

# An integrated holistic transdisciplinary landscape planning concept after the Leitbild approach

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## ABSTRACT

Understanding the complexity of landscapes is an essential requirement to exhibit strategies for landscape development in the mid-term future to predict long-term effects and maintain future demands. In order to steer the landscapes of tomorrow to an aspired future state, it becomes clear that landscape planning could not be done without common consideration of socio-cultural, economic and political components besides the reflection about the ecosystem. In response to this challenge, this article presents a conceptual framework for describing, classifying and planning aspired states of future landscapes based on a transdisciplinary “Leitbild methodology”. First, a brief review to the Leitbild concept originally developed in the German speaking literature is given. In the second part of the paper the applied conceptual framework is introduced. Data collection and development of a natural scientific ecological framework integrating socio-economic and political values are starting points to frame scenarios representing the wishes, demands and requirements from local stakeholders with different interests in the use of landscape resources. On the ground of communication these realistic spatial explicit land-use/land cover scenarios frame the basis for negotiation and agreements to overcome constraints and conflicting interests towards the commonly agreed aspired future state of spatial utilisation and thus illustrate the future with the aim to provide a set of guidelines that will shape action. The results gained from an informal planning situation in a case study in the Mondsee catchment in Austria show that based on the ground of natural scientific knowledge an integration of socio-economic values and the involvement of local stakeholders enhances landscape planning through knowledge exchange, education among participants and building trust. Thus, it is argued that the developed semi-operational GIS prototype is a successful applied procedure in a transdisciplinary planning context to overcome current shortcomings of participation in present landscape planning with the aim for protection, management and planning of landscapes.

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## 1. Introduction

As shown in numerous publications, a variety of planning approaches exist which aim to develop the landscape of tomorrow in a sustainable way (Potschin and Haines-Young, 2006). During the last decades process-driven deductions of priority areas based on qualified ecological expert opinions (Mosimann et al., 2001), landscape development based on the historical origin of a landscape (Ehrlich, 1985; Bender et al., 2005) or a functional approach to the ecosystem (de Groot et al., 2002) have been developed. There are many more approaches to be mentioned in such a general way. Traditionally the landscape was ‘evaluated’ through Environmental Impact Assessments (EIA); later the social and even later the Strategic Impact Assessment (SIA) and the Sustainable Impact Assessment (SIA) or the Strategic Environment Assessment (SEA)

(Arbter, 2003; Directive on the Strategic Environment Assessment 2001/42/EC) were used. Potschin and Haines-Young (2003) already compared those to the ‘Quality of Life – Capital approach’ which tries to capture the gaps of the holistic transdisciplinary approach. In the Special Issue of Potschin and Klug (2010) and Potschin et al. (2010) analyse the similarities and differences compared to the Leitbild approach.

Having applied these different views on the same resource landscape raises the question: ‘which method is the most appropriate and leads to the best future state of the landscape?’ From these controversial discussions on how to develop optimal future states (Sarapatka and Sterba, 1998; Seppelt and Voinov, 2002; Grabaum and Meyer, 1998) it becomes apparent that it is necessary to get to a common agreement on the functions with primary importance to provide certain goods and services that would best satisfy human needs. Due to the missing approaches (or best practice guidelines) it is therefore necessary to address the topic of landscape development with a transdisciplinary reflection of landscapes (Bastian, 1999; Jessel, 1994; Tress and Tress, 2001b; Tress et al., 2005).

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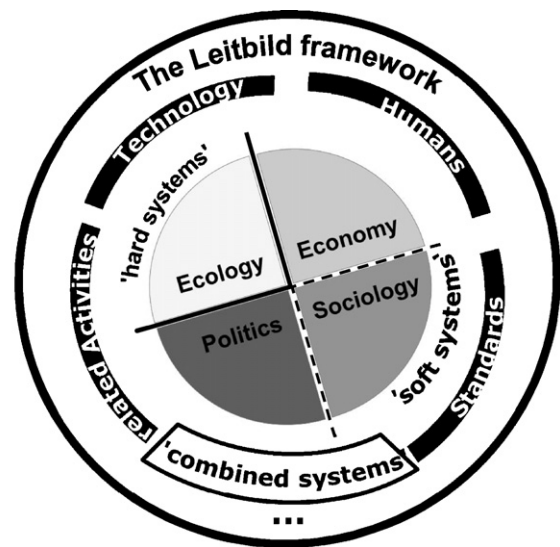
Having agreed that there is a strong need for inter- and trans-disciplinary concepts in landscape development (Tress et al., 2002), the remaining question is how to tackle this process and if there is any patent or recipe existing (Bastian, 2000). In a more general thought, Haber (1993) and Jessel (1995) posed the question, if landscapes could ever be steered, synthesised, or even programmed in computers. However, due to many pressures arising from growing settlements, infrastructure enlargement, increase of daily new recreation actions, and more and more political constraints, it becomes clear that landscape planning is an urgent task to overcome. This means to define subjects and areas of prime or inferior importance related to many interdisciplinary claims on natural resources, environmental protection and others. The assessment of how to use a specific spatial unit has to be done through reasonable justification on an argumentative base in the contention with natural goods and services (de Groot et al., 2002), its utilisation or interventions in the landscape under consideration of societal norms and values.

Landscape development is target driven and thus there is not one and only one holistic preferable concept to plan landscapes at all. As a consequence, until now only partial attempts have been made to combine physical–geographical and human–geographical perspectives (Zepp et al., 2001). In the German speaking planning literature the Leitbild concept was developed to overcome this gap (Potschin et al., 2010). These approaches are mainly summarised in Wiegleb (1997) and Finck et al. (1997).

As a result of many planning studies, an extended process-based Leitbild approach comprising several modules has been established. Joined to a hierarchical framework, a matrix of functional superimpositions and a matrix of buffer stripe areas operate as a base to allocate an appropriate land use/land cover type to a spatial explicit area (Klug, 2002; Klug and Zeil, 2006). Further essential elements in this Multi-Goal Spatial Decision Support System (MGSDSS) are linked modules of social demands, economic requirements and political constraints, which altogether allow for a pursuable and transparent landscape planning. Having converted this complex approach into the ArcGIS 9 environment, it supports semi-operational analysis towards the aspired state of the future landscape through scenario development.

The overall aim of this paper is to capture basic characteristics of the ecosystem integrity to avoid irretrievable damages to the environment and its resources. These characteristics refer to environmental conditions, states, processes, functions, potentials, and risks. The capacity and the vulnerability of the landscape was measured and – combined with socio-economic criteria – the goods and services analysed.

The theoretical fundamentals are provided by Bastian (1999), Klug (2002), Klug (2000) and Mosimann et al. (2001). These approaches incorporate an interdisciplinary ecological base, where according to Haber (1971) farmland priority zones are delineated with respect to their spatial explicit ecological potentials. Such an ecological-, well-founded and scientifically approved analysis has many advantages, but also lacks any steering mechanisms of planning resulting from socio-economic behaviour, agricultural funding strategies as well as political laws and directives (Water Framework Directive, Natura 2000 Directive with Bird Directive and Flora-Fauna-Habitat Directive). National and European wide funding conditions such as the Cross Compliance (Council Regulation (EC) No. 1782/2003), subsidising management and protection tasks are crucial criteria, which can drop or apply action and development plans successfully. Further impact factors are the ethno-social behaviour of the farmers, shaping and embossing the landscape (Zimdahl, 2002). However, as far as the acceptance of development directions and with it the alterations in the system landscape farming and environment is not established, planning is unthinkable (Tress and Tress, 2001a).



### to ensure, process, distribute, use, maintain, and preserve human service demands

Fig. 1. Merging environmental, social, economic, and political science into one single “combined system” for integrated holistic and transdisciplinary spatial planning.

Recently, first attempts have been made to build consensus out of different visions of landscape. By drawing and exploring insights, Fish et al. (2003) and Bastian and Lütz (2006) highlight some challenges raised in how to display and reconcile these visions.

## 2. Brief overview on the Leitbild concept

As thoroughly discussed in Potschin et al. (2010) the Leitbild term dates back to the beginning of the last century. Nevertheless, first approaches in the eighties and nineties made this word a planning concept (Wiegleb, 1997; Finck et al., 1997). Due to the numerous approaches developed, the term has partly been used more fashionable than scientific (Jessel, 1994; Fellner and Kohl, 1994). To avoid further misinterpretation and understanding when introducing this concept to the English speaking world, Potschin et al. (2010) summarised the main topics and requirements and concluded with the following definition:

*“A Leitbild (pl. Leitbilder) is a summary statement describing a desired and releasable future state for a specific issue or spatial unit, which takes account of the primary objectives and drivers in a holistic and integrated way. All present knowledge is used to balance future constraints and demands from social, economic, cultural, political and environmental perspectives. Therefore, a commonly accepted Leitbild projects a specified trajectory for the future spatial structure, distribution, utilisation, condition and development of the socio-natural system. It provides a set of guidelines that shape actions, and a framework within which the impact of particular developments can be judged and socially negotiated.”*

The main lesson to be learned from this definition is to combine natural, social, economic, and political sciences and that the synergies of all together increase the knowledge about feasible landscape change towards an aspired future state – the Leitbild (Fig. 1).

The main advantages and disadvantages resulting from this combination are in detail explained in Klug (2010). From this paper can be summarised that natural system was regarded as crisper than the messy soft systems. But despite the efforts that need to be spend to combine both systems in practice, Klug (2010) and Klug and Jenewein (2010) showed that the results of the planning process were enlightened in several ways: communication

enhancement, knowledge generation, education and better understanding of the values and thinking from others.

The process of identifying, inviting, and interacting with stakeholders has been described in Klug (2010). The socio-economic and environment-related modelling process is explained in Klug and Zeil (2008) and Klug and Jenewein (2010). The following section gives a comprehensive insight in the methodology developed describing the workflow and the elements passing through.

### 3. Materials and methods

Comprehensive planning presupposes a high degree of on-site knowledge of specific potentials, vulnerabilities, risks and interdependencies. As a consequence, the realisation of this intended integrative and holistic planning approach is due to the complexity a great mental, temporal and cost intensive challenge, especially the conversion of information from numerous parameters of socio-political categories as a base for decision support and management of landscapes (Neef, 1969; Potschin and Bastian, 2004).

The constitutive objective of this analysis is to capture the basic characteristics of the natural household with its natural endowed features and moreover to determine the capability of landscape functions and potentials, measured with respect to economic and social criteria. This places planners and practitioners in the situation to estimate the landscape capability, resilience and loading capacity of the environmental balance. This is to consequently avoid irreversible damage to the environmental integrity and proper functioning of natural processes and the deteriorations of resources through a place based reasonable utilisation.

The developed process-driven Leitbild methodology is a multi-level concept, currently comprising 15 modules. As shown in Fig. 2, each instrument (module) is numbered in the top left corner of each box and serves as an orientation for the following explanations. Furthermore the sequences of numbers reflect the praxis-oriented workflow, whereas the arrows in-between indicate how each module is connected to another.

The concept shown in Fig. 2 consists of three main modules in detail explained in Klug (2002), Klug and Zeil (2006) and Klug (2007):

1. a hierarchical framework determining the priority of functions, which can be allocated to an area (3),
2. a matrix of possible or excluded functional superimpositions (utilisation, protection, and regulation) (4),
3. a matrix of necessary buffer (stripe) areas between excluded borders of land use (11), and

three complementary modules:

1. a table with the utilised assessment and evaluation procedures for secondary datasets (2),
2. a table of standard values, threshold values and critical values (5),
3. a matrix of structural indicators (landscape metrics) (12), as well as

three additional modules:

1. socio-economic module (6–10)
2. a funding module (14), and
3. an action catalogue (15).

Having described the superior structure of the concept, the next paragraphs explain each of the modules in more detail.

#### 3.1. (1) GIS database

As usual in landscape planning, the analysis starts with the acquisition of available primary geodata to analyse and describe the present state of the landscape. Sources for GIS data layers and remote sensing data are manifold, but mainly available from the departments of the Federal State Agencies, local institutions, companies, universities and other research organisations. In addition information on the quality and origin of each dataset are stored in a metadata base in the metadata standard such as ISO 19115 and others. This step is a necessary task to ensure the assessment quality of the whole analysis. Finally all datasets were pre-processed (e.g. adaptation of the projection system) and compiled in a geodatabase. Dataset attributes were adopted and tables to join additional information organised and linked.

#### 3.2. (2) Assessment and evaluation procedures

In the absence of required primary datasets (e.g. measures for the ground water recharge or soil erosion), assessments and estimation procedures from the literature were chosen to derive secondary datasets. The secondary datasets can be regarded as re-evaluation of existing primary geodata to extract further information from it. Roughly speaking, these spatial models are GIS-based representations of supposed, predicted, or desired states of affairs or processes in the landscape. They were created by applying assumptions and well-defined rule sets to existing data to produce new data. Methodologies provided in Bastian and Steinhardt (2002, p. 217ff) or in German language by Marks et al. (1992), Zepp and Müller (1999), Bastian and Schreiber (1999) and Usher and Erz (1994) are good compendiums as a starting point for estimation of spatially non-measurable explicit values.

The main procedures useful to apply – and tailored for landscape analysis in the study area concerned – have been compiled in the table of this module. It is directly linked to the metadata base to capture information on which method the dataset was derived. The dataset itself is stored in the geodatabase and therefore linked to module 1.

#### 3.3. (3) Hierarchical framework

The primary and secondary datasets stored in the geodatabase (module 1) provides the basis for the hierarchical framework. The main objective of the framework is to structure, maintain and further develop the processes of the underlying ecosystem to get back the best benefits demanded from society. Therefore, the hierarchical framework in detail explained in Klug (2002) is the centre of the whole concept, being supported by the modules surrounding it. Thus, module 3 represents a hierarchically structured, solid knowledge base with proven scientific methods based on facts like physical, chemical, and biological values. The inductive analysis (from specific to more common findings) is characterised by a systematic and transparent deduction across scales that intend to realise the aspired future state of spatial explicit land use allocations. Therewith, it provides information about the course of development, which a functionally diverse landscape could take on the grounds of interdisciplinary ecology-related scientific criteria. The aim is to designate zones for intensive and extensive land use, which can be selected according to place based criteria and where functional change is advocated, and the landscape is balanced with compensatory zones for protection and regulation.

In general the model takes care of a three-dimensional perspective: (1) integration of numerous disciplines (inter-/transdisciplinary); (2) vertical processes like functional superimpositions (module 4); and (3) horizontal harmonisation of different kind of feasible land use interconnections through buffer functions

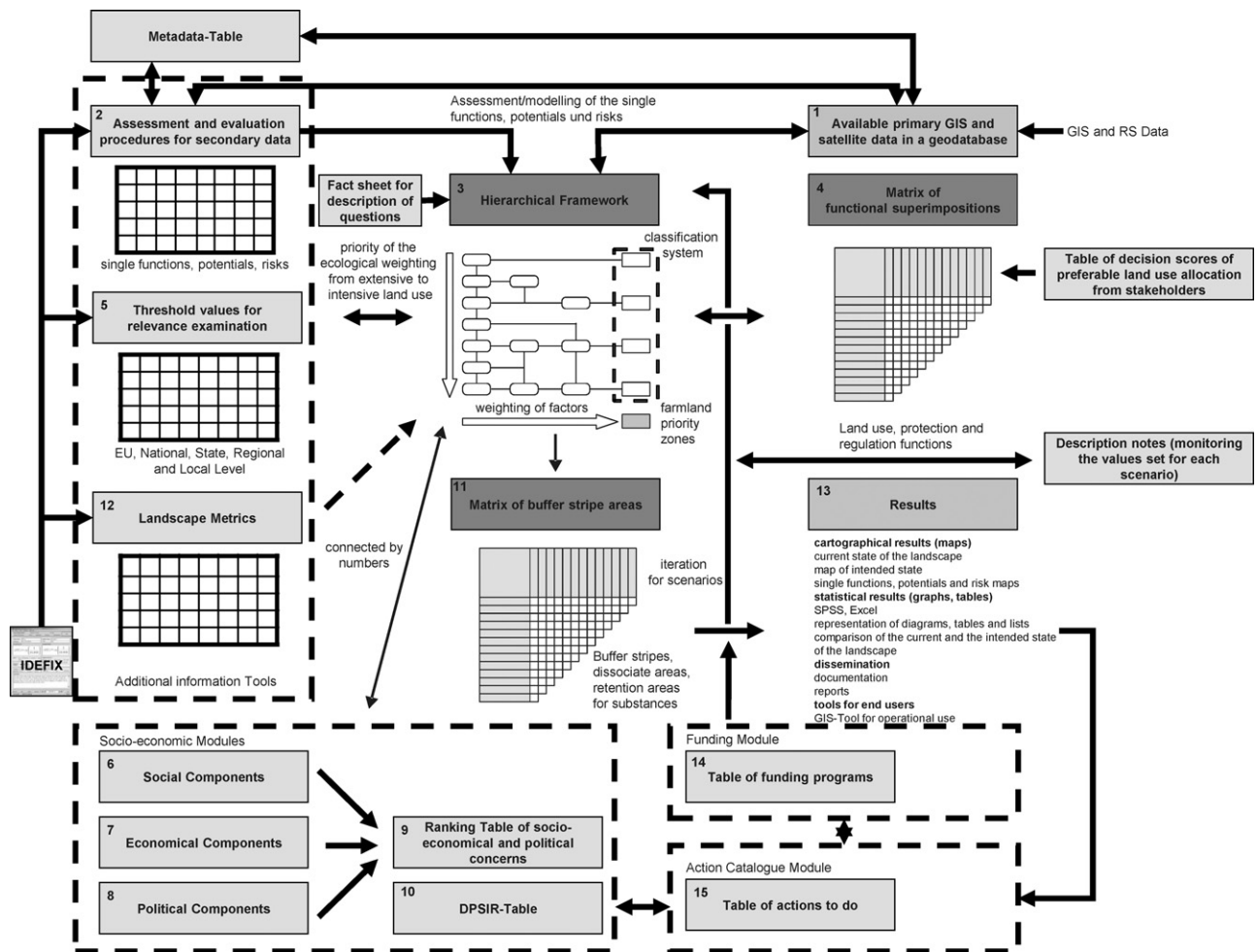


Fig. 2. The integrated holistic Leitbild concept and its modules from data acquisition towards the aspired future state.

(module 11). Whereas (2) and (3) are based on matrixes explained in detail in Klug and Zeil (2006), (1) based on interrogations requesting certain functions under consideration elaborated from a stakeholder meeting (Klug, 2010).

In particular, the hierarchical framework consists of a twofold internal structure, which is oriented (a) top-down and (b) left-right. Beginning with the first, (a) represents the priority of the ecological weighting from extensive to intensive land use. Hence, existing non-changeable sites such as settlements, rivers, lakes and infrastructure as well as natural zones protected by law are identified first; extensive meadows and pastures are followed by intensive meadows and pastures. Arable land without and with management restrictions are allocated at last. The decisions to make by the stakeholders depend on the feasibility of change dependent on the present land-use and the site specific potential an area hold. This means for example, the higher the agricultural yield potential, the better the suitability for arable land in case there are no further restrictions resulting from other perspectives such as the suitability for a high biotope potential. Therefore, the framework actually processes the value of certain potentials each stakeholder primarily wants/needs to develop. Therewith, the stakeholder has the choice, to which degree the preferred potential (e.g. agricultural yield potential, the biotope development potential, the use of sites for forests, the ground water extraction potential, the recreation potential, etc.) should be used. Hence, it should be clearly emphasised that the choices to make in the hierarchical framework do not depend on aspired future land-use shares but instead refer to the

degree the main functions and respective services demanded by society should be used. Therefore, for each service potential developed on the basis of estimation procedures mentioned in module 2 a five-class category from very good to worse has been assigned. Thus, it would be possible for the scenario holder to consider just the areas with a very high potential for arable land but also the areas associated with class 2 or higher. However, the modifications of priorities of potentials to use effect the land-use configuration and arrangement of land use units in the study area and therewith result in different shares of land-use classes.

A deeper insight in the internal structure from the left to the right reveal the weighting of factors from a main function outlined at the left site through sub-parameters towards a certain land use unit at the right site. Once an area has been allocated to a certain land-use in the classification system at the right site, this area could only be considered twice, if the second function has the possibility to overlap with the function already dedicated. Therefore, the model is directly connected to a matrix of rules concerning the superimpositions of functions like utilisation, protection, and regulation (Klug and Zeil, 2006). As an example, an area used for forestry in the case of proper walking ways in a non-restricted area can also be considered for recreational use or as an area suitable to filter emissions from a nearby industry.

The description of the meaning and background of each question and the goods and services provided by the considered functions for society are further explained in a document called ‘facts sheet’ which is directly connected to the hierarchical framework. To get

the focal point of these explanations, the internal structure of the hierarchical framework need to be observed in detail.

As pointed out in many papers, patterns and processes occur in specific scales – there are an infinite number of possible scale-dependent interactions (McGarigal and Marks, 1995; Wiens and Milne, 1989). Following the thought that pattern-related behaviour and processes occur within specific dimensions, so-called domains of scale, functions can be allocated to a specific spatial scale under consideration and the land use classification system belonging to that scale (Peterson and Parker, 1998). While Hein (mentioned in de Groot and Hein, 2005) claimed the integration of different temporal and spatial scale levels as an outstanding issue, a first attempt has been made to overcome the lack of spatial levels here. The necessity of having the possibility to get to a more specific level of analysis is best described in Potschin and Haines-Young (2003, p. 99): ‘... it is apparent that the assessment itself [...] made at a very general level, which often tended to obscure specific, but nevertheless important effects that became apparent at a more detailed level of analysis’. Therewith, content and sharpness of the analysis are defined in three reflection levels (macro-scale, meso-scale, local scale). Reflecting different spatial planning levels and goal systems, the functions can be allocated to a certain reference level.

The left-right structure is also considered as a hierarchical multi-scale structure starting from a broad overview with functions at macro-scale and narrowing them down to meso- and local scale. Each scale therewith incorporates its own classification system.

Without going into too much detail, it should be mentioned that the used classification system is built upon existing classifications systems as, e.g. CORINE Biotope Classification or EUNICE and therefore comparable to those via a translation key (Brown and Duh, 2004). Due to the used map-to-map comparison explained in the results chapter (module 13), according to Singh (1989) a stable classification scheme needs to be established to secure the reliability of the underlying change detection from the present to the aspired state of future land use. Additionally, satellite images from ASTER have been considered as a basis for providing the present state of a landscape at meso scale analysis (Klug et al., 2007). Furthermore, advantages of these satellite images are taken for monitoring purposes evaluating the implementation process of the action plan mentioned in module 15. Therefore it is indispensable to have a persuasive classification system where each of the land use classes developed in the Leitbild analysis could be detected in the satellite image as well. This means in turn that the classification system also has to consider remote sensing capabilities to extract the classification system from these scenes in order to be suitable for monitoring purposes.

### 3.4. (4) Matrix of functional superimpositions

According to traditional physical planning, a segregation of functions and supply services happens in space by dedicating a specific function towards a separate spatial entity. In this new approach, the matrix of functional superimpositions shows the possibility of mutual overlapping of functions (Fig. 3). Furthermore, mutual impacts that hinder their development are dedicated to function that are not allowed to overlap. Besides the prioritised function shown in the Leitbild map, the geographical information system (GIS) is able to extract further information which are able to take place at the same time on the same land unit (Klug and Zeil, 2006).

When functions can overlap with restrictions, further attributes need to clarify these restrictions as precise as possible. For example, not spraying pesticides in a certain time or extend, banning hunting during migrating season, retarding the mowing rate until a certain time due to grow up time of certain species.

From an ecological point of view, the maintenance or improvement of a sustainable landscape needs to consider these three

general interrelations of land use, as there are restricted, allowed, and forbidden actions. With these considerations it becomes clear, that the expected spatial configuration and composition and the spatial distribution of land use types strongly depend on landscape management and the implementation of respective measures.

Besides the possibility of the superimposition of functions in a multifunctional landscape it is necessary to consider further aspects as topography or hydrological landscape structure for a sustainable landscape. While one setting in a certain area is considered to be sustainable, the same setting in another environment may not be sustainable at all. Thus, the transfer of this methodological framework needs to consider the respective landscape configuration and composition and need to integrate this knowledge into the hierarchical framework.

It now becomes clear that different functions can be dedicated to one spatial unit. As stated above, the landscape is not merely consisting of isolated functions and services, but forms an interacting mosaic of superposing functions and services. According to the matrix in module 4, basic superpositions were inferred from multiple ecological studies, extracted from the literature and own experiences. The result is an indicator system which considers functions that can be superimposed, with certain restrictions and which are restricted to be superimposed.

The land use types compared in the matrix are categorised in utilisation, protection and regulation functions, also including functions, which adhere to a certain land use (e.g. recreational use in forests). The manifold restrictions result from certain combinations of multiple aspects, e.g. type, structure and shape of an area. For each partly allowed superimposition a number indicates the tangible restrictions.

The priority of functions could be framed by its maximum natural potential (module 5) as well as by the demands from stakeholders (module 9) as shown in Klug (2010). If there is an ambiguous decision to make, according to Mosimann et al. (2001), the allocation of a certain land use is based on three further decision criteria: (1) examination of which land use is restricted or excluded by other land use types; (2) allocation to a land use category, which is the most demanded one; and (3) allocation to the most intensive land use with respect to the promotion of intensive agriculture in suitable places.

### 3.5. (5) Limits

As indicated in the description of module 3, the table of module 5 includes a number of norms, standard values, threshold and limit values stemming from legislations (EU, national, state, regional and local level) and scientific literature dealing with landscapes and its compartments with respect to the functions used. Hence, the values give insight to the conditions of certain function through a classification expressed as the given human value system. They belong to evaluation scales separated into five classes to rate areas as indicating values from very good (1), through medium (3) to bad (5) according to a set of criteria.

Threshold values are set to indicate in how far the system can be exploited without pushing the system beyond a critical distance from equilibrium, where the process is inevitably reconfigured and resulting in a new structure not producing the same goods and services as provided before. In that way we can influence our system to guide it towards the intended direction with an enhancement of the dissipating capabilities of the landscape.

### 3.6. (6)–(10) Socio-cultural, economic and political module

The modules 6–10 aim to produce practicable proposals for implementing socio-economic aspects of landscape development and functioning, with a particular focus on the study area in Austria.

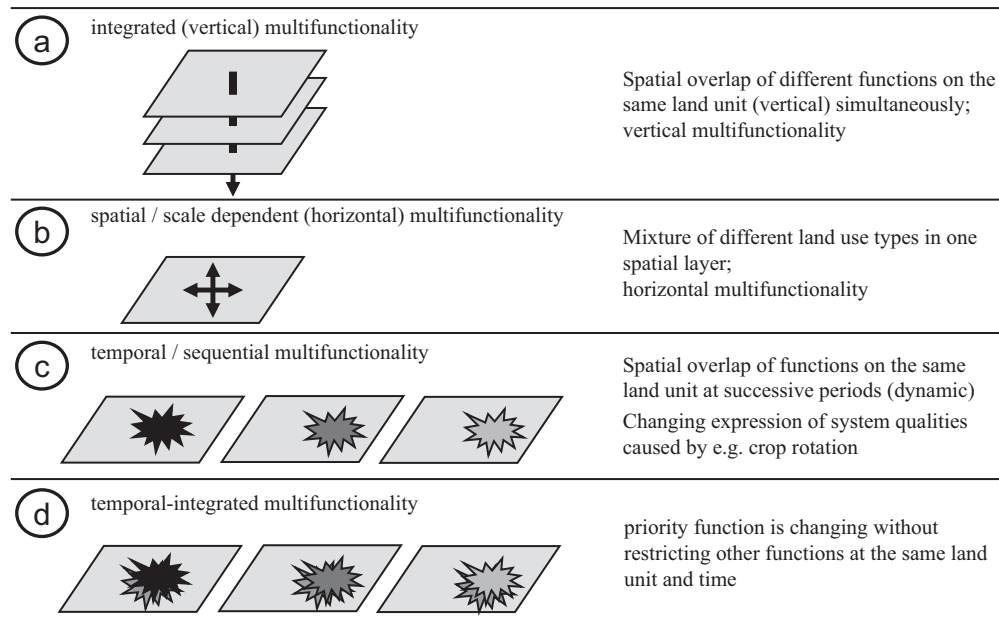


Fig. 3. Aspects of multifunctionality.

As outlined in de Groot and Hein (2005), ‘many studies have presented conceptual frameworks addressing (part of) the complex issue of linking ecosystem (and landscape) functions to economic values’ as well as socio-cultural perceptions. These mentioned ecosystem functions are brought into the hierarchical framework (module 3) and linked to ecological-value categories defined in de Groot et al. (2002) (e.g. (in-)direct market valuation, contingent valuation and group valuation). Socio-cultural values mainly belong to information functions, referring to identity and cultural values but also from perceptions of landscape scenery (sense of place).

The values remaining from the economic and socio-cultural analysis (Klug, 2010; Klug and Jenewein, 2010) are captured in the socio-economic modules. While applying the hierarchical framework from module 3, these values were taken to build scenarios. The deductions of scenarios are based on the impressions and demands of the stakeholder involved in the planning process. They are the appropriate means to provide sufficient and scientifically sound information for the identification of intervention options by means of the demands and requirements from stakeholder groups. The scenarios serve as a basis for sharing positions and situations resulting in a strategy development together with the stakeholders and negotiating parties. Hence, both the construction of the scenarios and the analysis and comparison of the result among others will benefit the final aspired future state. When having realised a target under certain assumptions made (module 9), it is a natural behaviour that one starts to think about new ways to produce an equal or different target with the aim to develop one’s own service demands or to improve the target framed before. Within this process it could happen that an individual scenario begins to dominate, but not necessarily. But going further in scenario development with different demands and requirements from different stakeholders a certain preference for some scenarios could be observed from the discussions around. This is due to a single scenario might even substitute and outdate another one. This is for instance when one Leitbild at a certain time period is seamlessly transcending into another scenario. Having not elaborated this idea in detail, additional future work should also pay attention to the issue in how far several scenarios developed can follow one another in time without losing the direction towards the aspired future state.

Ultimately, all scenarios developed belong to the greater future development trajectory. These trajectories can be named particular

or sectoral Leitbilder which need to be synthesised towards a common Leitbild. This process is a new line for landscape development, or for enriching the communication process which allows the deduction of a realised target through parameter shifts to another promising somehow similar target. Therefore, the common Leitbild not only refers to the development trajectory of one actor rather than a greater group of people agreeing to the aspired developments. It acts as an interpersonal stabiliser as long it carries out certain demanded and required services under consideration. The Leitbild pursued ever tighter precision of manufacture and tolerances throughout the development process.

As stated above, the scenarios were clearly defined by the assumptions made by stakeholder groups which are captured in module 9. When applying the hierarchical framework each value is considered and processed and finally result in a certain land use pattern. The priority weighting of the goods and services allows for transparency and repetitiveness of each scenario developed. Hence, this approach will leave it to the specific societal views to identify the land use types from functional point of perspective. Nevertheless, according to certain functions to develop, scientific founded ecological values from module 5 could advise stakeholders in placing values.

In general, the stimuli for the involvement of social, economic and political aspects in the planning process are the following key questions throughout the framework:

- To whom do the benefits and services to be developed matter?
- Why do the benefits and service matter?
- At what spatial scale do the benefits and service matter?
- How important are the benefits and services for society at all?
- Are there enough benefits and services?
- What can be done to make up for any loss or damage to the functioning of the environmental system(s) that generate these benefits and services?

### 3.7. (11) Matrix of buffer stripes

While applying the matrix of buffer stripes, single patches are delineated by bordering patches (Klug and Zeil, 2006). This span reaches from very similar land use areas to land use areas which are very distinct. It is assumed that the greater the difference of the

bordering patch type, the higher the degree of energy gradient (e.g. intensively used arable land bordering to conservation zones). This in turn led to a one sided energy flow with unclosed substance cycles such as soil erosion or soluble nutrient runoff processes, which should be interrupted by buffer stripes.

Having applied module 3 and considered all vertical superimpositions to avoid land use conflicts with the matrix of functional superimposition, module 11 aims to close substance cycles based on lateral site-to-site restrictions. Therefore the land use pattern revealed from module 3 is analysed to separate restricting bordering land units by a certain buffer space or re-allocation of the intensive land use to a more extensive one. For example, intensively used arable land bordering to surface water has to be separated by a buffer stripe. This buffer could be an extensive meadow with the aim to operate as a substance and matter deposition area to prevent surface water from eutrophication.

As a result of this module, the matrix identifies buffer stripes which are always required, partly required, and not required. Partly means that there is a need to refer to specific advices indicated by a number placed in the matrix. The type, size and structure of the buffer needed to be placed between excluded land units, is dependent on the types of land use bordering one another and the spatial configuration at all (e.g. slope gradients). Having stored this information in a database and linked to the matrix, the process of delineating buffer stripes could be done semi-operational in a GIS. The land use type to be placed as buffer stripe is in accordance with the land use classification system developed in module 3.

### 3.8. (12) Landscape metrics

Many recent empirical studies within the quantitative approach of landscape ecology have tried to investigate and describe landscape structure and pattern using a spatial explicit approach (Gardner and O'Neill, 1991; Hargis et al., 1998; Turner, 1989; Blaschke, 2000). Without the intention of repeating the whole history and the debate on assets and drawbacks of this approach called landscape metrics, some aspects have been discussed critically in Klug and Zeil (2004), Klug and Blaschke (2003) and Klug et al. (2003). Despite the fact that 'numerous measures and indices were developed to describe, characterise and evaluate landscapes in terms of processes, mutual relations, connectivity, diversity, functionality' (Lang, 2001) landscape metrics hampered the lack of transferability in comparative studies. While describing the pattern of a landscape by pointing out its spatial characteristics, the interpretation of the returned values from the computer-driven study remains crucial in evaluating underlying landscape functions, processes and change (Forman, 1995). Thus, investigations on the integration of landscape metrics into the hierarchical framework reveal that they cannot directly be integrated to the Leitbild finding process. This is due to the non-spatial transferability and non-predictable behaviour, especially in multi-scale assessments, but also due to the lack of knowledge regarding what the retuning values really mean in site specific ecological relation. 'Quantifying relevant spatial characteristics of a landscape therefore requires at least a sound concept based on empirically proved methods' (Lang, 2001). To overcome these shortcomings a tool called IDEFIX (Indicator Database for Scientific Exchange) was developed (Klug et al., 2003). IDEFIX aims to capture the behaviour of a metric in different applications and test areas to delimit lower and upper threshold values with the aim of delineation good and worse conditions.

### 3.9. (13) Results

As a first result scenarios were mapped which represent the development direction under the circumstances captured during

the development process with the stakeholders. Scenarios are helpful in establishing and generating potential policy options evolved by public participation reaching a balance of opinion among interested parties as to what factors define suitability. They can further shed light on and offer insights regarding possible future developments of the conditions set in module 9. The conditions result from priorities framed by different stakeholders and their point of interests and perspectives. Having a couple of scenarios at hand, they operate as an excellent basis for discussion, ending in a commonly agreed future state – the Leitbild. This agreement was achieved by balancing the values of functions towards a common denominator (Klug and Zeil, 2006).

In a commitment process the partners are willing to build a consensus. This consensus needs agreements on certain issues that have been developed by the process of decision making. These agreements lead to concrete objectives and activities for which responsibilities are formulated while going ahead to the process of implementing and evaluating a certain amount of determined activities.

Hence, the Leitbild is in the end the output of a commonly agreed aspired future state. After Hasler et al. (2003) the term output 'refers to both behavioural changes induced by the regulatory and non-regulatory instruments, and to the public services of landscape management. Finally, the term outcome refers to intended and unintended changes in landscape and nature quality from the agents' behaviour and from public services, and includes consequences for the economy and institutions as well'.

The Leitbild is a *spatially explicit* representation of land use units, their intensity as well as the buffer stripes identified. Having the database of the geographical information system (GIS) in background, each function of the land unit can be extracted and provide further insight in the use of the area under consideration.

As the Leitbild is not the only outcome, the results of this analysis can be mainly divided in four parts which are supported by smaller tools developed for semi-operational analysis: (a) cartographical maps, (b) statistics, (c) dissemination and documentation, and (d) tools.

- (a) *Cartographical maps*: Not being mentioned in this paper, the first result of the analysis is a land use/land cover classification representing the pattern of the present landscape. Secondly, after having applied module 12 we arrived at the commonly agreed aspired future state of the landscape. The map represents the land-use allocation and structural pattern of the landscape resulting from ecological, economic and socio-cultural values. Additionally, several maps of single functions and services (e.g. buffer functions), potentials (e.g. biotope development potential, ground water recharge potential) and risks (e.g. soil erosion, nutrient discharge) could be mapped, presented, and analysed.
- (b) *Statistics*: Diagrams, Tables and Lists comparing the shares of present and aspired land use, length of buffer stripes implemented, and others serves for a better understanding of the findings.
- (c) *Documentations*: Several documents are accompanying the analysis, explaining the methodology. For example the 'Fact Sheet' from module 3 serves for transparent deduction and practical implementation of the approach each step of the analysis is explained in the tools developed. Additionally, the semi-operational models are well documented using labels and further explanations in the GUI.
- (d) *Tools*: As outlined in Klug (2005) GIS tools have been developed in the ArcGIS 9 to allow semi-operational and therefore efficient application of the Leitbild.

### 3.10. (14) *Subsidising programmes*

The resulting spatial explicit actions or countermeasures gained from the comparison of the land use classes of the present and aspired landscape in module 13 needs to be re-checked on the basis of the payment schemes through a list of funding budgets and equalisation payments (this module) available from regional, national and international investors (e.g. Cross Compliance) from EU, ÖPUL (<http://land.lebensministerium.at/article/articleview/62457/1/21409/>) in Austria, ELER in Germany (<http://www.eler.sachsen.de>). It is argued, that only the link between such subsidies with the developed action plan gives certainty of realisation of the aspired agri-environmental measures, especially the increasing attitude of farmers receptiveness for the management plan when supporting them (Lütz and Bastian, 2002). If the budget to fund single or combined measures is not secured, the parameters developed in module 3 needs to be verified and if necessary revised.

### 3.11. (15) *Action catalogue*

Having highlighted the action potential through the comparison of present and aspired state, and having extracted the budget ready to use in module 14, an action catalogue need to be established to allocate financially manageable measures to be applied in the landscape through farmers. In particular, the activities should be time dated and implemented through a simple set of funding schemes, used either alone or in combination, and need to be discussed with the farmers themselves during participation of the planning endeavour.

## 4. Implementation, documentation, and validation

Whereas different landscape processes, functions and services as well as their value and demand for society run mentally simultaneously and implicit in each stakeholder perception for one's vision, in digital processing all these elements considered framing the future state need to be modelled, coded and programmed in e.g. a GIS. This means, the human brain is able to manage and delineate features with ease that in a machine-based way are hardly detectable (Albertz, 1999). Hence, in GIS analysis we need to atomise the derivation process, separate the parts of the landscape and make the functions of these parts explicit in a workflow. Expert knowledge is required to derive certain potentials, functions and risks for certain resources. Thus, the result of experiences gathered over decades need to be formalised and encoded in binary rule sets. A semi-automated application system has been successfully applied in ArcGIS 9 Model Builder and is explained in detail by Klug (2005). It could be shown that the advantage of digital landscape analysis with GIS lies in the strength of the computer's efficient processing capability classifying numerous of small landscape patches, whereas the human brain may be strong in interpreting and formalising complex structures.

The more complex the landscape planning workflow becomes, the more difficult it is to keep track of the various contents, steps, datasets, processing procedures, parameters, and assumptions being used. Therefore, documentation is a necessary task for communication and explanation. Hence, a twofold strategy is used: First, documentation of the methodological framework as outlined in each module (e.g. the facts sheet of module 3), and second accompanying instructions of the models build in the ArcGIS 9 Model Builder. Despite the fact that the model itself represents the analysis structure while atomising each step, an established Help File and other documenting possibilities such as labels guides the user through using the tools and recalls the reasons for the choices

made. Additionally, messages explaining the status of each process to convince others of the existing study's legitimacy. Moreover the documentation is strongly recommended for a repeatable and transparent analysis making allowances for justified adaptations of parameters and lastly the following validation process.

The behaviour of such complex systems can only be explored through the variation of conditions, relationships, parameters, and structures. This includes the analysis of the behaviour of single parameters and their contribution to the model results in the form of sensitivity and significance tests. This is one of the most challenging and time consuming tasks to do in detail in further research. So far only single sub-modules as for instance the ground water recharge potential or the biotope development potential were sequentially improved through field trips and optimisation of algorithms and at last could be verified together with local and scientific experts and therewith approved useful in application. Nevertheless, the process of making scenarios reveal that the results gained from the scenarios suit well in comparison to the values set by the stakeholders and the expectations from the stakeholders.

## 5. Discussion

Each module described above is a methodological result of the overall concept and has its endogenous results, assets and drawbacks. Thus, besides the already mentioned outcomes from module 13, the following section is dedicated to grasp the main results and benefits from the methodological, technological, and application point of perspective.

From the methodological point of view, a unique structure of analysis and planning support has been investigated. It incorporates the design of spatial concepts considering lateral and horizontal processes with reference to structure, functions, and change while understanding and identifying interactions, planning, and managing the landscape. Different views of planning approaches have been synthesised in one framework and make it accessible for practitioners through GIS procedures. It enables planners to predict ecological consequences from a hierarchical structured and transparent deduction of pattern and process relationships based on functions in a multi-purpose planning approach to tackle the highly dynamic and interactive change processes. Furthermore, the concept serves as a basis for a transparent methodology to exclude and/or prioritise areas for land use and protection. It fits the role of an ecological scale for continuous monitoring and evaluation with the decisive question: 'Does the planning process lead to the right results?' It provides criteria for progress control in landscape planning through continuous monitoring. This ensures intelligent registration of unwanted developments with possibilities of interventions from politics and the planning site.

From the technological viewpoint, the progressive character of this approach mainly lies in the fact that it provides transparent and pursuable tools to establish different perspectives of landscape development through scenario techniques from a single geodatabase. Whereas earlier landscape studies were restricted to single functions and viewpoints, nowadays the scope of issues tends towards a multi-functional approach being applied for instance in the approach of Ecosystem services – bridging ecology, economy and social sciences (Burkhard et al., 2010). These capabilities widely correspond with the reflections stated above and its employment leads to a promising approach of integrating GIS and remote sensing, both significantly coupled with a strong link to landscape ecological findings. 'Optimistically one might assume that integrating valuable experiences of landscape ecologists are no longer limited by operational shortcomings or technical restrictions' (Lang, 2001).



The main challenge was to provide an open structured product based on the latest techniques representing ecological interdependencies extracted from numerous publications and narrowing them down to binary decisions to be applicable in a GIS. The main benefit of this approach, contributing to a more holistic future planning, is supported by practical GIS toolsets.

From the application point of perspective, this approach applied to the grassland dominated area in the MC seems to be proofed suitable in practice (Klug, 2010). This methodology was able to improve soluble phosphorus discharge to surface waters from non-point source pollution through a better distribution of land-use and buffer stripe areas. The detailed effects of these solutions could not be measured so far. It remains on the countermeasure plan implementing the proposed Leitbild and further observation of the phosphorus intake to surface water in future. The results from the application are discussed in more detail in Klug (2010).

## 6. Conclusion and outlook

This paper contributes to the analysis of Leitbilder (German plural of Leitbild) in transdisciplinary planning purposes which might contribute to the construction of scenarios and to the argumentation process based on them. While Potschin et al. (2010) could show how the Leitbild concept works as a holistic transdisciplinary approach in detail; this paper extrapolates this knowledge into spatial units by using a holistic and transdisciplinary Leitbild methodology. While the findings from Klug (2010) shows in detail the workflow within the participation framework, here the author gives a brief overview how the concept works as a whole framework. Complementary with the paper from Klug and Zeil (2006) the hierarchical framework allocates specific land use types to spatial explicit land units. From the matrix of functional superimposition in detailed explained in Klug and Zeil (2006) the function running in parallel or time after time can be shown.

Although this planning exercise did not change the general approach in looking at landscapes, it did identify a number of different and innovative management implications not previously considered. The new potentials of landscape planning with this model lie within information and communication. It integrates research activities yielding more knowledge of perceptions, attitudes and behaviour of stakeholders, conflict resolution and preferences in decision making.

In particular this approach highlighted the importance of environmental goods and services as initially proposed by Costanza et al. (1997) and de Groot et al. (2002). These concepts have been further developed by others (see e.g. Burkhard et al., 2010). This environmental capital of substitution provides greater understanding of the underlying reasons why these particular features or services may be important to the local community or not. Similarly, a combination of ecological and socio-economic demand is taken into account to adequately bear in mind potential impacts, i.e. to compare different types of alternatives. The exercise also revealed the intangible but symbolic or cultural importance attached to the presence of the aspired landscape as a major factor influencing landscape development. Therefore it is argued with many other authors that existing environmental planning approaches need to be re-evaluated by socio-economic values and measures.

Several particular or sectoral Leitbilder have been identified in the scope of different stakeholders' opinions. Among them, there might be more or less relevant Leitbilder based on endangered ecological settings. The choice of relevance is with the participating members, while in general the shared vision is both desirable to the vast majority of humanity and ecologically sustainable.

The identification of key actors representing a scenario allows on the one hand for constructive criticism from other participants and

on the other hand on underpinning statements about the assumptions made. This debate causes communication and clarification. Arguments concerning challenges were discussed, which partly need to be mediated between conflicting parties. Nevertheless, setting clear objectives and constructive discussion is regarded as extremely important and has partly observed a very underdeveloped skill in our society (Meadows, 1996).

Participative Leitbild development has high burdens to overcome. Researchers dedicate to this transdisciplinary planning approach often face a difficult dilemma. On the one hand they need to proof that their work will yield results before receiving financial resources. On the other hand they are unable to precisely predict the outcome due to the emergent and unpredictable behaviour of the people. Additionally, researchers are unable to get in action without these financial resources. Finally, it based on the trust of the investor who also takes the risk for an unsuccessful end of the analysis.

However, this case has shown that participatory Leitbild development can provide a basis for more sophisticated promising future landscapes that will go beyond the mere ecological deduction of ecological 'optimal' states. As Yankelovich (1991) presented, effective ways to start the dialogue between the participants is to present complex issues to solve in a number of scenarios, which clearly lay bare the conflicts and inconsistencies buried in opinions, demands, and requirements. Creating a shared vision is therefore the most effective engine for change in the desired direction which is fair and equitable to all of humanity without extrapolating past trends rather than based on realistic scenarios based on present societal demands and requirements. Nevertheless, the characterisation of this planning approach indicates the early-stage of participatory landscape development with all its benefits and limitations but also shows the potentials it holds. The exchange of factual arguments inform what the participants consider as key success or failures in their own field and how these might function as starting point of promising landscape development. Analysis of future visions can help to both to design the future landscape pattern and its underlying land use and maximise the chances of our getting there safely. The exercise underlines the transdisciplinary nature of the landscape which provides a substantial challenge to what is perceived as necessary development and collaboration between interdisciplinary disciplines and society.

From start on it must be obvious that the scenarios have to be flexible and evolving towards a commonly aspired future state. Thus it must be clear that each scenario developed could directly make the way to be the Leitbild for the future. This requires giving up and taking some other demands to get to one denominator.

Governing landscape means the necessary ingredient to move change in a particular direction which is truly shared by the members of the planning group. Governing is indispensable since the world is more and more interconnected every day. Everything is related to everything and decisions and actions therewith affect everyone. Therefore, after Yogi Berra we need to decide where we want to go because 'If you don't know where you're going, you end up somewhere else' (<http://de.wikipedia.org/wiki/Yogi.Berra>). Thus, bridging the gap between experts of science and local people prerequisites consciousness-raising, awareness generation, and developing understanding is the challenge we need to face as fast as possible to allocate resources including both marketed and non-marketed resources such as ecosystem services.

While principles of sound integrative landscape management and development must govern any arbitrary use of landscape resources, a broader flexibility in politics, the behaviour of farmers and other stakeholders must be afforded, in order to allow the full and complete use of the landscape as natural capital in the most efficient sustainable way. Such flexibility would help to enable landscape planning to play its fullest possible role in contributing

to the EU's broader policies and societal objectives in this context. Approaches in this respect will be considered in future to amend the landscape applicable to the general demands and needs. Of course, it is not possible to find the proper rule set to overcome all environment conflicts. But again, when aiming to delineate areas with a certain priority for a particular function we have clear assumptions of how to do so.

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