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WIS.2 – A SUSTAINABLE FOREST MANAGEMENT DECISION SUPPORT SYSTEM

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Abstract. WIS.2 is a DSS for monitoring and implementing the goal-oriented and sustainable management of forest ecosystems, especially with regard to the integral management of significant spatial and temporal scales in forest ecosystems. WIS.2 considers multiple ecosystem goods and services in silvicultural management and the implementation of silvicultural interventions, which are in accordance with the Swiss silvicultural tradition. WIS.2 takes a top-down approach, starting with the entrepreneurial strategy, and ending at short and mid-term interventions at stand level. WIS.2 structures the overall decision process across multiple scales and provides decision support for each decision to be taken by organizing and connecting available data and models.

WIS.2 is based on MS Access and ArcGIS View and is composed of different applications, each handling a main aspect of the management of forest ecosystems. The tool is used at the level of higher education in forest management in Switzerland. WIS.2, initially developed during 2001-2005 within the framework of a PhD thesis at the ETH in Zurich (Rosset 2005a), has been successively improved through practical use in more than 10 case studies in five Swiss Cantons. The main challenge is now to advance from a prototype to an easily available consolidated IT product.

Keywords: Decision support system, sustainable forest management, silvicultural planning, strategic planning, tactical planning, forest entrepreneurial strategy, multi-purpose forestry, close-to-nature silviculture.

1 Intorduction

In the 1990s, a new two-level forest planning concept was introduced in Switzerland; one level dedicated to forest authorities with the main purpose to ensure public needs like sustainable wood supply, nature conservation, protection (against e.g., rock fall, avalanches,...) and recreation; the other level dedicated to forest owners and forest managers, which is meant to ensure the success of forest management, especially from an economical point of view. The main planning instruments are the Forest Development Plan (FDP) at the authority level and the Forest Management Plan (FMP) at the owner level. Public needs fixed in the FDP are implemented at the owners' level by means of agreements, contracts or authorization for harvesting. The FDP is only binding for the authorities, not for the owners. The FMP gained a new role with the emphasis on entrepreneurial strategy instead of being focused mainly on the silvicultural planning. The entrepreneurial strategy defines the goods and services likely to ensure the success of the forest enterprise (Bachmann *et al.* 2002, Bachmann 2005).

From this new perspective, the silvicultural planning of an extended forest area is a challenging task that spans between the mid to long-term oriented forest entrepreneurial strategy, the short-term harvesting planning, and the long-term necessity to ensure sustainable forest development. As such, silvicultural planning is an important instrument within the framework of FMP for connecting and integrating the relevant temporal and spatial scales of forest management, particularly with regard to consolidating the entrepreneurial strategy with the planned intervention at stand level (i.e., making the strategy effective), without forgetting to assess the long-term consequences of the decisions taken for the whole forest area (i.e., making forest management sustainable). It should also be flexible enough to easily adapt to unforeseen and sudden changes like storms, as well as to new strategic orientation.

In other words, silvicultural planning aims at shaping the entire forest mosaic in a flexible way by organizing and coordinating interventions at the stand level (the basic unit of the mosaic). Since clear-cut is forbidden by law in Switzerland (Art. 22 LFo; RS 921.0) and close-to-nature silviculture is compulsory (Art. 20 LFo; RS 921.0), stand mosaics tend to be fine-grained with its smallest units smaller than 1ha. The planed intervention at stand level should be detailed enough to implement the strategy efficiently, and at the same time leave enough leeway for harvesting planning, which is subject to market fluctuations and harvesting capacities. The planned intervention also needs to be adapted to the specificities of the local situation and to be inline with a liberal and pragmatic view of silviculture in Switzerland (see Schütz 1999).

Decision Support Systems (DSS) represent a useful concept to develop computer-based tools to support forest managers in implementing the depicted silvicultural planning. DSSs help organize and structure the overall decision process over the multiple scales of silvicultural planning, as well as provide the support for each decision to take by organizing and connecting available data, models and methods. Wierzbicki *et al.* (2000) define a DSS as "a computerised system that supports its users in a rational organization and conduct of a decision process (or its selected phases) and, besides a database, also contains a pertinent knowledge representation in the form of models of decision situations as well as appropriate algorithms for using these models". Alter (2004) expresses some scepticism about new developments in DSSs, which just consist of the implementation of new technological capabilities ("technical artifact"). As long as the technical capabilities are not incorporated into work systems, they have little or no impact. In other words, "Decision support is not about tools per se, but rather, about making better decisions within work systems in organizations" (Alter 2004).

WIS.2, a prototype DSS, was developed to implement a pragmatic approach to silvicultural planning in Switzerland. WIS.2 is a DSS for monitoring and implementing the goal-oriented, sustainable management of forest ecosystems. It functions in a top-down manner, starting with the entrepreneurial strategy and ending with short and mid-term interventions at the stand level. Concretely, WIS.2 helps forest managers keep the big picture of an extended forest area in mind, not only of the current situation, but also of past developments and future trends. It provides support to take decisions on fundamental aspects of the forest mosaic like the overall tree species composition, the target tree dimensions and their related rotation period, the extent of the regeneration of the demographic structure (age structure, development stages), as well as particular stand structures. It supports its user to elaborate guidelines to implement the overall targets down to the single stands, like tree species promotion according to the prevailing site conditions, as well as tending and thinning intervention milestones according to the development stages of the stands. Based on these decisions, an intervention map and the prescribed yield are computed, which are the prerequisites for the annual harvesting planning. The development of WIS.2 was basically decision-driven, while taking into account the forest data likely to be easily available by practitioners. Accordingly, the main input data to WIS.2 are stand maps and site conditions maps based on phytosociolgical units. Both are available in many Cantons in Switzerland (e.g., Zurich, Aargau, Basel and Fribourg).

The depicted approach (top-down, decision-driven, pragmatic) to DSS about silvicultural planning is new in Switzerland (see Heinimann *et al.* 2014) and does not seem to have any equivalent in Central Europe (see e.g., Vacik *et al.* 2014, Felbermeier 2014, Portoghesi 2014, Bonèina *et al.* 2014).

WIS.2 was developed within the framework of a PhD thesis at the Swiss Federal Institute of Technology Zurich (ETHZ) (Rosset 2005a), and has since then been successively developed in an iterative manner using inputs gained from practical experience.

This article presents the methodology used to develop WIS.2, the planning system underlying WIS.2, the WIS.2 prototype, as well as the WIS.2 project and the next steps to take.

2 Methodological Framework

WIS.2 was modelled through a systems engineering approach (see Daenzer and Huber 2002) according to the methodology of Schönsleben (2001) and Specker (2001). This methodology describes the development of integral information systems, especially with regard to supporting the value-adding process of an enterprise. Based on this important process for the success of an enterprise, the necessary supporting functions and objects are organized and structured, and the implementation tasks defined. These tasks are allocated to organizational units in the enterprise, which have the necessary competencies and resources. Specker (2001) developed a technique named after these four perspectives called PrOFA, which means **Pr**ocess (focus on system dynamics, especially on the way system activities should be performed), **O**bject (focus on system elements necessary to support system activities), **F**unction (focus on system functionalities, especially on the outputs expected from system activities) and task (focus on the organization of system activities). Specker (2001) also adds a fifth perspective about IT-techniques (i.e., hardware and software solutions to support system activities). The PrOFA technique organizes modelling methods according to these perspectives, considered alone or in combination in order to model the system successively and to handle its complexity step-by-step with increasing formalism. In order to obtain an overview, the methods are organized in a matrix according to the perspectives which represent the main focus of the modelling. The developer team can then select the modelling methods suitable and fitting to the problem to solve. The modelling methods should be as simple as possible in order for the targeted users to be able to understand the results and take an active part in the development. The methods should also be understandable for IT specialists, who will develop the IT solution on a given IT platform (e.g., see Schönsleben 2001).

The PrOFA technique was used and adapted in WIS.2. The added value supported by WIS.2 is made out of the decisions taken by the user in order to have a clear reference to manage forest ecosystems in a sustainable way. WIS.2 is designed to guide the users in the overall decision process and provide them with decision resources to support decision making. Each decision to make corresponds to a task that the user should accomplish and for which the user should have access to the necessary resources in terms of decision support (information and knowledge). A task is structured according to the decision model of Simon (1980), who divides the decision process into four phases: the decision to take (problem to solve) corresponds to the intelligence phase, the decision options to the concept phase, the decision taken to the selection phase and the documentation of the decision taken (consolidation) to the review phase. The notion of task implies that the user is responsible for the decision taken. As a prerequisite, the user of WIS.2 should have the necessary professional competencies. Furthermore, the decision support provided should enhance creativity to explore unconventional and innovative solutions (see e.g., Wierzbicki *et al.* 2000). The complex overall decision process in silvicultural management is divided into tasks and sub-tasks in a recursive, top-down manner with clear interconnections. Basically, the questions to be answered regard what decisions are to be taken and their interdependencies, in which order these decisions should be taken, what sort of support is needed for each of the decisions, and how the resources necessary to provide the overall decision support should be organized.

Figure 1 depicts the modelling steps applied for the development of WIS.2. Based on Specker (2001), these

Perspectives: primary→ ↓secondary	process	task / function	object	technique
process	system overview (1)	overall decision tasks system (3)		interfaces with other technical systems (7)
task / function	decision support resources (4)			technical system and tasks (9)
object		single decision task (2)	decision support resources as object-oriented system (5)	technical system and objects (8)
technique				IT system architecture (6)

Figure 1: Modelling steps and modelling aspects of WIS.2 according to the prevailing (primary/secondary) modelling perspectives (process, task/function, object and technique.

steps are organized in a matrix according to the main focus (primary, secondary) the PrOFA-perspectives have for the modelling respectively. The modelling process can be divided in three phases: in the first phase (Steps 1-3), the overall decision process is designed and organized as a tasks system based on the single decisions the user should take (decision system). In the second phase (Steps 4-5), the support required by the decision making process is formalized in an object-oriented system (support system), and in the third phase (Steps 6-9) the whole system is integrated in the IT-solution (decision support system).

The process perspective is mainly for organizing the task system and the order to provide decision support for a given task. The object perspective is mainly for organizing the resources of the decision support in a coherent object-oriented system that includes the system functionalities (i.e., methods assigned to object classes).

Step 1 is designed to give an overview of the system, to delimit it and to highlight interfaces with other systems. Steps 2 and 3 concern determining the single decisions the user has to take by the silvicultural planning and building up the overall decision process as a coherent tasks system. Steps 4 and 5 focus on identifying which supporting resources (information, knowledge) each decision requires and organize them in an object-oriented system. Steps 6 to 9 are dedicated to implementing the system in an IT solution.

Figure 2 illustrates the methods used for the modelling of Steps 2 to 5 (modelling of the overall decision system and the decision support). The complexity is handled step-by-step with increasing formalism.

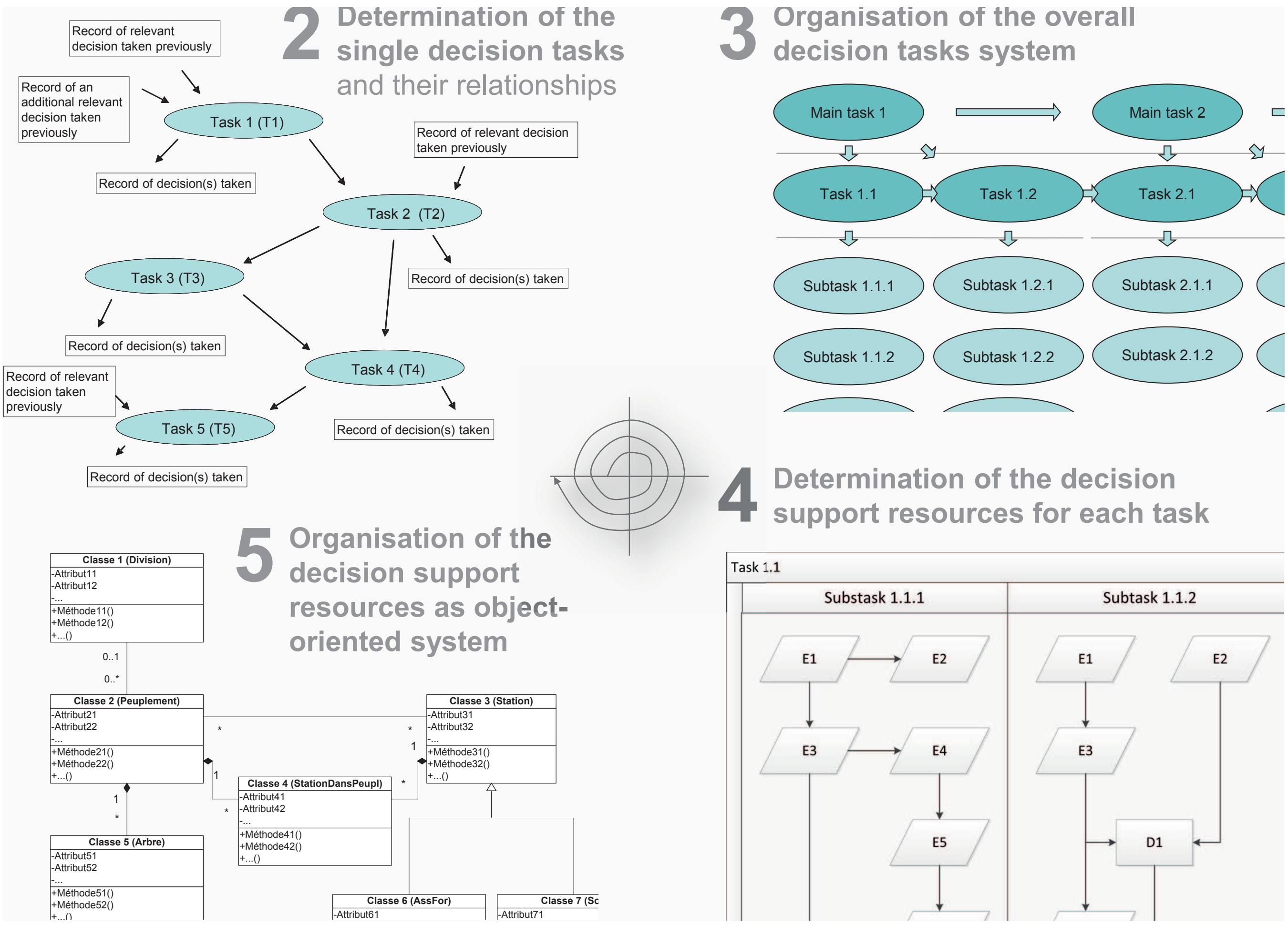

Figure 2: Methods used for modelling the overall decision process and the decision support (Step 2-5 of Fig. 1; adapted from Rosset 2005b). In the data flow diagram of Step 2, the tasks are depicted as ellipses and the rectangles symbolize decisions, either former decisions that have an influence on the performance of a task or decisions resulting from the respective task. In the data flow diagram of Step 3, the tasks are organized according to their hierarchical level and the order to accomplish them (top-down, left to right). In the flow chart of Step 4, parallelograms correspond to decision support resources (E) necessary for performing the task at hand; the rectangles represent the making of a decision (D) by the user. The rectangles in the UML class diagram (bottom left, Step 5) each represent an object class.

A data flow diagram (see e.g., Schönsleben 2001) was used to determine the decisions to take and their corresponding task, as well as to highlight decision interdependencies (single decisions to take, Step 2). For consolidating the results from Step 2, the tasks were organized in a coherent, hierarchical system to obtain an overview and a structured workflow to accomplish the tasks (overall decision tasks system, Step 3). The accomplishment of a task at a given hierarchical level presupposes the accomplishment of all subtasks and the consolidation of the whole. An adapted flowchart helped organize the decision support for each task, as well as the order of provision of these support (decision support resources, Step 4). Finally, the decision resources (data, models, methods) necessary for the overall decision support, as well as for the decisions themselves were organized in an Unified Modeling Language (UML) class diagram as an object-oriented system (objects for the decision support resources, Step 5).

The software selected to develop the IT-prototype was Microsoft® Access and ESRI ArcGIS® View. These two applications were chosen because of their complementarity, widespread use, relatively low costs, full integration into the Windows system, the possibility of extending their capabilities by using Visual Basic for Application (VBA), an easy-to-use programming language, and the ease with which user interfaces can be created.

Step 6 of Figure 1 is the organization of the prototype in a modular system. It comprises different applications each representing a main task (based on the results from Step 3). Forest data are stored separately from the applications, and a clear distinction is made between data about the state of the forest and the interventions carried out in the forest and management data (variations, decisions).

Step 7 entails ensuring the working interfaces with other IT solutions; Step 8 involves implementing the object-oriented diagram (Step 5) in Access and ArcGIS View in the form of databases, program codes like functions, procedures and module classes; Step 9 refers to implementing the user interfaces in each application according to the result from Step 4, which provides the articulation of the user interfaces.

Considering the complexity and modularity of the system, the spiral model (Boehm 1988) was chosen to successively develop the WIS.2 prototype. This model reflects the underlying concept that each cycle involves a progression that addresses the same sequence of steps, for each portion of the product and for each of its levels of elaboration, from the overall concept of operation document down to the coding of each individual program (Boehm 1988). Developing WIS.2 in this manner not only gave the advantage of learning from experience gained during the development of one application for the elaboration of the next, it also provided potential users with concrete application in the early stages of the project.

3 Planning System

The entrepreneurial strategy of a forest area is the starting point of the silvicultural planning process in WIS.2 (top-down-process). In order to be able to react flexibly to changes while leaving as much room as possible for operational leeway, a slim planning process was developed and implemented in WIS.2, focusing on a relatively small number of decisions with far-reaching implications. The users of WIS.2 can proceed with the planning at two levels: the basic level and the extended level. The basic level is about fundamental aspects of a forest area like trees species composition, tree dimensions and the renewal of the demographic structure. The extended level focuses on the composition of the stands mosaic and the structure of the stands themselves. This level complements the first level with the possibility to specify particular stand structures and to allocate them to specific locations.

The **basic planning level** comprises five main decisions, three of them as overall objectives and the last two for consolidation at stand level. Firstly, the planner has to define (a) the targeted tree species composition on the long term, (b) the targeted tree dimensions and rotation periods necessary to reach these dimensions, and (c) the overall regeneration policy (i.e., extent of forest regeneration per decade respectively the renewal of the demographic structure). Then, (d) guidelines for tree species promotion at stand level have to be defined according to the existing phytosociological units (i.e., an area with more or less homogenous site conditions). Finally, (e) a tending and thinning concept is elaborated for each tree species by determining milestones within stand lifespan. These milestones are set in order to determine when to intervene and how to efficiently reach the production targets (e.g., tree dimensions, quality, and stability). From these decisions, the yield and an intervention map for a time horizon of 10 years is derived from growth functions, and represents the interface to the annual harvesting planning. Furthermore, to better coordinate the regeneration activities, spatial and temporal constraints can be highlighted to avoid e.g. steep edges (wind damage, emergence of epicormic branches that decrease the quality of wood) and damage in the new tree generation, because of wood transportation within the stands (see Rosset and Schütz 2003).

The **extended planning level** concerns requirement profiles, which are used as the basis for the refinement of the stand mosaic. Forest products and forest services can be described with WIS.2 in the form of silvicultural requirement profiles with regard to stands (what characteristics to influence), and site and forest road system conditions (location priorities). The requirement profiles are used to assess forest areas fitting to the profiles, and serve on one hand to evaluate the potential of a forest product or service in the given area; and on the other hand to define the location to provide them if backed up with the strategy. Profiles can be then compared to highlight complementarities (possibility to provide more than one product / service on the same area) or incompatibilities (see Rosset *et al.* 2009a). The requirement profiles enable the explicit connection of the silvicultural planning to the entrepreneurial strategy and enable highlighting the managerial constraints consequent to the implementation of a forest product/service.

The forest area can be subdivided in major planning units each dedicated to a particular silvicultural system. Currently, only the irregular shelterwood cutting system has been implemented in the prototype, which is characterized in Switzerland by a renewal of trees in discrete generations through progressive group felling and a liberal felling policy (Schütz 1999).

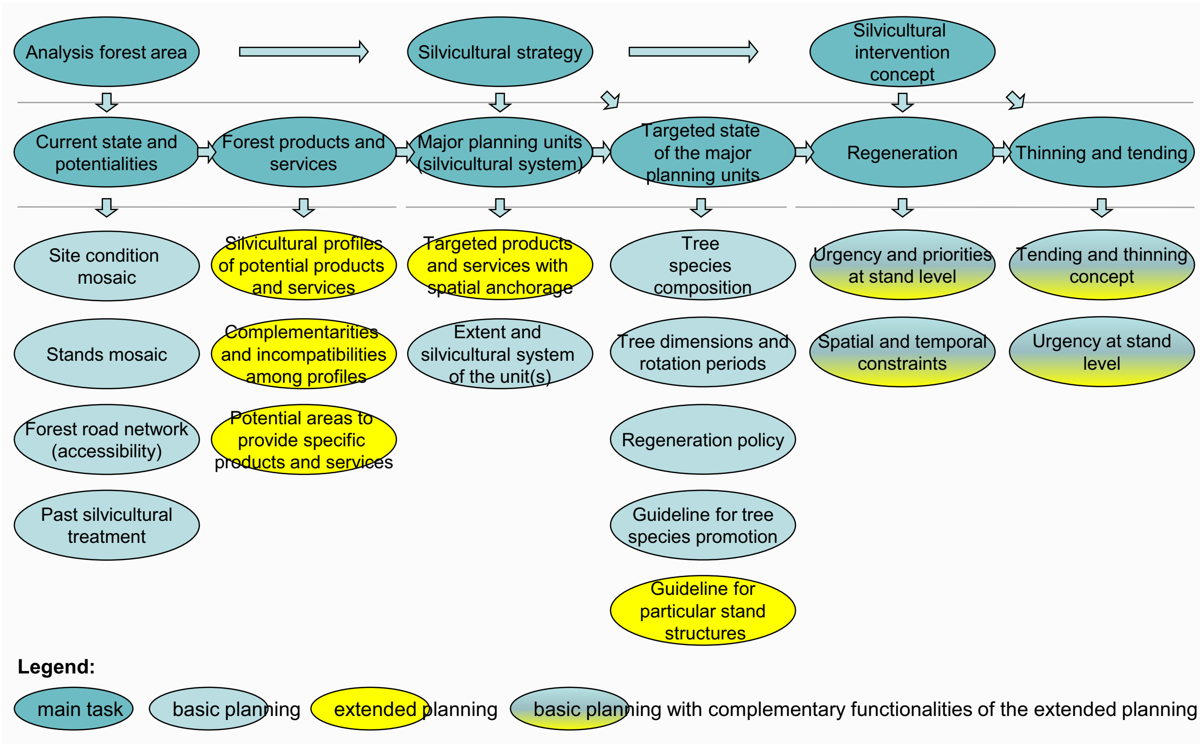

Figure 3: Overall decision tasks system (adapted from Rosset 2005b). The tasks (ellipses) are organized according to (a) their hierarchical level and (b) the order to accomplish them (top-down, left to right).

Figure 3 illustrates an overview of the two-level silvicultural planning system and their respective tasks (overall decision tasks system as a result of the 3^{rd} modelling step, see Fig. 2).

Each task of the 2^{nd} hierarchical level of Figure 3 corresponds to an application in WIS.2, which are described in the next chapter.

4 Prototype

WIS.2 has a modular structure and comprises several applications that each focus on a main task in silvicultural management. These specific applications are found in the field of (a) data management, (b) analysis of forest areas in the preliminary stage of devising an enterprise strategy and (c) the silvicultural planning of the implementation of this strategy. Analogue to the decision making process, each application is structured in several user interfaces in which the user can move freely (see Fig. 4). Important information for making the decision is prompted, as well as the possibility to test several variations. The interfaces also provide the possibility to comment on the planning process in a systematic way and to print the silvicultural plan in a step-by-step manner. The handling of the tool is simple, giving the user the opportunity to concentrate on making decisions. All available functionalities are directly accessible on the interfaces, and the standardized layout makes the prototype easy for the user to quickly get accustomed to the system.

WIS.2 relies on inputs provided by practitioners, which include data on stands, phytosociological units (spatial unit with more or less homogenous site conditions), topography and forest road infrastructure (see Rosset and Schütz 2003, Rosset *et al.* 2009b for more information). The main outputs of the planning process are the decision sheets, which are in essence simplified reports of the silvicultural plan that give concrete instructions on how to implement the enterprise strategy at stand level. Figure 5 illustrates these main inputs and outputs as well as the planning process in the case of the basic silvicultural planning. The processes encompass the five decisions to take presented in the previous section, as well as their consequences. The user has the opportunity to not only comment on the decision taken, but also explicitly on the consequences of these decisions. There is at least one decision sheet for each process illustrated in Figure 5.

The decision sheets serve as a cockpit for the manager to monitor and steer the development of the forest

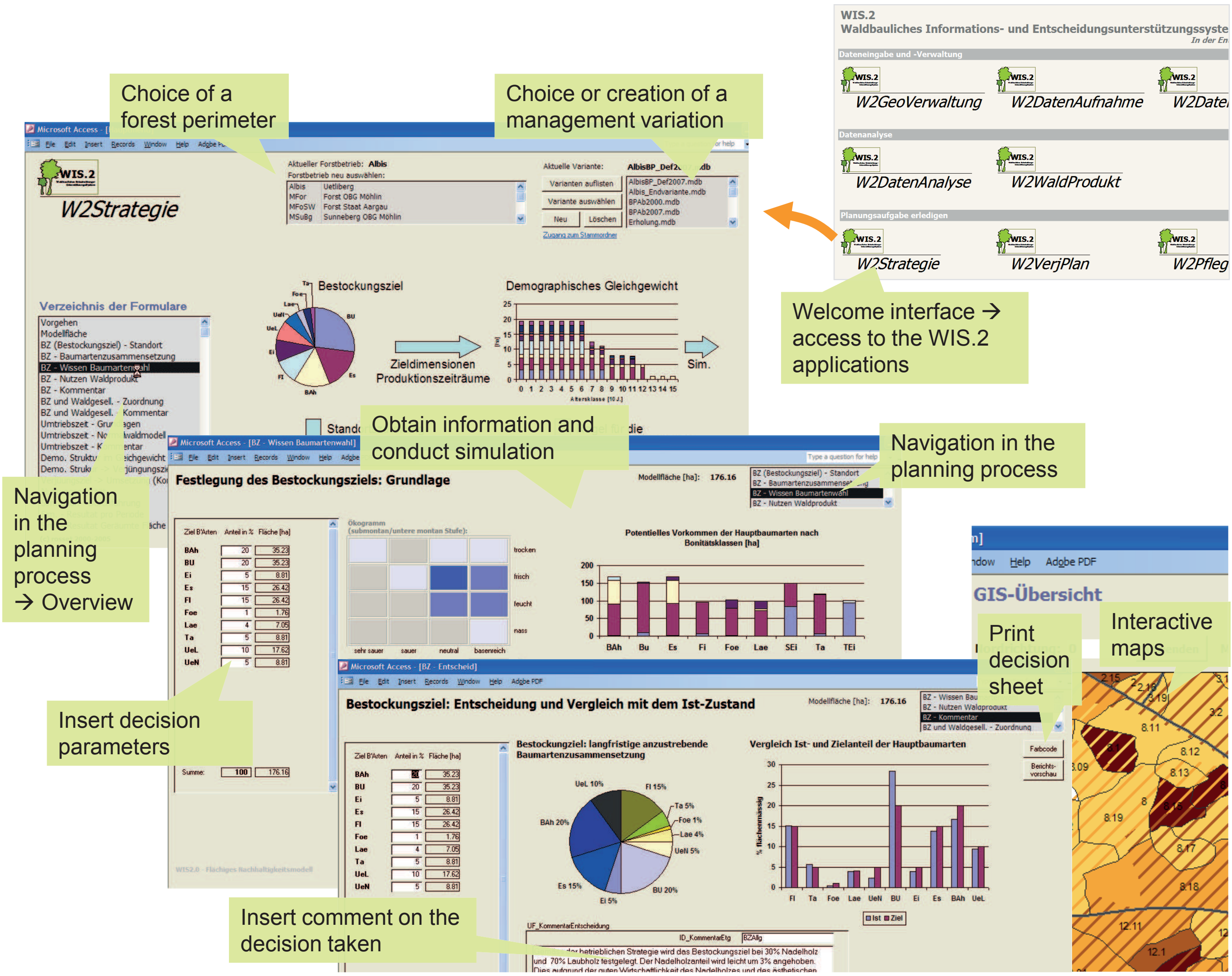

Figure 4: Examples of the WIS.2 user interfaces.

ecosystem. They provide information (such as graphs, tables or maps) about the decisions made and their consequences, place them in comparison to the current state of the forest area, depict the developments over the past years/decades, show the mid- to long-term trends, and state the necessity of action in the form of maps. The information provided in the decision sheet is automatically updated through the actualization of the input data. This dynamic information allows the manager to continuously monitor the development of the forest area, to compare it to the objectives and, if necessary, to introduce some corrective measures at an early stage. The decision sheets have a uniform structure: the position of the decision sheet in the planning is highlighted on the left, reasons to perform this planning stage are mentioned in the lower left corner and the field below the graphs is dedicated to comments. Figure 6 gives an example of a decision sheet (see Rosset *et al.* 2009b for further examples).

On the decision sheet shown in Figure 6, we can see that the regeneration of the 10 last years corresponds more or less to the targeted composition. In this case, the manager has decided to pursue in future the regeneration philosophy applied in the last 10 years, which was a big change at that time (strong decrease of the proportion of *Picea abies* ‘Fi’ in favour of *Fagus sylvatica* ‘Bu’).

5 Discussion and Conclusion

It is premature to claim that WIS.2 is entirely successful, since it is in essence still a prototype and is only used by a limited number of people. Nevertheless, after the

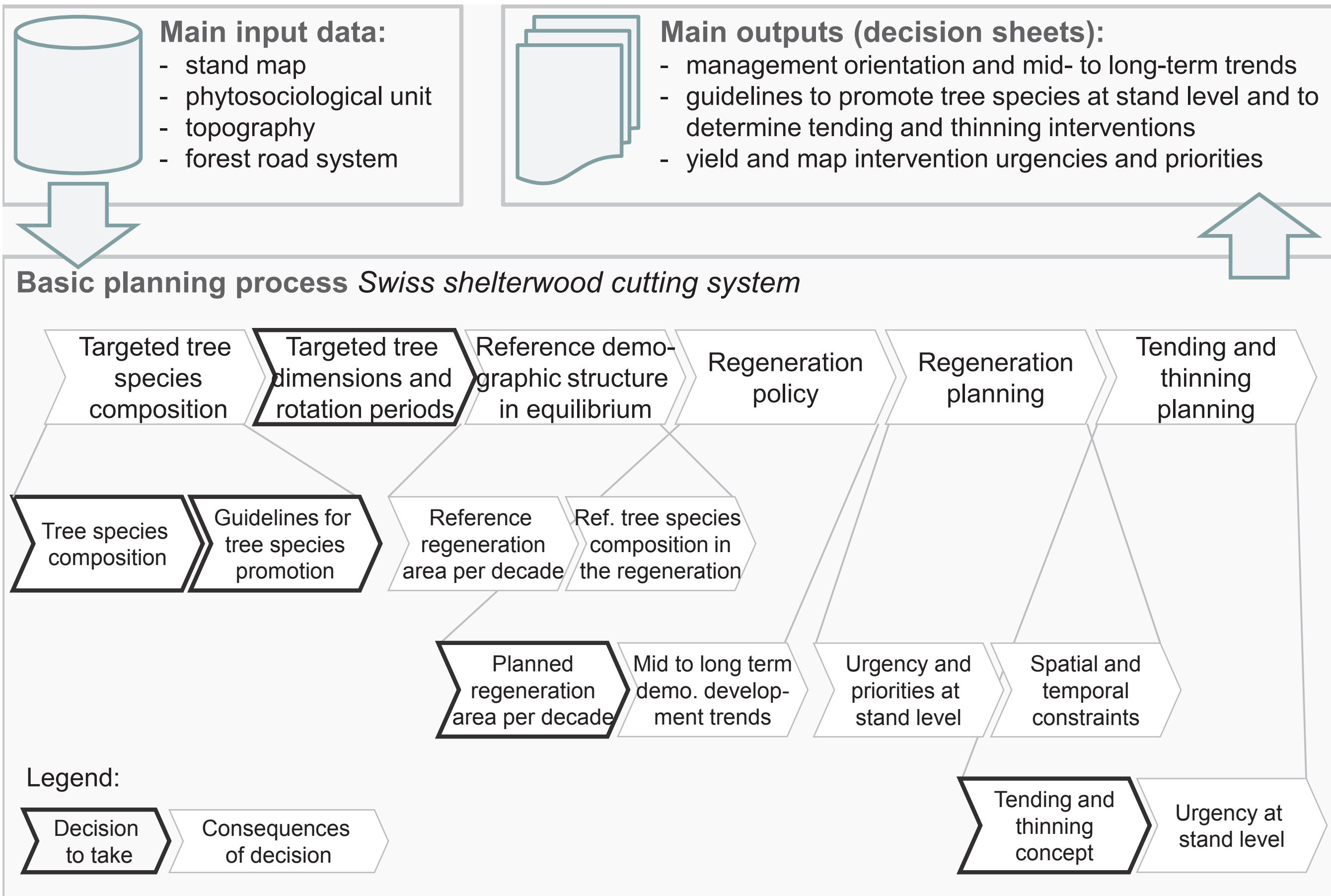

Figure 5: WIS.2's main inputs, outputs and processes of basic silvicultural planning (adapted from Rosset et al. 2009b).

completion of the PhD, WIS.2 passed the first important hurdle from research to practice after receiving resources from a forest engineering firm to be further developed. In an early stage, three forest enterprises also showed interest in using the tool, which was an important phase for adapting WIS.2 for practical use and gaining experience with new functionalities. The decision sheets are an example of such an adaptation, and since then these sheets have been used in consultancy services for other forest enterprises, significantly enlarging WIS.2's scope of application.

Numerous WIS.2 contributions have been published in professional journals and on specialized websites and WIS.2 has also been presented and applied in several continuing education courses for practitioners (see Rosset *et al.* 2009b for an overview). These activities have been going on since 2002 and have paved the way to arouse the interest of practitioners on the one hand, and ensure a smooth transition after the thesis on the other.

WIS.2 was already applied in teaching at the Swiss Federal Institute of Technology Zurich (ETHZ) at the early stages of the PhD, ensuring that the applications successively developed could regularly be tested in concrete situations and appropriately adapted to the valuable feedback from students. Particular attention has always been paid to the user-friendliness of the application. The development of WIS.2 also profited from more than 15 years of experience, experiments and results obtained at an annual 10-day practical course on silvicultural planning held at the ETHZ. Currently, it is still demonstrated at the ETHZ and since 2007 used at the School of Agricultural, Forest and Food Sciences HAFL, which is part of Bern University of Applied Sciences (i.e., at the level of higher education in forest management in Switzerland). WIS.2 has already been used in several Cantons in Switzerland (Zurich, Aargau, Fribourg, Vaud and St-Gallen) and was also tested by students in different countries in the frameworks of student bachelor and master theses (Belgium, Italy, Spain, Thailand).

The main factors contributing to the positive development of WIS.2 as a prototype mainly come from almost a decade of experience, experiments, feedback and

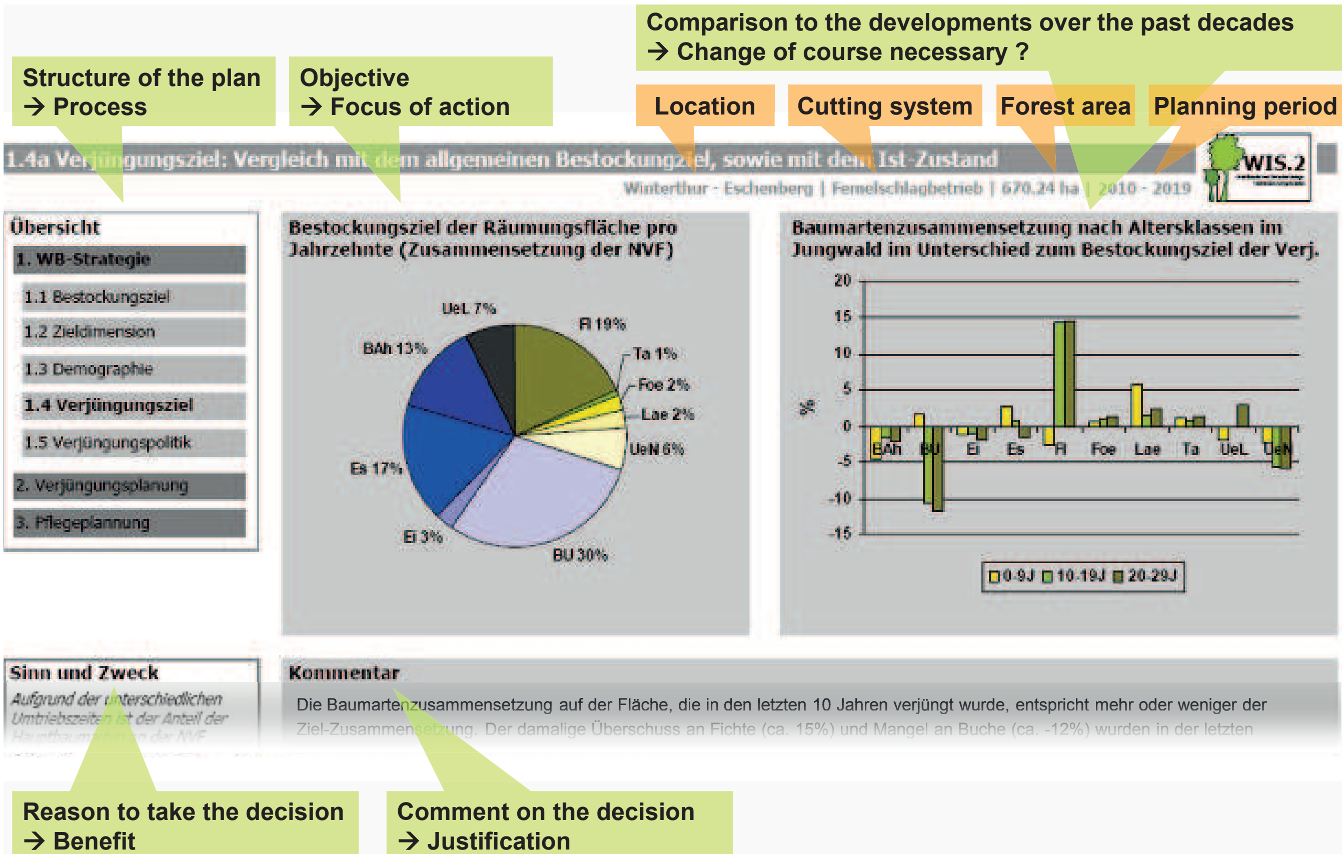

Figure 6: Example of a decision sheet. The pie chart represents the targeted tree species composition to promote over the whole regeneration areas to come. The bar chart illustrates the difference between the targeted tree species composition (y = 0 %) and the factual species composition of the forest area issue of the three last 10-years regeneration periods. The yellow bars (0-9 J; "J" is short for "Jahre" in German, i.e., "years") represent the forest area, that have been regenerated during the ten last years; the light green bars (10-19 J), the product of the penultimate regeneration period; and the dark green bars (20-29 J) the product of the antepenultimate regeneration period. This decision sheet corresponds to the process "Ref. tree species composition in the regeneration" in Figure 5.

results obtained during university courses and practical use through engineering firms and forest enterprises. Since the beginning, WIS.2 was designed to be as simple as possible (i.e., just the right level of detail), providing clear outputs to forest managers based on data acquirable from practitioners. Further positive traits of the tool are the use of Access and ArcGIS, which are not too costly and widely-used software packages, making it easy to adapt the prototype when students or practitioners propose amelioration or adaptation. While the bundling of competencies (i.e., silviculture, forest planning, and information technologies) can be an advantage, it also represents a danger due to the sole dependency on one person (see Tab. 1).

It is now high time to build on all these rich experiences gained over the past decade, to move a step forward and develop an easily available consolidated product, build a team and professionalize support, maintenance and further developments.

In order to verify that this new product can be well positioned on the Swiss market, an extensive strategy development analysis was conducted (see Schmid 2009). In summary, the analysis revealed there is actually a strong potential market for WIS.2 in Switzerland, especially considering the political and legal environment in which the Cantons are in charge of forest planning and responsible for ensuring sustainable forest development. Also, the difficult financial situation is forcing forest enterprises to rethink their strategie and increase their productivity. The main limiting factor, however, might be the lack of suitable data in some Cantons (e.g., stand maps). Enhanced growth models like SiWaWa should be integrated in the DSS (see Schütz and Zingg 2007).

Table 1: Review of critical factors of success.

	Strength	Weakness
Planning	Streamline planning with few well-documented decisions and far-reaching implications	Acquiring an overview (decision, consequences and interdependencies) is an important prerequisite that takes time and has to be done prior to using WIS.2, otherwise there is a danger of getting lost in details
Output	Clear outputs for forest managers, ready for use on the field; providing the basis to concretely evaluate the utility of the tool	
Input	Available in many Swiss Cantons	Stand-level data not available in all Cantons and rarely available outside of Switzerland
Growth models	Simple growth models easy to interpret (for the development of the main dbh)	Based solely on the Swiss yield tables (Badoux 1983) or on simple growth models implemented in WIS.1 (only differentiated after the main tree species; Good and Pistor 1992)
User interface	User-friendly GUI (Graphical User Interface), focussed on the decision to take, not on the technique	GUI only available in German
Software	Not too costly, widely-used software packages	Sensitive to the locally installed version of ArcGIS and MS Access. VBA is not to be supported anymore
Prototype	Flexible development of the prototype	Danger of never having a consolidated version over all the applications (always in development)
Methodology	Stakeholders can take an active part in the development of the IT-solution from the beginning; they have the opportunity to rethink the whole planning system and to better understand it with increasing level of detail and formalism	Long, iterative and recursive modelling process that has to be well-organized and for which enough time has to be planned, otherwise frustrations might occur
Competencies	Author's competencies in silviculture, planning, information science, as well as in research, practice and teaching.	Maintenance and development still depend on one person

The main challenge will be to advance from a prototype based on ArcGIS View and Access to a DSS based on a new IT-platform (a stand-alone application or a web application), while building on the current strengths, but also strengthening the current weaknesses.

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