software installation and configuration time. The enhancement of web services to "geodesign evaluation services" (Flaxman, 2010) using open and interoperable formats will enlarge the development of tools and software systems. Standardized data models like CityGML (Flaxman, 2010) or XPlanung (Pietsch et al., 2010; Benner & Krause, 2007; Benner et al., 2008) in Germany are necessary as semantic representations of design domains but have to be expanded to evaluate the compliance of a plan for sustainable planning (Flaxman, 2010). The necessary elements that a hybrid GeoDesign System (GDS) requires are described by ERVIN (2011). He mentions sixteen essential components knowing that additional to the technical evolution some shifts in working styles are necessary. However the inevitable complications remain the GeoDesign concept remains enormous potential to improve design and planning processes if new ways of interaction towards a process-driven planning and project implementation will be achieved (Tomlin, 2011; Stockman & von Haaren, 2010; Schwarz-v. Raumer & Stokman, 2011).

6. Outlook

The rapid technical evolution in combination with internet technologies (e.g. Web 2.0) offers a chance for more collaboration and participation. New hardware like smart phones or tablet pc's with integrated GNSS facilitate the development of location based services or location sensitive services. They can be used for collecting data by the public (e.g. species data) or to publish information in the context of public participation processes. Using augmented reality technologies alternative futures can be presented in the real spatial context to improve decision-making processes. While GIS moved from workstations to desktop pc Web technologies and mobile devices are arising. GIS on demand using cloud technologies will be the next step.

Taking technical evolution in consideration standardization and a qualified information management will get more and more relevant. Moving the planning cycle from a step-by-step framework to a more process-oriented one standardized data models are needed. A unified terminology as a base for developing scientific models is necessary as well. Research in new design methods and the integration of science in the decision-making process is needed as well as the discussion about required changes in teaching students.

7. References

Adriaensen, F., Chardon, J.P., De Blust, G., Swinnen, E., Villalba, S., Gulinck, H., Matthysen, E. (2003): The application of least-cost modelling as a functional landscape model. in: Landscape Urban Planning, 64 (4), S. 233-247

Al-Kodmany, K. (1999): Combining Artistry and Technology in Participatory Community Planning, in: Berkeley Planning Journal, 13, p. 28-36

Amler, K., Bahl, A., Henle, K., Kaule, G., Poschlod, P. & Settele, J. (Hrsg.) (1999): Populationsbiologie in der Naturschutzpraxis, Ulmer Verlag, Stuttgart, 336 S.

Appleton, K., Lovett, A. (2003): GIS-based visualization of rural landscapes: defining 'sufficient' realism for environmental decision-making, in: Landscape and Urban Planning, 65, p. 216-224

Arnold, V., Lipp, T., Pietsch, M., Schaal, P. (2005): Effektivierung der kommunalen Landschaftsplanung durch den Einsatz Geographischer Informationssysteme, in: Naturschutz und Landschaftsplanung, Heft 11/2005, S. 349

Benner, J., Krause, K.-U. (2007): Das GDI-DE Modellprojekt XPlanung – Erste Erfahrungen mit der Umsetzung des XPlanGML-Standards, in: Schrenk, M., Popovich, V., Benedikt, J. (Eds.): Real Corp 007 Proceedings, S. 379-388

Benner, J., Köppen, A., Kleinschmidt, B., Krause, K.-U., Neubert, J., Wickel, M. (2008): XPlanung – Neue Standards in der Bauleit- und Landschaftsplanung, in: Buhmann/Pietsch/Heins (Eds.): Digital Design in Landscape Architecture 2008, Wichmann Verlag, Heidelberg, p. 240-248

BfN (The Federal Agency for Nature Conservation) (2002): Landscape planning for sustainable municipal development, Leipzig, 24 S.

Bishop, I., Lange, E. (2005): Visualization in Landscape and Environmental Planning. Technology and Applications. Taylor & Francis, London/New York, 296 S., 2005

Bishop, I., Smith, E., Williams, K., Ford, R. (2010): Scenario Based Evaluation of Landscape Futures – Tools for Development, Communication and Assessment, in: Buhmann/Pietsch/Kretzler (Eds.): Digital Landscape Architecture 2010, Wichmann Verlag, VDE Verlag GmbH, Berlin and Offenbach, p. 296-312

Blaschke, T. (1997): Landschaftsanalyse und –bewertung mit GIS, Forschungen zur Deutschen Landeskunde, Heft 243, Trier, 320 S.
Blaschke, T. (1999): Habitatanalyse und Modellierung mit Desktop-GIS, in: Blaschke, T.: Umweltmonitoring und Umweltmodellierung, Wichmann Verlag, p. 259-274
Blaschke, T. (2003): Habitatmodellierung im Naturschutz: Unterschiedlich komplexe Modelle und deren Zusammenführung. In: Dormann/Blaschke/Lausch/Schröder und Söndgerath: Habitatmodelle: Methodik, Anwendung, Nutzen – Tagungsband zum Workshop 8.-10. Oktober 2003, Ufz-Berichte 9/2004, S. 135-140
BMV (Bundesministerium für Verkehr) (1998): Musterkarten für die einheitliche Gestaltung landschaftspflegerischer Begleitpläne im Straßenbau, Verlags-Kartographie, Alsfeld
Botequilha, L., Ahern, J. (2002): Applying landscape ecological concepts and metrics in sustainable landscape planning, in: Landscape and Urban Planning, 59, p. 65-93
Brandt, M. (2007): Nutzen und Einsatzschwerpunkte von Freiflächeninformationssystemen, in: Die Wohnungswirtschaft, Sonderheft Freiflächenmanagement, 4/2007, S. 32-33
Brail, R. (Ed.): Planning support systems for cities and regions, Cambridge, 312 p.
Buhmann, E., Pietsch, M. (2008a): Interactive Visualization of Flooding Impact of Selke River, Harz. in: Buhmann/ Pietsch/Heins (Eds.): Digital Design in Landscape Architecture, Herbert Wichmann Verlag, S. 152-162
Buhmann, E., Pietsch, M. (2008b): Interaktion mit digitalen Landschaften, Szenarien und Modellen. in: Garten+Landschaft Heft 03/2008, S. 36-39
Buhmann, E., Pietsch, M., Langenhaun, D., Santosh, C., Paar, P. (2010): Visualizing Boathouses of Dwejra Bay in Gozo, Malta for Access Through WebGIS Applications, in: Buhmann/Pietsch/Kretzler (Eds.): Digital Landscape Architecture 2010, Wichmann Verlag, VDE Verlag GmbH, Berlin and Offenbach, p. 406-414
Bundesamt für Naturschutz (Hrsg.) (2004): Empfehlungen zur Umsetzung des §3 BNatSchG „Biotopverbund“, Reihe Naturschutz und Biologische Vielfalt, Heft 2, Bonn-Bad Godesberg
Bunn, AG., Urban, DL, Keitt, TH. (2000): Landscape connectivity: a conservation application of graph theory, in: Journal Environmental Management, 59, S. 265-278
Busse, J., Dirnberger, F., Pröbstl, U. & Schmid, W. (2005): Die neue Umweltprüfung in der Bauleitplanung, 1. Auflage, Verlagsgruppe Hüthig Jehle Rehm GmbH, Heidelberg/München/Landsberg/Berlin, 316 S.
Calabrese, J. M., Fagan, W. (2004): A comparison-shopper’s guide to connectivity metrics, in: Front Ecol Environ, 2 (19), S. 529-536
Commission for Environmental Assessment (Eds.) (2006): Biodiversity in EIA & SEA – Voluntary Guidelines on Biodiversity-Inclusive Impact Assessment, Utrecht
Dangermond, J. (2009): GIS: Design and Evolving Technology, ArcNews, ESRI, Fall 2009
Dangermond, J. (2010): GeoDesign and GIS – Designing our Futures, in: Buhmann/Pietsch/Kretzler (Eds.): Digital Landscape Architecture 2010, Wichmann Verlag, VDE Verlag GmbH, Offenbach and Berlin, p. 502-514
Dembinsky, K. (2008): Die Kommunikation in gemeinsamen PLanungsprozessen der Straßen- und Landschaftsplanung aus Sicht eines Straßenplaners, in: Buhmann/ Pietsch/Heins (Eds.): Digital Design in Landscape Architecture 2008, Wichmann Verlag, Heidelberg, p. 281-286

Erstling, R. & Portele, C. (1996): Standardisierung graphischer Daten im Straßen- und Verkehrswesen. Teil 1 – Studie. – Forschung Straßenbau und Straßenverkehrstechnik 724, Bundesministerium für Verkehr, Abteilung Straßenbau, Bonn-Bad Godesberg.

Ervin, S., Hasbrouck, H. (2001): Landscape Modeling: Digital Techniques for Landscape Visualization, McGraw-Hill, 289 S.

Ervin, S. (2011): A System for Geodesign in: Buhmann/Ervin/Tomlin/Pietsch (Eds.): Teaching Landscape Architecture – Prelimenary Proceedings, Bernburg, S. 145-154

European Commission Environment DG (2002): Assessment of plans and projects significantly affecting Natura 2000 sites, Luxembourg

Flaxman, M. (2010): Fundamentals of Geodesign, in Buhmann/Pietsch/Kretzler (Eds.): Digital Landscape Architecture 2010, Digital Landscape Architecture 2010, Wichmann Verlag, VDE Verlag GmbH, Berlin and Offenbach, p. 28-41

Francica, J. (2012): GeoDesign Is About Collaboration and Process, DirectionsMagazine, http://www.directionsmag.com/articles/geodesign-is-about-collaboration-and-process/225065

Galk-DST (Hrsg.): Grünflächen-Management, Beckmann Verlag

Georgi, B. (2003): Die Umweltfolgenprüfung als Instrument zur Umsetzung der Biodiversitätskonvention, UVP-report 17 (3+4), S. 148-150

Georgi, B., Peters, W. (2003): National Expert Workshop: Further development of the draft guidelines for incorporating biodiversity-related issues into environmental impact assessment legislation and/or process and strategic environmental assessment, Berlin 2003

Gontier, M. (2007): Scale issue in the assessment of ecological impacts using a GIS-based habitat model – A case study for the Stockholm region, in: Environmental Imapct Assessment Review, 27, p. 440-459

Gontier, M., Mörtberg, U., Balfors, B. (2010): Comparing GIS-based habitat models for application in EIA and SEA, in: Environmental Impact Assessment Review, 30, p. 8-18

Groot de, R.S. (1992): Function of nature. Evaluation of Nature in Environmental Planning, Management and Decision Making, Wolters-Noordhoff

Guisan, A., Zimmermann, N.E. (2000): Predictive habitat distribution models in ecology, in: Ecol. Moel., 135, p. 147-186

Harms, B., Knaapen, J. P. and Rademakers, J. G. (1993): Landscape planning for nature restoration: comparing regional scenarios, in: Landscape Ecology of a Stressed Environment, p. 197–218.

Hendler, R. (2009): Biodiversität in der Umweltprüfung – Rechtliche Sicht, in: Umweltbundesamt (Hrsg.): Umwelt im Wandel – Herausforderungen für die Umweltprüfungen (SUP/UVP), Berichte 1/09, Berlin, S. 17-24

Hennig, S. Bögel, R. (2004): Multivariate Statistik als Grundlage zur Habitatmodellierung – Am Beispiel der Habitatnutzung der Gams (Rudicapra rudicapra) im Nationalpark Berchtesgaden, in: Z. Naturschutz und Landschaftsplanung, 36, p. 363-370

Heins, M., Pietsch, M. (2010): Fachtechnische Standards für die vorhabenbezogene Landschaftsplanung, Edition Hochschule Anhalt, Selbstverlag, S. 125

Hettwer, J. (2008): Objektkatalog für das Straßen- und Verkehrswesen – OKSTRA, in: Buhmann/ Pietsch/Heins (Eds.): Digital Design in Landscape Architecture 2008, Wichmann Verlag, Heidelberg, p. 234-239

Höhn, K. (2008): Monitoring in der Bauleitplanung, VDM Verlag Dr. Müller, Saarbrücken, 146 S.

Hunger, H. (2002): Anwendungsorientiertes Habitatmodell für die Helm-Azurjungfer aus amtlichen GIS-Grundlagendaten, in: Natur und Landschaft, 77, p. 261-265

Jessel, B., Tobias, K. (2002): Ökologisch orientierte Planung, Verlag Eugen Ulmer, Stuttgart, 470 S.

Jessel, B., Böttcher, M. & Wilke, T. (2009): Biodiversität in der Umweltprüfung, in: Umweltbundesamt (Hrsg.): Umwelt im Wandel – Herausforderungen für die Umweltprüfungen (SUP/UVP), Berichte 1/09, Berlin, S. 1-16

Jooß, R. (2003):Ermittlung von Habitatpotenzialen für Zielartenkollektive der Fauna – Expertensysteme und empirische Ansätze im Landschaftsmaßstab. In: Dormann/Blaschke/Lausch/Schröder und Söndgerath: Habitatmodelle: Methodik, Anwendung, Nutzen – Tagungsband zum Workshop 8.-10. Oktober 2003, Ufz-Berichte 9/2004, S. 151-166

Jooß, R. (2005): Planungsorientierter Einsatz von Habitatmodellen im Landschaftsmaßstab-Schutzverantwortung für Zielarten der Fauna. In Korn, H./Feit, U. (Bearb.) Treffpunkt Biologische Vielfalt V – wissenschaftliche Expertentagung an der Naturschutzakademie Insel Vilm 23.-27. August 2004, Hrsg. BfN

Kaule, G. (1991): Arten- und Biotopschutz, 2. Auflage, Eugen Ulmer Verlag, Stuttgart, S.519

Keitt, T.H., Urban, D.L., Milne, B.T. (1997): Detecting critical scales in fragmented landscapes, in: Conserv. Ecol., 1 (1), p. 15-16

Kleyer, M., Kratz, R., Lutze, B., Schröder, B. (1999/2000): Habitatmodelle für Tierarten: Entwicklung, Methoden und Perspektiven für die Anwendung, in: Z. Ökologie und Naturschutz 8: p. 177-194

Köppel, J., Peters, W., Wende, W. (2004): Eingriffsregelung – Umweltverträglichkeitsprüfung, FFH-Verträglichkeitsprüfung, Eugen Ulmer Verlag, Stuttgart, 367 S.

Krämer, B. (2008): Die Kommunikation in gemeinsamen Planungsprozessen der Straßen- und Landschaftsplanung aus Sicht eines Landschaftsplaners, in: Buhmann/ Pietsch/Heins (Eds.): Digital Design in Landscape Architecture 2008, Wichmann Verlag, Heidelberg, p. 287-301

Krause, K.-U. (2011): Stand der Einführung von XPlanung in Norddeutschland, in: Schrenk/Popovich/Zeile (Eds.): Proceedings Real Corp 2011, p. 1399-1403

Kretzler, E. (2002): Computer Visualization of Environmental Impacts, in: Buhmann/Nothhelfer/Pietsch (Eds.): Trend in GIS and Virtualization in Environmental Planning and Design, Wichmann Verlag, Heidleberg, p. 58-67

Kretzler, E. (2003): Improving Landscape Architecture Design Using Real Time Engins, – in: Buhmann/Ervin (Eds.), Trends in Landscape Modeling, Herbert Wichmann Verlag, Heidelberg, p. 95-101

Lambrecht, H., Peters, W., Köppel, J., Beckmann, M., Weingarten, E., Wende, W. (Bearb.) (2007): Bestimmung des Verhältnisses von Eingriffsregelung, FFH-VP, UVP und SUP im Vorhabensbereich, BfN-Skripten 216, Bonn-Bad-Godesberg

Lang, S., Blaschke, T. (2007): Landschaftsanalyse mit GIS, UTB Verlag, 404 S.

Lange, E. (1994): Integration of Computerized Visual Simulation and Visual Assessment in Environmental Planning, in: Landscape and Urban Planning, 30 p. 99-112

Lange, E. (2002): Visualization in Landscape Architecture and Planning, in: Buhmann/Nothhelfer/Pietsch (Eds.): Trends in GIS and Virtualization in Environmental Planning and Design, Wichmann Verlag, Heidelberg, p. 8-18

Lipp, T. (2007): Der Landschaftsplan Güstrow online, in: Naturschutz und Landschaftsplanung, 39 (1), p. 25-29

McHarg, I.L. (1969): Design with Nature, The Natural History Press, New York, USA

Nikolakaki, P. (2004): A GIS site-selection process for habitat creation: estimating connectivity of habitat patches. in: Landscape Urban Planning, 68, S. 77-94

Opdam, P., Foppen, R., Vos, C. (2002): Bridging the gap between ecology and spatial planning in landscape ecology, in: Landscape Ecology, 16, p. 767-779

Ozimek, A., Ozimek, P. (2008): Computer-Aided Method of Visual Absorption Capacity Estimation, in: Buhmann/Pietsch/Heins (Eds.): Digital Design in Landscape Architecture 2008, Wichmann Verlag, Heidelberg, p. 105-114

Paar,P. (2006): Landscape visualizations: Applications and requirements of 3D visualization software for environmental planning, in: Computers, Environment and Urban Systems, 30, p. 815-839

Paar, P., Malte, C. (2007): Earth, Landscape, Biotope, Plant. Interactive Visualization with Biosphere3D, in: Schrenk/Popovich/Benedikt (Eds.): REAL CORP 007 Proceedings, Vienna, 207-214

Pascual-Hortal, L., Saura, S. (2006): Comparison and development of new graph-based landscape connectivity indices: towards the priorization of habitat patches and corridors for conservation. In: Landscape Ecology, 21 (7), S. 959-967

Pascual-Hortal, L., Saura, S. (2007): Impact of spatial scale on the identification of critical habitat patches for the maintenance of landscape connectivity. in: Landscape and Urban Planning, 83/2007, S. 176-186

Penko Seidel, N., Cof, A., Breskvar Zaucer, L., Marusic, I., (2010): The Problem of Large Protected Areas in the Process of Planning: A Case Study in the Municipality Ig, Slovenia, in: Buhmann/Pietsch/Kretzler (Eds.): Digital Landscape Architecture 2010, Wichmann Verlag, VDE Verlag GmbH, Berlin and Offenbach, p. 154-162

Pietsch, M., Buhmann, E. (1999): Auf dem Weg zur GIS-gestützten Landschaftsplanung – Die Hürden in der Praxis am Beispiel des Landschaftsplans der Verwaltungsgemeinschaft Sandersleben, in: Strobl/Blaschke/Griesebner (Hrsg.): Beiträge zur AGIT 1999, Herbert Wichmann Verlag, Heidelberg, S. 392-398

Pietsch, M. (2007): Softwarelösungen im Freiflächenmanagement, in: Die Wohnungswirtschaft, Sonderheft Freiflächenmanagement, 4/2007, S. 30-31

Pietsch, M., Schmidt, D., Richter, K. (2007): Ansatz zur Integration von Habitateignungsmodellen in die FFH-Managementplanung am Beispiel der

Flussperlmuschel. in: Strobl/Blaschke/Griesebner: Angewandte Geoinformatik 2007 – Beiträge zum 19. AGIT-Symposium Salzburg, Wichmann Verlag, S. 571-576

Pietsch, M., Heins, M. (2008): Qualifizierung und Optimierung der Landschaftsplanung durch Standardisierung und Informationsmanagement am Beispiel des OKSTRA®, in: Buhmann/Pietsch/Heins (Eds.): Digital Design in Landscape Architecture 2008, Herbert Wichmann Verlag, Heidelberg, p. 321-336

Pietsch, M., Krämer, M. (2009): Analyse der Verbundsituation von Habitaten und –strukturen unter Verwendung graphentheoretischer Ansätze am Beispiel dreier Zielarten, in Strobl/Blaschke/Griesebner (Hrsg.): Angewandte Geoinformatik 2009, Herbert Wichmann Verlag, Heidelberg, S. 564-573

Pietsch, M., Heins, M., Buhmann, E., Schultze, C. (2010): Object-based, process-oriented and conceptual Landscape models for standardizing landscape planning procedures in the context of road planning projects, in: Buhmann, Pietsch, Kretzler (Eds.): Digital Landscpae Architecture 2010, Wichmann Verlag, VDE Verlag, Berlin and Offenbach p. 62-68

Pietsch, M., Spitzer, S. (2011): Landschaftsbildvisualisierung im Hochwasserrisikomanagement unter Verwendung von open source Software, in: DWA (Hrsg.): GIS und GDI in der Wasserwirtschaft – Die Hochwasserrisikomanagementrichtlinie im Fokus von GIS und GDI, Selbstverlag, S. 1-16

Ray, N., Lehmann, A., Joly, P., (2002): Modelling spatial distribution of amphibian populations: a GIS approach based on habitat matrix permeability. in: Biodivers. Conserv. 11 (12), S. 2143-2165

Reck, H., Hänel, K., Huckauf, A. (2010): Nationwide Priorities for Re-Linking Ecosystems: Overcoming Road-Related Barriers – Summary, Leipzig, 23 p.

Richter, A. (2009): Öffentlichkeitbeteiligung durch den Einsatz von Web-GIS-Lösungen – Praxisbeispiel "Beteiligung-Online" der Landes- und Regionalplanung Mecklenburg-Vorpommerns, Vortrag im Rahmen des 1. Geofachtags Sachsen-Anhalt am 18.02.2009 in Bernburg, http://www.netzwerk-gis.de/files/richter_oeffentlichkeitsbeteiligung_2.pdf

Riedel, W., Lange., H. (Hrsg.) (2001): Landschaftsplanung, Spektrum Akademischer Verlag, Heidelberg – Berlin, 364 S.

Riedl, U., Taeger, S. (2009): GIS-basierte Habitatmodelle für das Biosphärenreservat Spreewald – Ergebnisse eines Forschungsvorhabens, in: Natur und Landschaft, 84 (4), p. 145-152

Rudner, M., Schadek., U., Damken, C. (2003): Habitatmodelle und ihre mögliche Integration in die Planungspraxis-ein Diskussionsbeitrag. In: Dormann/Blaschke/Lausch/Schröder und Söndgerath: Habitatmodelle: Methodik, Anwendung, Nutzen – Tagungsband zum Workshop 8.-10. Oktober 2003, Ufz-Berichte 9/2004, p. 167- 171

Saura, S., Pascual-Hortal, L. (2007): A new habitat availability index to integrate connectivity in landscape conservation planning: Comparison with existing indices and application to a case study. in: Landscape and Urban Planning, 83/2007, S. 91-103

Säck-da Silva, S. (2007): Visualisierung und Interaktivität: wie GIS die Öffentlichkeitsbeteiligung unterstützt, in: Haustein/Demel (Hrsg.): GIS in der Stadt- und Landschaftsplanung, Heft 164, Universität Kassel, S. 87-96

Schauerte-Lücke, N. (2008): Informations- und Datenmanagement in gemeinsamen Planungsprozessen der Straßen- und Landschaftsplanung, in: Buhmann/Pietsch/Heins (Eds.): Digital Design in Landscape Architecture 2008, Herbert Wichmann Verlag, Heidelberg, p. 302-309

Schwarz-v. Raumer (2011): GeoDesign – Approximations of a catchphrase in: Buhmann/Ervin/Tomlin/Pietsch (Eds.): Teaching Landscape Architecture – Prelimenary Proceedings, Bernburg, p. 106-115

Sheppard, S., Shaw, A., Falnders, D., Burch, S. (2008): Can Visualisation Save the Worlds? – Lessons for Landscape Architects from Visualizing Local Climate Change, in: Buhmann/Pietsch/Heins (Eds.): Digital Design in Landscape Architecture 2008, Herbert Wichmann Verlag, Heidelberg, p. 2-21

Spangenberg, J.H. (2007): Biodiversity pressure and the driving forces behind, in: Ecological Economics, p. 146-158

Steinitz, C. (2010): Landscape Architecture into the 21st Century – Methods for Digital Techniques, in: Buhmann/Pietsch/Kretzler (Eds.): Digital Landscape Architecture 2010, Wichmann Verlag, VDE Verlag GmbH, Berlin and Offenbach, p. 2-26

Schaller, J., Mattos, C. (2010): ArcGIS ModelBuilder Applications for Landscape Development Planning in the Region of Munich, Bavaria, in: Buhmann/Pietsch/Kretzler (Eds.): Digital Landscape Architecture 2010, Wichmann Verlag, VDE Verlag GmbH, Berlin and Offenbach, p. 42-52

Schmidt, D. (2007): Ein wissensbasiertes Habitateignungsmodell für die Flussperlmuschel (*Margaritifera margaritifera L.*) im Rahmen der FFH-Managementplanung, Diplomarbeit an der Hochschule Anhalt (unveröffentlicht)

Schröder, B. (2000): Habitatmodelle für ein modernes Naturschutzmanagement in Gnauck, A.: Theorie und Modellierung von Ökosystemen – Workshop Kölpingsee 2000, Aachen

Schroth, O. (2010): Tools for the understanding of spatio-temporal climate scenarios in local planning: Kimberley (BC) case study, University of British Columbia, Vancouver

Schultze, C., Buhmann, E. (2008): Developing the OKSTRA Standard for the Needs of Landscape Planning in Context of Implementation for Mitigation and Landscape Envelope Planning of Road Projects, in: Buhmann/Pietsch/Heins (Eds.): Digital Design in Landscape Architecture 2008, Wichmann Verlag, Heidelberg, p. 310-320

Schwarz-v. Raumer (2011): GeoDesign – Approximations of a catchphrase in: Buhmann/Ervin/Tomlin/Pietsch (Eds.): Teaching Landscape Architecture – Prelimenary Proceedings, Bernburg, S. 106-115

Stockman, A., von Haaren, C. (2010): Integrating Science and Creativity for Landscape Planning and Design of Urban Areas, in: Weiland/Richter (Hrsg.): Urban Ecology – a global Framework, Oxford, Blackwell Publishing

Taeger, S. (2010): GIS and Hydrological Models as Tools for Habitat Modelling in Alluvial Plains, in: Buhmann/Pietsch/Kretzler (Eds.): Digital Landscape Architecture 2010, Wichmann Verlag, VDE Verlag GmbH, Berlin and Offenbach, p. 370-378

The Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (Eds.) (1998): Landscape Planning, Bonn

Theobald, D.M. (2006): Exploring the functional connectivity of landscapes using landscape networks. in: Crooks, K.R., Sanjayan, M. (Eds.): Connectivity Conservation, Cambridge University Press, New York, S. 416-443

Tischendorf, L., Fahrig, L. (2000): On the usage and measurement of landscape connectivity. in: Oikos 90 (1), S. 7-19

Tittmann, P. (2003): Graphentheorie: eine anwendungsorientierte Einführung, München

Tomlin, C.D. (2011): Speaking of Geodesign in: Buhmann/Ervin/Tomlin/Pietsch (Eds.): Teaching Landscape Architecture – Prelimenary Proceedings, Bernburg, S. 136-144

Umweltbundesamt (Hrsg.) (2008): Leitfaden zur Strategischen Umweltprüfung (Langfassung) – Forschungsvorhaben 206 13 100, Berlin, 52 S.

Urban, D., Keitt, T. (2001): Landscape connectivity: A graph –theoretic perspective. in: Ecology 82 (5), 1205-1218

Urban, D.L., Minor, E.S., Treml, E.A., Schick, R.S. (2009): Graph models of habitat mosaics, Ecol. Lett., 12 (3), p. 143-157

von Haaren, C. (Hrsg.) (2004): Landschaftsplanung, Eugen Ulmer Verlag, Stuttgart, 528 S.

Warren-Kretzschmar, B., Tiedtke, S. (2005): What Role Does Visualization Play in Communication with Citizens? – A Field Study from the Interactive Landscape Plan, in Buhmann/Paar/Bishop/Lange (Eds.), Trends in Real-Time Landscape Visualization and Participation, Herbert Wichmann Verlag, p. 156-167

Weiers, S., Bock, M., Wissen, M., Rossner, G. (2004): Mapping and indicator aproaches for the assessment of habitats at different scales using remote sensing and GIS methods, in: Landscape and Urban Planning, 67, p. 43-65

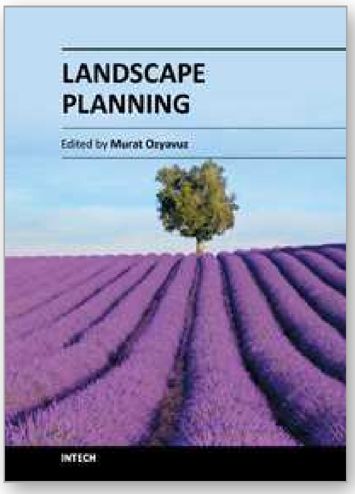
Wiegleb, G. (2009): Methodik der Erfassung und Bewertung von Biodiversitätsschäden aus ökologischer Sicht, in: Knopp, L., Wiegleb, G. (Hrsg.): Der Biodiversitätsschaden des Umweltschadensgesetzes, Schriftenreihe Natur und Recht, Band 11; Springer Verlag, Dordrecht Heidelberg London New York, S. 29-148

Wissen, U. (2009): Virtuelle Landschaften zur partizipativen Planung – Optimierung von 3D Landschaftsbildvisualisierungen zur Informationsvermittlung, IRL-Bericht 5, vdf Hochschulverlag an der ETH Zürich, 242 p.

Wolfrum, S. (2006): Theorie und Methodik der Quantifizierung von Biotopverbundfunktion – Landschaftsgraphen als Alternative zu Landschaftsstrukturmaßen bei der Erfassung eines funktionalen Zusammenhangs in der Landschaft. in: Kleinschmit, B., Walz, U. (Hrsg): Landschaftsstrukturmaße in der Umweltplanung, Schriftenreihe der Fakultät für Architektur Umwelt Gesellschaft, Band 19, Berlin, S. 73-83

Zetterberg, A., Mörtberg, U., Balfors, B. (2010): Making graph theory operational for landscape ecological assessments, planning and design, in: Landscape and Urban Planning, 95, S. 181-191

Zölitz-Möller, R. (1999): Umweltinformationssystem, Modelle und GIS für Planung und Verwaltung? – Kritische Thesen zum aktuellen Stand der Dinge, in: Blaschke, T. (Hrsg.): Umweltmonitoring und Umweltmodellierung, Herbert Wichmann Verlag, Heidelberg, p. 183-190



Landscape Planning
Edited by Dr. Murat Ozyavuz

ISBN 978-953-51-0654-8
Hard cover, 360 pages
Publisher InTech
Published online 13, June, 2012
Published in print edition June, 2012

Landscape architecture is the design of outdoor and public spaces to achieve environmental, socio-behavioral, and/or aesthetic outcomes. It involves the systematic investigation of existing social, ecological, and geological conditions and processes in the landscape, and the design of interventions that will produce the desired outcome. The scope of the profession includes: urban design; site planning; town or urban planning; environmental restoration; parks and recreation planning; visual resource management; green infrastructure planning and provision; and private estate and residence landscape master planning and design - all at varying scales of design, planning and management. This book contains chapters on recent developments in studies of landscape architecture. For this reason I believe the book would be useful to the relevant professional disciplines.

INTECH
open science | open minds

InTech Europe
University Campus STeP Ri
Slavka Krautzeka 83/A
51000 Rijeka, Croatia
Phone: +385 (51) 770 447
Fax: +385 (51) 686 166
www.intechopen.com

InTech China
Unit 405, Office Block, Hotel Equatorial Shanghai
No.65, Yan An Road (West), Shanghai, 200040, China
中国上海市延安西路65号上海国际贵都大饭店办公楼405单元
Phone: +86-21-62489820
Fax: +86-21-62489821