Urban Calculation for an optimized Land Management

Theo KÖTTER and Domink WEISS, Germany

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SUMMARY

Within urban land management for new housing or comercial areas, new infrastructure facilities and for inner urban renewal districts a broad range of stakeholders introduce individual project-related demands in terms of costs and benefits. To achieve a sustainable urban development and acceptance by the stakeholders, the public as planning and controlling institution of land use and infrastructure should analyze alternative projects quite thoroughly. Technical devices and tools, like urban calculation models and decision support systems (DSS) are developed for making this process more transparent, rational and reasonable. The aim of the paper is to conceptualize functional and technical requirements of a proposed state of the art DSS. Therefore the content of various existing DSS models in terms of considered costs and benefits were evaluated. The costs and benefits of urban development are structured subject to the life cycle of land use and to the related infrastructure. Furthermore we analyze in a stakeholder view the main target groups and identify which kind of decision is supported by the existing DSS. The life cycle assessment approach allows addressing topical challenges for planning like the redevelopment and adjustment of obsolete infrastructure and brown fields. In doing so, an evaluation scheme focused on relevance and applicability is developed.
Based on this examination the paper provides best practice characteristics, functional requirements and recommendations with regard to form and content of DSS for urban development.

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1. INTRODUCTION

Urbanized area can be seen as the unique product of a city as economic unit (Hoffmann Axthelm (2010). Public planning means to provide a sufficient and fair allocation of the public good urbanized area with infrastructure that matches with the individual interests of society´s different stakeholders. Measures and actions to reach this target of sustainable development for a city or region are ideally codified in integrated plans and concepts (Franke/Strauss 2010; German Association of Cities 2004).

Normative decisions in this field have to be valued quite well by forecasting the effects and outcomes of intended measures:

Every settlement activity provides benefits and satisfies human needs like living, mobility, production and consumption of goods, services or leisure activities. The expenses for producing these benefits consist of costs construction, maintenance and financing capital as well as natural resources like land, energy and construction material. Costs and benefits occur not only at the time of decision or realization of the development project but over a long time and by far not all the costs and benefits can be properly accounted to the public or the private sector, not to mention the bunch of intangible and non-monetary effects. Among these intangibles are changes of the demographic situation, cultural imprint of land use, local identification and ecological feedback reactions or opportunity costs due to the limitation of natural resources and ecosystem services.

Furthermore, benefits and costs are site-specific. They vary between different locations, within an urban region and they are dependent on the form of settlement. This multitude of influencing factors outputs and stakeholders increases the demand for technical tools for the mediation and decision support within planning processes (Parker et al. 2002; Voinov & Bousquet 2010). There are different methodical approaches. Some approaches like cost-benefit analysis have a broader scope while others like fiscal impact analysis have a more narrow perspective.

The request for tools supporting collaborative decisions has increased over the last few years (Joerin et al. 2001). Institutions such as the Academy for Spatial Research and Planning (2008) or the German Council for Sustainable Development (2007) argue for a greater use of cost-benefit analyzes in planning and development of urban infrastructure. Also the NCGIA (National Centre for Geographical Information and Analysis) promoted an initiative for spatial decision support systems (Densham et al. 1995, Joerin et al. 2001).

Despite the importance that is attributes to DSS in scientific literature the implementation in practical planning is still quite limited. It seems essential to enhance these systems for rational decision making and supporting sustainable development. For this purpose we derive in this paper a structure of cost and benefits of land use and urban development as frame for a DSS. We focus on cost transparency of economic measures because monetary outcomes are different depending of a stakeholder´s viewpoint or situation within the process of urban development. As result we propose a life cycle approach to disentangle the complex relations

and interactions of urban processes into accountable figures of costs and benefits for different stakeholders. The life cycle approach allows furthermore addressing the challenge of redevelopment and adjustment of infrastructure in mature cities.
The theory-section (chapter 2) of the paper gives a definition of DSS and analyzes the decision problem of urban development by identifying mayor challenges for sustainable infrastructures and the interests of the main stakeholders.
In chapter 3, we describe the underlying methodology for the case-study-based examination of existing economic DSS. The framework is based on the life cycle of land use and related infrastructure which consists of four phases: “Monitoring & Adaptation”, “Planning & Design”, “Construction & Establishment”, and “Operate and Maintain”. Cost and benefits of each stakeholder group can be allocated within this concept. This analytic framework is applied in a comparative case study of several existing tools and models in section 4. In the results-section of this paper (chapter 5) we derive best practice characteristics, functional requirements and recommendations for the new and further development of new and enhanced DSS with regard to content output and applicability.

2. THEORY: DEFINITION AND PURPOSE OF A DSS FOR URBAN DEVELOPMENT

A decision support system is a computer-based tool designed to give assistance in determining and evaluating alternative courses of action. Systems of this kind had been developed since the 1970 in all fields of business and public management. A DSS analyzes relevant raw data with advanced statistical methods to extract meaningful, values about the alternatives and narrows down the alternatives of development by applying methods based on decision theory. Its objective is facilitation of 'what if' analysis and not replacement of a manager's judgment (Businessdicionary).
In the context of urban planning and real estate development decision support systems provide current information and forecasts about the city structure as an economic and ecologic system of human, technical, and natural interaction. DSS can help to avoid wrong decisions about land use which can be harmful as they can lead to adverse welfare effects in a city. More than in other economic and administrative areas computerized information and analysis for decision support in urban planning have to be spatial. A lot of efforts have been made to combine Geographic information Systems (GIS) with Multi Criteria Decision Analysis (MCDA) (Jankowski 1995, Laaribi et al. 1996).
Next to the integration of geographic software tools (GIS) into a DSS the integration of expert knowledge into knowledge based spatial decision support systems (KBSDSS) has been proposed as an advanced approach to cope with the complexity of environment in business and organizational-making activities (Zhu et al 1998). To model the dynamic relationship between economic use of resources and the environmental processes of the ecosphere a lot of methods and theories of integrated assessment have been applied (e.g. Jakeman et al., 2006). The need for integrated assessment and modeling is vibrantly stressed in the literature because current environmental and social challenges are complex and intertwined by nature, and global in extent (e.g. Parker et al., 2002: 210; McIntosh et al. 2011: 1390). The integrative task of a DSS for land use development and urban planning is to describe these spatial relations and translate the results of analysis into monetary or at least quantitative figures.
Integrated urban management consider different policy fields and requirements of sectoral

planning authorities under limited financial, natural and social resources for spatially and temporally balanced decisions. Furthermore the process of integrated planning and city management is driven by urban megatrends and macroeconomic conditions, like demographic development, structural change, fiscal situation and technologic innovation. The following aims and political goals frame the requirements that have been frequently addressed by DSS for urban development.

i) Fiscal Crisis and Economic transparency:

A DSS should help to improve economic transparency with a profound monitoring of all costs connected with urban development. If information about invest and follow-up costs and revenues during the life cycle of technical and social infrastructure are blurred or insufficient planners make wrong decisions.
Lack of rentability and financial viability of a development leads to costly adjustments or even vacancy. Inefficient urban structures occur, if real costs are frequently underestimated or neglected by municipal planners. Often, municipalities are stuck within a competition to attract new residents by providing new settlement areas plus the related infrastructure. The problem is that limited communal budgets often do not allow a sufficient maintenance of technical and social infrastructure. The discussion on urban sprawl in the United States of America and related cost of municipal services is not new (Wheaton & Schussheim, 1955). A lot of tools have been developed for the calculation of residential development and studies about the costs of community services or the economic impact of conversion of open space into built land (Knaap & Knauss, 2001; Coupal & Seidl 2003; Kelsey, 1997; Snyder & Fergason, 1994). In Germany, Reidenbach (2007) carried out a fiscal analysis for new urban developments and finds in many cases a fiscal los instead of a profit for the fiscals. But not only have the cost of new greenfield developments to be assessed. Infill or Brownfield developments use to be even more complex and risky projects due to the clearing and demolition cost and the effects of new structures on the neighboring area.

ii) Redevelopment for reduced land consumption:

The recycling of urban land and the revitalization of inner city locations becomes more important. One major finding of research about the cost of development is that density of settlement in a city region is a very sensitive driver of cost efficiency. In most cases, new settlement development causes new infrastructure and more traffic. Therefore land use causes new invest and follow-up costs. The high correlation between land consuming sprawl and cost for infrastructure is used as an argument to save natural land resources e.g. for agriculture (American Farmland Trust 1993, 2001).The aspirations to reduce land consumption significantly set by the German government (Germany Council of Sustainability 2007) demand a smart integration of a profound infrastructural concept within the planning process. For an effective reduction of land consumption and an economic reasonable land use, development decisions should consider the question of the technical availability and quality of existing infrastructure and the spatial adjusting of new settlements to that. The questions of expenses and revenues are much more relevant for decision-making of different stakeholders. Therefore various economic assessment models and decision support systems with different methods exist for the purpose of creating cost transparency in the area of residential and commercial settlement (Preuß&Floeting 2009, 159).

iii) Demographic change, obsolete infrastructure and vacancy in mature cities:

Although bricks and concrete are physically quite durable housing and urban infrastructure age. Without regard to operation cost build structures usually have to be replaced or renovated after one or two generations. Shrinking demand due to economic transformation and demographic change speed up this process and can lead to blight and vacancy which affects negatively the image of a neighborhood on the one hand and increases segregation and social imbalances on the other. Another focus on the relation of infrastructure and demographic change was put by scientists because efficiency and effectivity of public infrastructure is offended especially in declining areas (Moss, 2008; Haug / Deilman 2008). A third strand of literature addresses the problem of deferred maintenance. The problem is that fiscal stress makes it impossible to invest in necessary renovations of infrastructure. These studies recommend sustainable arrangements of funding, pricing and management of infrastructure (Pagano 2011, Lewis 1991).

In fact municipalities have to carefully assess rentability and financial viability of development projects in the long-term and to monitor the capacity utilization of the existing infrastructure at operating. Gathering and processing information about urban resources, demands and functions help to identify changes in efficiency. This knowledge should help to limit the fiscal problems by proactive land management and reorganization of infrastructure. This holistic approach of constant monitoring of is a main feature in the concept of life cycle assessment where all economic and environmental impact during the technical lifetime of a product or serve is analyzed (Reap et al 2008).

iv) Participation and stakeholder orientation

Planning culture and urban development paradigms often have been criticized and are changing over time due to the trends of society (Albers 1993). Since pluralism and fragmentation of society does not fit to technocratic decisions and formalized procedures of participation in the planning process people often oppose against urban projects. Recognizing the active role of stakeholders the concept of collaborative planning forms a new quality of participation (Healey 1997). Also for DSS as technical tools it is getting more and more important to model the various interests of different stakeholders of a project and a lot of different methods and approaches how to make it have to be discussed (Voinov & Bousquet, 2010: 1268).

The decision problem, the public planner has to solve is a balancing act between limited public budgets, technical and legal requirements but also between the manifold claims and interests of stakeholder groups.

For the reason of feasibility the stakeholders can be divided into three interest groups (Table 1). This classification which is quite simplifying because there are different lifestyles, peer groups, political attitudes and individual interests within each stakeholder groups but it is in accordance with typical roles within the process of urban development.

Table 1: Main stakeholder groups of land use planning

Stakeholder	Intention within the planning process	Costs of infrastructure	Benefits of infrastructure
Public Planners	Responsible for providing space for housing and infrastructure as well as a livable environment at bearable cost (Bökemann 1982, 328).	Maintenance and operating cost of roads sewer,	Spillover effects, Follow-Up investments Urban growth Tax income
Residents	Chose best location by moving. Need information for proper valuation of new developments in their neighborhood.	Transportation and Commuting costs. User fees Taxes Emission cost	Accessibility, Better life quality Precondition for economic activity and jobs
Landlords and investors	Risk takers that are providing capital and land.	Investment fees Taxes Compensations	Precondition for Property sales Rent revenues

Compilated by author

Public planners and the local government as their employer and elected representative form the first important group. For simplification also the authorities for public services like municipal utility companies belong to this group, which is the natural leader of infrastructure projects and urban development strategies due to its sovereign legitimation.

Residents which are households and firms search for information to value and comment locations and new developments in their neighborhood. To organize a coherent spatial structure of town and to create locations according to the preferences and the demand of households and firms participation in planning process is getting more important.

The third stake holder group are the landlords and investors, which are key actors in the development processes because they bring in financial capital and decide whether they take the chance to develop a site or not after valuing the risks and rentability of the development project.

3. METHODOLOGY

In this section we derive a framework of an infrastructure life cycle assessment to structure the requirements and important contents of an optimal DSS that incorporates the challenges for urban development described in the latter section. This framework can be used firstly to evaluate existing planning support systems and secondly to define the requirements for the development of an advanced planning support system.

Life Cycle Assessment Processes are originally ecologic motivated quality management and product development approaches (Hauschild&Wenzel 1990) and codified in several standardizations (ISO 14041 – 14044). Transferred in the context of cities and infrastructure the lifecycle view addresses several connected problems:

It enhances cost transparency as it provides a good separation between singular and current effects and shows on a symbolic timeline the dates when decisions are made and effects occur. This helps to comprehend and to communicate the manifold expenses connected with the extension of social and technical infrastructure due to Greenfield development land. The long-term view of the life cycle approach allows focusing not only on the development of urban land but also the operation and renovation of related infrastructure systems. Information about obsolete infrastructure or about the deferred maintenance of infrastructure gives signals to redevelop existing location according to the political goal of reduced land consumption. The life cycle approach incorporates the fact that infrastructure projects are very durable and partly irreversible investments. It is quite likely that infrastructure facilities have to be adjusted to higher or lower capacity or to different use than originally planned. The relationship to economic up- and downswings makes and the influence of demographic development on the performance and efficiency of settlements and related infrastructure show that a deterministic assessment of urban projects have to be reviewed and updated with new data.

Continuous monitoring of the efficiency or frequent assessments if the infrastructure and housing supply of the city is congruent with the needs of current and expected population supports decisions about the adjustment of infrastructure due to modified demands (e.g. reduced user-numbers due to demographic change)

Therefore we propose a Life Cycle Assessment of infrastructure which can deal with estimating and controlling costs and revenues in different stages of project life as well as monitoring and recognizing changes of needs and demand.

It is quite convincing that the outputs that should help city managers and planners as well as developers to decide about development projects have to be quantitative and especially economic key figures. But potential residents chose their location choice not only because of monetary considerations. Distances to work, shopping and leisure amenities image of the neighborhood and the quality of schools play an important role.

A transparent DSS should be able to inform about the relevant topics and interests of all stakeholders. The Life Cycle approach helps to focus in our specification on decision relevant economic outputs of the DSS but at the same time not ignore the manifold non-monetary information about preconditions and that has to be gathered to generate path dependent cost drivers and relevant outputs in another moment during the course of the development project.

To derive the relevant measures of interest the costs and benefits of the involved stakeholders will be positioned systematically in a matrix of stakeholder groups and phases of the life cycle.

According to the methodology of life cycle assessment four main phases of the infrastructure life cycle can be identified that are displayed in figure 2. The scheme presents relevant features and questions as well as costs and benefits of urban development projects, which are attributable to the different phases.

In a broader sense the infrastructure life cycle includes not only the time span in which it physically exists, but also phases of monitoring, planning and design. Indeed, the latter phases are not necessarily connected with costs and benefits, but are important for gathering information to optimize the efficiency of urban infrastructure.

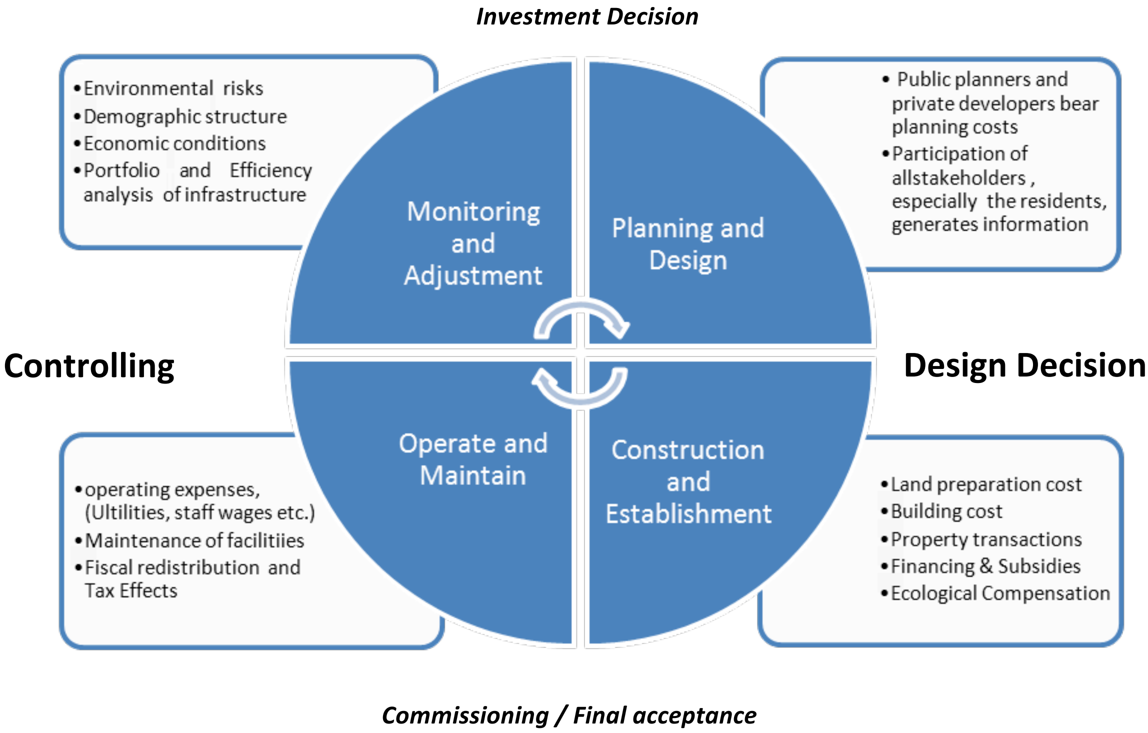

Figure 1 Expenses and Revenues along the Life Cycle of Land Use and related infrastructure

Planning and Design

Before physical realization of an urban development project e.g. the conversion of green land, infill within urban land or revitalization of brown land planning and design is needed to quantify the demand for new settlements and to find out the right locations for different functions (e.g. residential, commercial, shopping zones). This is the time to estimate and assess the expenses and revenues of different alternatives and to and to decide what respectively whether to develop or not. Furthermore this phase offers the great opportunity to influence the total costs of a project. For this purpose the public planner needs to precast all potential cost drivers in the following phases. With better information about economic, social and environmental conditions and an estimation of costs and benefits a smarter infrastructure can be realized. The participation of stakeholders like citizens, local firm or other institution of society like churches, lobby groups and authorities of adjacent territorial units is a part of this analysis to get better information about the appropriate concept and design.

We state that in this phase an urban project do not cause any costs than the planning process itself. This include the cost for planning and analysis services that are usually outsourced to consultants and private engineering companies as well as the workload of the responsible sectoral authorities. Depending on the arrangement the stakeholder group of public planners and developers bear different shares of the planning cost.

Construction and Establishment

Construction and establishment is not a single event but a phase that takes several years. In this investment-phase of the life cycle usually a big initial payment is essential to set up the infrastructure of a new urban development.

This and productions typical costs categories are the acquisition and allotment of land and the

construction of infrastructure including local streets, sewers and utility lines for electricity and water and maybe gas.
Additionally urban green spaces as parks, playgrounds and compensation for ecologic impacts of the development are costly and might differ between the location and quality. Another other big block of costs for land and construction is connected with social infrastructure. Most important public social facilities are playgrounds, schools, nursery and kindergarten facilities as well as sports grounds or public gymnasiums. Controlling, consulting and marketing of the development project cause additional costs.
While the costing of network infrastructure is very strong correlated with the density and structure of the settlement, it is much more difficult to find typical cost standards per flat or per ha of urban land for social infrastructure. The reason is that the need for new schools or kindergartens is not only dependent from the estimated amount of new inhabitants but also the demographic structure, and capacity of existing facilities.
Revenues that can be attributed to this phase are in the first place development charges for local public infrastructure. Depending from the initial situation of ownership there are revenues from the sale of lots or buildings. Also subsidies and funding are revenues that are usually attributed to the construction.

Operate and Maintain

Costs for operations and maintenance should be presented separately from investment and construction cost cause their origin is the not the construction, but the existence of the infrastructure. Nevertheless this following-cost could be analyzed simultaneous during the planning phase for the whole lifetime of the facility because traditional planning theory and experience of real estate development practitioners suggest that optimal planning and design might influence these costs significantly more than subsequent modifications (Dunham 1958; Girmscheid 2010).
Among the operation costs of a social facility are expenses for energy water sewerage, waste collection fees etc. Further cost drivers are staff wages as well as cleaning, security and maintenance of buildings, outside facilities, public green spaces and playgrounds.
The frequency of these periodical costs differs from monthly payments for staff salaries or mortgages and annual depreciation up to restorations and replacement of equipment with larger time lag. For simplicity it might be useful to sum up them to an annuity.
User fees, taxes and findings for municipal financial equalization are frequent revenues that cover costs during the life time of the infrastructure. However, a prognosis of these revenues is usually based on very vague assumptions about the demographic and economic development of the inhabitants and users of the infrastructure.

Monitoring and Adaptation

Even with rational planning an infrastructure investment can lose its intended function quite early. That means the duration of the lifecycle is not deterministic, but can be shorter or longer than expected. Economic development or structural and technological change can make locations obsolete. Vacancy, underemployment or missing supply in other urban areas or service sectors indicates the need for counteractive measures or an adaptation of infrastructure. To plan the urban renewal processes cities need to know not only a lot about the spatial development of population and economic activities, but also about the status quo, the capacities and qualities of the different existing facilities and networks. Efficiency and

performance analysis indicates whether the current supply of infrastructure still matches with current demand or whether modifications are needed. Permanent monitoring provides this knowledge for an optimal management of local public infrastructures. Generally the planning tasks and the set of information that is needed for a decision about adaption and renewal is the similar like in the first phase of planning and design. Indeed if an infrastructure is removed or replaced by another one the restart of the lifecycle is located at the transition of both phases. This similar need for information at the beginning and the end of the lifecycle emphasizes the importance of a monitoring function within a DSS tool for good governance of Land Use processes.
In the following chapter we derivate important contents as well as functional and technical requirements for an optimized decision support system (DSS) for land use management and infrastructure investment valuation.

3.1 An optimal spatial decision support system

This lifecycle model of infrastructure serves as guideline for the development of the DSS to identify costs and benefits of land use. The consequence from this idea is that a DSS should provide information for two stages of decision making which mark roughly the transition points between the lifecycle phases (fig. 1).

(i) Investment Decision

At this level of strategic planning the DSS should collect and provide information about demographic and social preconditions to analyze demand for public infrastructure and information about natural resources and risks and cost structures of potential development sites and the existing infrastructure. This information can be condensed to decisions about the location of new development or redevelopment of urban land or the adjustment of related infrastructure.

(ii) Design decision

The task at this level of decision is to precast the expected cost and benefits of possible development variants and to choose the optimal alternative. The calculation at this step should include costs for planning, construction and operating as well as the revenues and benefits for the different stakeholders.

After the design decision the responsibility is shifted to the technical execution by building companies which are controlled by architects and managing supervisors. With completion the responsibility for the project (buildings or infrastructure) shifts further to the sectoral authorities and operating companies (e.g. water or energy supplier, public transport company, school authority). The focus of the operators is related to the physical infrastructure itself and does not question the infrastructure on the whole.
The management tasks of approval for operation and controlling are related to the construction and the operation of the infrastructure show again the path dependency of within the infrastructure lifecycle. Strictly spoken they are necessary actions as effects of the earlier investment and design decisions.

Due to the sectoral expertise in the different fields of infrastructure the DSS for urban development cannot provide enough details for the operative management itself. But a DSS should inform about the change of environmental conditions and the systemic capacity of the infrastructure to decide whether the running infrastructure is obsolete or have to be renewed. At this time the life cycle of land use and its related infrastructure closes with decisions about mayor adjustments, redevelopment or abandonment of a site.
This means that the investment and design decisions are kind of critical junctions within the infrastructure lifecycle and have to be rationalized with appropriate information by the DSS.

4 Evaluation of urban calculation tools as DSS

In this section we examine the functionality of developed DSS tools as case studies to find out which features and analyses concerning the costs and benefits of urban development are implemented. For the sample of 5 case studies we choose tools that are designed mainly for the professional public planner. Other Stakeholders like citizen, investors and landowners seem not to be the main target group. Tools for them are rather seldom and have the character of marketing or public relation instruments. Therefore we do not make any differentiation between usability for different stake holders.
Some of the tools we examined are even run only by consultants as service provider and are not dedicated for individual use by public authorities. But since the public planning authorities are the target group of these consultants we included these tools in our sample.
We examine whether a DSS is concipied more to support only the strategic investment decision or the project related design decision or both and describe the functionality and strengths and weaknesses of each tool. The comparison of the DSS-tools provides furthermore an overview which costs and benefits are included. We recur on the allocation of costs and benefits along the phases of the life cycle that we presented in figure 1. The results have been collected by literature and document analysis and are summarized in table 2. We follow up with a description of the case studies.

4.1 Urban calculation Tools

LEAN KOM

The software LeanKom is a commercial product that was developed with public funding under the working title "LEAN ² municipal financial management and sustainable human settlements". It is designed as a tool for strategic cost-benefit analysis at the level of the land-use-plan. By comparing the small-scale population trends, cost and utilization effects of technical and social infrastructure as well as revenue from taxes and revenues, alternative development areas will be prioritized. The instrument is also usable for the analysis and optimization of a development plan (Planersocietät 2009, 8). The core of this system is a set of determinant values (cost-characteristics; types of buildings, formulas) and a small-scale population model which has to be fed with local data namely the population distribution and age structure in the city districts (Schwarze 2007). The population model approach is deterministic and predicts gender-specific population cohorts on the spatial scale of neighborhoods or districts according to the assumptions of fertility, mortality and migration made by the user. The calibration of the internal standards for planning, construction density types, variants of housing, service levels of infrastructure and the associated cost structures is

based on an empirical analysis of 600 development plans as well as literature values and sample.
The type-specific configuration of the building areas simplifies the entry and use of the tool because less detailed information is required. With the structural information about the proposed areas the network infrastructure needed is determined and typical construction and following costs assigned. With the demographic processes generated by the population model the need for social infrastructure over time is calculated and compared with the existing capacity. Similarly, the population prognosis is used for calculating the effects on tax revenues and on the payment of municipal financial equalization. The results are displayed in tabular charts and maps (Beilein et al. 2009).

Fokos BW

The aim of the software Fokos is a fiscal impact analysis of residential area development projects. Provider of the tool is the STEG consulting company which is working as agent and project manager for cities especially in the southern parts of Germany. As a consulting based tool the focus is project orientated. The tool calculates revenues and expenditures of the city from the assessed construction area over a 25 years period and is able to simulate statutory land development processes as well as contract solutions that are implemented within the town planning code. This model uses empirically determined standard costs for infrastructure on typical development settings (new development, extension, and infill or brownfield development). In addition optional choices for quality and local features are available. Thus, the investment and running costs for the internal and external transport development, other development measures, street lighting, water supply, sewage disposal, public parks and children playground, and case-specific special structures can be calculated.
The information about potential needs for adjusting social infrastructure facilities and resulting costs are based on the particular age distribution of new development areas population. As revenues the Fokos BW includes taxes and allocations from the German system of municipal financial equalization, charges for local public infrastructure, and real estate sales within the development process if the municipality is the owner of the land developed. Additional modules quantify the accruals in the municipal budgets for the replacement of infrastructure (Hauerken et al. 2009).

FIN 30

This Decision Support Tool provides a multidimensional assessment of potential Housing development sites in all three dimensions of sustainability in terms their contribution to a more resource efficient and economically sustainable urban development at the strategic level of the land use plan. But the tool is also usable to value development variants of a distinct site. For example is it possible to simulate different statutory land development processes and to vary the prospected building density. The evaluation framework consists of a user interface and an indicator matrix that operationalizes social, ecologic and economic target dimensions.
The economic calculation is structured in cost groups like planning, technical infrastructure, social infrastructure and ecologic compensation, which are defined by the characteristics of the projected sites and locally adjusted standard costs. Fin 30 calculates the present value of the one-time construction cost and the recurring follow-up costs of 15 years as well as on-time and recurring revenues from the development site and for the community as whole for the same period. For the ranking of rentability these cash flows will be related to the real

estate values of the site after development.
These results of the fiscal impact analysis can be linked in a multi criteria assessment to non monetary characteristics like mobility and reachability, quality of life, vulnerability and ecologic impacts. Site-specific characteristics (e.g. noise emissions, slope of terrains and the soil type) that have significant effects on costs and revenues are considered as lump-sum surcharges and reduction on the standard cost for technical and social infrastructure. The initial production costs and the present value of annual maintenance costs are related to the expected land value after realization to get a measure for rentability for the examined development sites.
The integrated assessment of all three dimensions includes qualitative data at metric, ordinal and nominal scales. To aggregate these single characteristics to final overall statement a transformation takes place to single rank scaled classes. These indicators are then individually weighted by the user users and decision makers. In final step the summation of the values in each dimension leads to a ranking of all potential building sites (Kötter et al. 2010).

Regional Portfolio Manager

The aim of the Regional Portfolio Manager is to measure the economic welfare of land uses and development strategies. The potential housing development sites will be compared with each other to various monetary evaluation criteria. All potential development sites are captured in a GIS-based calculation tool. The software then calculates the area size and the value of land depends on current use. This analysis includes cost for the internal and external road and utility network, efficiency and capacities of social infrastructure, the ecological effects and the private sector benefits. A special feature of the portfolio manager tool is the systematic inclusion of brownfield areas and their redevelopment with regard to the different costs and economic effects.
The monetay valuation of the ecological impact is based on equivalent costs to recover the natural ecologic functions of the land related of the initial situation before development (Ruckes et al 2010). Private benefit is measured as the expected willingness to pay for building area. The prognosis for local values per squaremetre land is based on a hedonic regression of land and rent prices. Because not all types of cost resulting from urban development can be assigned individually to the different development sites, the tool includes also a technique to calculate cumulative costs. As an example a scenario of several development sites planned by different municipalities may require the extension of a mayor traffic junction in the region.
With this regional approach the tool provides results for more than one single municipality. Thus an objective information basis can be used to discus and negotiate the urban development policy of the involved municipalities. The authors stress, that the Regional Portfolio Manager is not capable to replace reveal detailed information of a single building site like that replace professional advice and expert's reports. But it provides a comparable and systematic evaluation of the different effects of specific development projects (Ruckes et al. 2010).

CIRCUSE (Circular Flow Land Use Management)

The Aim of the Land Use Management database CircUse is to support an integrative policy and governance approach which presupposes a changed land use philosophy with regard to land utilization. The interregional land use data base should support local decision makers on land use options and monitor the impacts on the polycentric development (www.CircUse.eu).The model follows similar to the lifecycle concept developed in chapter 3 a cycle of land use and defines different phases. The planning phase includes all formal and informal activities on planning decisions for future land use. The phase of use represents stable use and maintenance of land and buildings, which will be followed by the phase of cessation where underuse, neglected maintenance and closure of activities occur. Before the redevelopment three phases may follow. While abandonment means a status of dereliction without use it is also possible that interim uses occur. These non permanent or temporary activities can be a way for a step by step revitalization. The third phase is called Reintroduction and means a transition phase of land before getting available for new uses and planning (Otparlik et al 2010). The philosophy of land use behind the project can be expressed by the slogan "avoid –recycle – compensate" The technical core, a database that informs about all developing sites in the region, that should be monitored and assessed regard to their current phase of use and the potential for development.

Within the pilot project the Saxon state office for environment, agriculture and geology accounts for the development of the data base concept to provide a structure that can be applied in an international context. 6 Countries in central Europe (Poland, Germany, Austria, Czech Republic, Slovakia, and Romania) are working together in the CircUse project which is implemented and co-financed by the European Union.

The database for storing and managing field collected data about locations collects is based on the relational database system MS Access and has an interface to a GIS for presenting and viewing the collected data. The content of CircUse consists of detailed information about the recorded areas, like current and previous use, degree and material of sealing and building stock and the given infrastructure provision e.g. road and rail access. Furthermore it reports a complete set of planning status and zoning information, as well as environmental information that are relevant for further development e.g. terrain profile, contamination and flooding risk.

The set of information to each potential developing site will be collected by field research, and edited by the responsible planning authority e.g. county or municipality.

The manual data collection via field research and the additional documents provides very detailed physical information about the sites (Otparlik et al. 2012). Analytic methods and calculations for an assessment of expected costs and benefits of potential redevelopment are currently not implemented. Figure 2 shows a missing in about nearly all cost categories, while the set of planning information and environmental conditions is nearly complete.

That means that the valuation of the sites recorded in the database or the categorization into different development types have to be done by local planners or developers with own analytic methods or based on expert knowledge.

4.2 Comparison of included features

It is obvious, that the examined tools of the case study have different strength and weaknesses. One important differentiation is the about the level of decision that can be answered by the tools.

A clear emphasis on the design decision has the consulting based tool Fokos BW which is used to find the fiscal optimal method to develop an distinct site, while the Regional Portfolio Manager and CircUse have a more regional scope and to support the investment decision. Both regional tools are designed to prepare strategic decisions about further urban development by providing information to inform about all potential sites in the region.

CircUse monitors the status of sites (e.g. brownfield, space between buildings, Greenfield) and give an expert based classification about the development options like cessation of use, replacement and transformation to another use. The Portfolio Manager on the contrary predicts based on the information from the integrated GIS the expected economic welfare in terms of cost and benefits of a potential development.

Figure 2: Types of Cost included by state of the art DSS

	CircUse	LEANKOM	FOKOS BW	FIN 30	PM
Monitoring and Adjustment					
Environmental value and risks (externalities)	3				1
Planning information / zoning	3				
Contamination and Sealing of surface	3				
Building stock	3				
Demographic development	3	1	3		1
Efficiency of existing Social infrastructure/ derivation of demand	3	1	3		3
Efficiency of existing road Infrastructure	3				3
Planning and Design					
Internal administration workload					
External planning service and advisory		1	1	1	1
Construction & Establishment					
Land preparation (demolition, special grounding, brownfield cleaning)		1	1	1	1
Internal infrastructure development (roads, water, energy, etc.)		1	1	1	1
External infrastructure development (additional roads)		1	1	2	1
Special traffic nodes			2	2*	3**
Rehabilitation of existing structures					1
Greenspaces		1	1	1	1
Ecological Compensation		1	1	1	1
Noise and emission reduction facility / Flooding protection		1		1	1
Construction of social infrastructure schools / Kindergarten		1	1	1	1
Real estate value added			1	1	1

Revenue of property transaction		1	1	1	
Financing cost		1	1	1	
Subsidies				2	
Investor & house owner development fees (Erschließungsbeitrag)		1	1		
Operate & Maintain					
Operation cost of social infrastructure schools		1	1	1	3
Operation cost of public transport infrastructure		1	1		1
Maintenance of green spaces		1	1	1	1
Operation cost of road infrastructure		1	1	1	1
Fiscal redistribution impacts		1			
Tax impacts (property tax, shares of income tax, vat)		1	1		
user fees (cleaning, sewer, electricity, nursery)		1	1		

Assessment included
Assessment not included
Assessment inclusion unclear

1 monetary based on standard cost and real data
2 monetary based on user information
3 non monetary e.g. as traffic light symbol
* as external infrastructure development
** as cumulative effect

LeanKom and Fin30 are mixed forms which calculations can be use to forecasting cost of utilization variants of one site or compare rentability of different site developments. The idea of a database where information about the existing development sites of a region or community is consequently realized within the tools CircUse and Regional Portfolio Manager. Both have a special regional focus they are produced for (Region Bonn and cooperation of cities in Middle East Europe).
In theory the concept and technical framework can be transferred to other regions, but needs very long time to feed the system with all relevant information of the development sites until it provides useful information for planning decisions. The setup of these systems is based on field work, cooperation and manual recording. This database approach makes it possible to update information if the situation of a site changes. In contrary to this the other more project orientated tools usually do not have the possibility to store the characteristics of the assessed sites. Every change of the site specifications leads to a repetition of the workflow with all calculations. The results can only be stored and displayed as tables, documents or as map but it is not possible to store the initial site information in a database, to recall it when needed again.
We notice that all analyzed tools are products of the research projects. A mayor role played the initiative "Research for the reduction of the land conversion and sustainable land management" funded by the Federal Ministry for education and research. To the knowledge of the authors only the tool LeanKom and Fokos BW are in commercial use of public sector

consulting companies. A free use is not intended because too much special knowledge is needed for applying these tools to a cities special characteristic.
Also Fin 30 and the regional portfolio manager have to be updated individually for use in different cities. But only the database Circ Use is accessible as free download. It comes with a user manual and can be used freely by planners to organize and manage a local development site database.
Figure 2 displays which cost that occur during the life cycle of the site can be calculated by the case study tools. The majority includes the assessment of costs and cost relevant information during the phase construction and establishment. Especially the tools that are project-orientated need this feature to assess planning variants for a site.
The calculation of planning and design costs is with the exception of CircUse included in all examined tools. But it is limited to the cost for external consultant services. The internal workload which is depending of the legal situation and the resulting intensity of the planning process seems not to be part of the calculation.
Also with exception of CircUse the cost of operating and maintaining the physical and social infrastructure and maintenance of green spaces are included in all cases. These technical related costs usually can be derived empirically by observation of existing infrastructure operation processes. Generally the tools make assumptions about standard costs which are sometimes locally adjusted.
More comprehensive costs and incomes in the sense of a fiscal impact analysis are recognized only in the two cases. Due the long duration of the phase of operation, a lot of settings about the financial structure of the project on the one hand and about the situation of public budgets and tax revenues on the other which are difficult to hold for the whole time of calculation. All results have always to be interpreted with regard to these settings.

5 Conclusion

The analysis of case studies of give an insight about the state of the art of DSS that have been developed for practical use. It turns out that some topics seem to be easier to formalize and to implement in a DSS. These topics are mainly costs for construction and the technical costs for operation and maintenance which can be easily correlated with the quantity structure of physical part e.g. roads, sewers, and buildings. Also demographic figures play an important role for quantifying needs and related costs. This group of costs is derived from a good empirical basis and can be seen as a well developed standard for DSS systems.
Less common are profound fiscal impacts assessments that include tax and user fees. Presumably are time and effort to implement complex regulations quite high, compared to the anticipated validity of results. Furthermore due to the local regime of property tax and the fiscal equalization regulations like in Germany these effects differ more between cities or counties than between the potential development sites within a city.
A very conservative but rational way to develop a superior DSS for planning might be to combine the good working and successful features of every tool. Some advantages of the different tool have been revealed in the case study. For example in terms of the use of GIS which has been consequently developed in the regional portfolio manager. All other tool use GIS only for displaying results and not to intersect different spatial information. An open database is the exclusive idea of the CircUse-Project, while the project-orientated tools like Fokos BW, FIN 30 and LeanKom have advanced models to design the development sites and

to derive the connected cost structure. Combining a site – database with these algorithms within a GIS that contains all the Information that has to be collected by field work otherwise would be an improvement.

References

.Joerin, F.; Thériault, M.; Musy, A. (2001): Using GIS and outranking multicriteria analysis for land-use suitability assessment. International Journal of Geographical Information Science, 15:2, 153-174

Academy for Spatial Research and Planning (2008) Aus der Kostenfalle hin zu mehr Kostenwahrheit: Kosten und Folgekosten von Siedlungen und Infrastrukturen, positionspapier der Akademie für Raumforshcung und Landesplanung Nr.76. Hannover.

Albers, G.(1993): Über den Wandel im Planungsverständnis. In: Raumplanung 61, 1993, 97-103.

American Farmland Trust (1993) Is Farmland Protection a Community Investment? How to do a Cost of Community Services Study, Washington DC.

American Farmland Trust (2001) Review of Impact Studies Relevant to the Highland Region of Massachusetts, Washington DC.

Beilein, A.; Dittrich –Wesbuer; A.; Frehn, M.; Klemme, M:; Krause-Junk, K.; Osterhage, F.; Schwarze, B.; Suhre, R.; Tack, A. (2009): LEANkom- Ein Softwaretool zur Darstellung der fiskalischen Auswirkungen lokaler Wohnsiedlungsentwicklung. In: Folgekosten der Siedlungsentwicklung Bewertungsansätze, Modelle und Werkzeuge der Kosten-Nutzen-Betrachtung. Preuß T.; Floeting, H. (Hrsg.). DIFU. Berlin 2009, 106-117.

Bökemann 1982: Theorie der Raumplanung regionalwissenschaftliche Grundlagen für die Stadt- Regional- und Landesplanung. München Wien.

Businessdictionary: Deinition of Decision Support System (DSS), Link: http://www.businessdictionary.com/definition/decision-support-system-DSS.html

Businessdirectory: decicion support systems (DSS). Link: http://www.businessdictionary.com/definition/decision-support-system-DSS.html

Coupal, R.; Seidl, A. (2003): Rural Land Use And Your Taxes: The Fiscal Impact Of Rural Residential Development In Colorado. Land USE and Planning Report, Department of Agricultural and Resource Economics, No. 2 2003

Densham, P. J., Armstrong, M. P., and Kemp, K. K., 1995, Collaborative spatial decision making. Scientific report for the Initiative 17 (Santa Barbara: NCGIA), pp. 95–14.

Dunham A. (1958): A Legal and Economic Basis for City Planning (Making Room for Robert Moses, William Zeckendorf, and a City Planner in the Same Community) in: *Columbia Law Review*, Vol. 58, No. 5 (May, 1958), pp. 650-671

Florent Joerin, Marius Thériault & Andre Musy (2001): Using GIS and outranking multicriteria analysis for land-use suitability assessment, International Journal of Geographical Information Science, 15:2, 153-174

Franke, Thomas; Strauss, Wolf-Christian (2010): Integrierte Stadtentwicklung in deutschen Kommunen – eine Standortbestimmung. in: Informationen zur Raumentwicklung Vol. 4. 2010 253-262.

German Association of Cities (2004) Zukunftssicherung durch integrierte Stadtentwicklungsplanung und kooperatives Stadtentwicklungsmanagement. Positionspapier des deutschen Städtetages zum II. Nationalen Städtebaukongress, 10. Bis 11. Mai 2004. In: Informationen zur Raumentwicklung Vol. 4. 2010 321-323.

German Council for Sustainable Development (2007): Demographischer Wandel und nachhaltige Infrastrukturplanung. Deutscher Bundestag 16. Wahlperiode, Drucksache 16/4900.

Girmscheid, G. (2010): Projektabwicklung in der Bauwirtschaft: Wege zur Win-Win-Situation für Auftraggeber und Auftragnehmer Springer, Berlin 2008

Hauerken, J.; Hartung, F.; Ruther-Mehlis, A.; Wiedemann, S. (2009): Fokos BW: Eine Software zur Berechnung der Wirtschaftlichkeit von Wohngebieten im Praxistest. In : Folgekosten der Siedlungsentwicklung Bewertungsansätze, Modelle und Werkzeuge der Kosten-Nutzen-Betrachtung. Preuß T.; Floeting, H. (Hrsg.). DIFU. Berlin 2009, 56-105.

Haug, P.; Deilmann, C.: Kommunale Netzinfrastruktur: Demographischer Wandel, Stadtumbau und Ersatzbedarf als künftige Kostenfallen?, in: InfrastrukturRecht, Bd. 5 (11), 2008, pp. 322-325

Hauschild M, Wenzel H (2000) Life cycle assessment–environmentalassessment of products. In: Jørgensen SE (ed.) A systems approach to the environmental analysis of pollution minimization. Lewis, Boca Raton, pp 155–189

Healey, P. (1997): Collaborative Planning: Shaping Places in Fragmented Societies. Macmillan: London
Hoffmann-Axthelm, D. (2010): Flächenkosten und kommunale Finanzautonomie - Für eine Theorie der Stadtwirtschaft. Detmold.
ISO (1998) ISO 14041: environmental management–life cycle assessment–goal and scope definition and inventory analysis. ISO 14041:1998(E), International Standards Organization
ISO (2000a) ISO 14042: environmental management–life cycleassessment–life cycle impact assessment. ISO 14042:2000(E), International Standards Organization
ISO (2000b) ISO 14043: environmental management–life cycle assessment–life cycle interpretation. ISO 14043:2000(E), International Standards Organization
ISO (2006a) ISO 14040: environmental management–life cycle assessment–principles and framework. ISO 14040:2006(E), International Standards Organization
ISO (2006b) ISO 14044: environmental management–life cycle assessment–requirements and guidelines. ISO 14044:2006(E), International Standards Organization
Ives, B.; Hamilton, S.; Davis, G.(1980): A framework for Research in Computer-based management Information System. Management Science, Vol. 26,l No. 9, pp.910-934.
Jakeman, T., Letcher, R., Norton, J.P., 2006. Ten iterative steps in development and evaluation of environmental models. Environmental Modelling and Software 21, 602-614
Jankowski, P., 1995, Integrating geographical information systems and multiple criteria decision-making methods. International Journal of Geographical Information Systems, 9, 251–273.
Kelsey, T.W. (1997): Fiscal Impacts of Different Land Uses. The Pensylvania Experience. (Penn State University, College of Agriculrural Sciences, Extension Circular 410).
Knaap, G.; Knauss,P. (2001): Fiscal Impacts of Residential Development: Does Development Pay for itself?, Part I Sanitary Districts, Springfield Il.
Kötter, T.; Schetke, S.; Frielinghaus, B.; Weigt, D.(2010): Nachhaltige Wohnbaulandentwicklung – Ein bewertungsrahmen für die Flächennutzungsplanung. In: Flächen und Standortbewertung für ein nachhaltiges Flächenmanagement Methoden und Konzepte. Frerichs,S.; Lieber, M.; Preuß, T. (Hrsg.). Berlin, 133-145.
Laaribi, A., Chevallier, J. J., and Martel, J.M., 1996, A spatial decision aid: a multicriterion evaluation approach. Computers, Environment and Urban Systems, 20, 351–66.
Lewis, D.L. (1991): Turning Rust into Gold: Planned Facility Management. Public Administration Review, Vol. 51, No. 6 (Nov. - Dec., 1991), pp. 494-502
McIntosh B.S.; Ascough, J.C.; Twery, M., Chew, J; Elmahdi , A.; Haase, D. et al. (2011): Environmental decision support systems (EDSS) development e Challenges and best practices. Environmental Modelling & Software 26 (2011) 1389-1402
Moss, T.(2008): Cold spots of Urban Infrastructure: Shrinking Processes in Eastern Germany and the Modern Infrastructural Ideal; International Journal of Urban and Regional Research, Vol. 32, No. 2. (June 2008), pp. 436-451.
Otparlik, R.; Siemer , B.; Scherer, V.; Ferber, U. (2012): Land Use Management Data Base Installation Instruction –Draft. Part of Core Output Nr.3.3.1 Freiberg, Dresden.
Otparlik, R.; Siemer, B.; Ferber, U (2010): Terms of reference and land typologies for Circular Flow Land Use Management, Report/Output Nr. 3.1.1 (update), 12/2010, Freiberg, Dresden.
Pagano M. A. (2011): Funding and Investing in Infrastructure. Urban Institute
Parker. P; Letcher. R.; Jakeman, A. Beck, M.B., Harris G., Argent, R.M., Hare, M.; Pahl-Wostl, C.; Voinov, A. et al. (2002): Progress in integrated assessment and modelling. In: Environmental Modelling & Software 17 (2002) 209–217.
Planersocietät (2009): Mit Zukunft rechnen LEANkom® als neues Instrument für eine effizientere Siedlungsentwicklung. In Projektskizzen 1/2009, Dortmund, 8-9.
Preuß, T.; Floeting, H. (2009): Cost-benefit Analysis Tools and Models Summary and Synthesis In: Thomas Preuß and Holger Floeting (ed.) (2009): Folgekosten der Siedlungsentwicklung. Bewertungsansätze, Modelle und Werkzeuge der Kosten-Nutzen-Betrachtung, Beiträge aus der REFINA-Forschung, Volume III, pp. 159-176
Reap, J.; Roman, F.; Duncan, S.; , Bras, B. (2008): A survey of unresolved problems in life cycle assessment Part 2: impact assessment and interpretation. International Journal of Life Cycle Assessment (2008) 13:374–388
Reidenbach, M. (2007): Neue Baugebiete: Gewinn oder Verlust für die Gemeindekasse? Fiskalische Wirkungsanalyse von Wohn- und Gewerbegebieten. Difu (Edition Difu – Stadt, Forschung, Praxis, Bd. 3).

Berlin:
Ruckes, A.; Heyn, T.; Lennartz, G.; Schwede, P.; Toschki, A.: (2010): Regionales Siedlungsmanagement auf Basis monetarisierter Bewertung ökologischer infrastruktureller und privatwirtschaftlicher Dimensionen potenzieller Entwicklungsflächen. In: Flächen und Standortbewertung für ein nachhaltiges Flächenmanagement Methoden und Konzepte. Frerichs,S.; Lieber, M.; Preuß, T. (Hrsg.). Berlin, 146-156.
Schwarze, B. (2007): Das kommunale LEAN²- Bevölkerungsvorausschätzungsmodell Version 1.0, LEAN² Arbeitspapier Nr. 3 (November 2007) Dortmund.
Snyder, D.L.; Fergason, G. (1994). Cost of Community Services Study Cache, Sevier, and Utah Counties
Voinow, A. Bousquet, F. (2010): Modelling with stakeholders. Environmental Modelling & Software 25 (2010) 1268-1281.
Wheaton, W.L.C.; Schussheim, M.J. (1955): The Cost of Municipal Service in Residential Areas. Office of Technical Services. Washington.
Zhu, X.; Healey, R.G.; Aspinall, R.J.(1998): A Knowledge-Based Systems Approach to Design of Spatial Decision Support Systems for Environmental Management. Environmental Management Vol. 22, No. 1, pp. 35–48

CONTACTS

Prof. Dr. Theo KÖTTER and Dr. Dominik WEISS
University of Bonn
Nussallee 1
53115 Bonn
GERMANY
Tel. +49228-732612
Fax + 49228733708
Email:koetter@uni-bonn.de
Web site: www.igg.uni-bonn.de/psb