THE GERMAN FINAL FORAM REPORT 1998

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1 Introduction

1.1 Introduction of Computer Work

The following report compiles the achievements of all FORAM teams in terms of computer based landscape planning and design. The research work is part of task 3 „Computer Graphic Techniques“ of the Technical Annex and follows objectives which were developed in co-operation with the FORAM partners and external experts.

The teams researched the suitability of GIS, CAD and image processing systems for visualisation and the aesthetic analysis of forested landscapes or prospective afforestation areas. All partners agreed on the application of ArcInfo (Unix) and Photoshop (Mac and PC) as the common line in computer technique. Furthermore every country was free in choosing additional systems. So different software packages like Microstation, LandCad, MacGis, GRASS, ArcView, Easi/Pace, TRETOP, VistaPro etc. had been tested.

The FORAM computer research is focused on the development of adequate Geographic Information Systems, image processing systems, Multimedia and Internet applications, which are qualified to analyse and reproduce landscape phenomena in a realistic way. Those tools should also be able to simulate specific landscape conditions, in the past, in the present and in the future. Beyond this the presentation and mediation of planning results was an important point. Adequate planning tools help to improve the communication between planners, experts and the publicity during the planning process, which results in a higher general acceptance of all design proposals.

2 Materials and Methods

In the following paragraphs we occasionally refer to documents on our WWW-server without using the entire address, instead we replace the root directory „http://www.lnn.forst.uni-muenchen.de/daten/foram“ by 2 dots, i.e. „ ../report98/index.htm“ is in fact „http://www.lnn.forst.uni-muenchen.de/daten/foram/report98/index.htm“. Additionally we attach a black and white copy of the most important documents to the annex section of this report.

We selected 3 study areas in South Germany to research and test the methodologies we developed throughout the project period (see map ..report98/studarea.jpg). Our intention was to select areas which may reflect the huge bio-morphological and geological diversity of open and wooded landscapes throughout Germany. Due to budget constraints the selected areas should be within a reasonable travelling distance to our institute in Munich and the co-operating department of the University at Freiburg. Consequently any statistically provable adequate sampling of German landscapes will therefore be secondary.
Maps with landscape units in a large scale are attached to this report, which describe the German situation in terms of climate, geology, landuse, ownership, forest condition and distribution. The comparison of the selected study areas with the geo- and bio-morphology of landscapes all over the country may prove the adequacy of our selection.
In particular selection criterion were:

- relief and geomorphology
- diverse natural phenomena
- aesthetic quality
- ecological quality
- forest percentage, management and ownership
- location and significance of areas for recreation

With regard to these criterion and to an existing relevant database we have chosen 3 study areas with several test sites in South Germany. The study areas are:

- the Black Forest (Federal State of Baden-Wuerttemberg),
- the Nature Park Obere Donau (Federal State of Baden-Wuerttemberg), and
- the Bavarian Alps, with the *Spitzingsee area* and the *Community District of the village Burggen* (both Federal State of Bavaria).

A detailed description of the study areas can be read on the world wide web (WWW) address: http://www.lnn.forst.uni-muenchen.de/daten/foram/home/studyera.html.

2.1 Forest Landscape: Assessment and Planning in Germany

2.1.1 Legal Background and Responsibilities

Thinking about landscape planning in Germany , you have to separate forested areas which are defined by the Federal Forest Law (../home/forrev3.html) from areas outside legal forests, which are controlled by the Federal Nature Protection Act. Besides a variety of secondary regulations, these two laws chiefly determine the responsibilities and the way landscape planning is presently practised in Germany. Generally speaking the State Forestry Commission (normally professional foresters) and the private forest land owners influence the design of the forest interior and the official nature conservationists and private planning consultants

(normally professional landscape architects) determine the overall design of a landscape. Indeed, the Federal Nature Protection Act has strongly influenced the forest management and design in the past. Since the environmental awareness of the public has increased forests have become an object of public interests and nowadays the design of its amenity is an important planning task. These tendencies are fixed in §1 Section 1 of the Federal Nature Protection Act of 1976:
„The landscape and nature in populated and unpopulated areas are to be protected, maintained and developed so that

1. *the capacity of the ecosystem;*
2. *the availability of natural resources;*
3. *plant and animal species, and*
4. *the variety, character and beauty of the landscape and nature*

which are the basis for living and recreating, are preserved in an enduring way.“
In this context landscape planning always has to deal with both, the forested and the unforested areas. According to the Federal Nature Protection Act and the State Nature Protection Law, it is the task of landscape planning to present and justify the measures and demands required to achieve the goals of nature protection and landscape management. This means:
1. Landscape planning determines the capacity of the ecosystems in terms of various potentials of nature.
2. Landscape planning makes it possible for all the requirements of nature protection and landscape management to be considered in the planning decisions. It determines the capacity of the natural resources and their limits.
3. Landscape planning provides guidelines for assessing the environmental consequences and compatibility of other projects and measures.
4. Landscape planning provides the ecological and design criteria which are necessary for the safeguarding of the capacity of the ecosystem and scenic landscape.

To follow the guidelines which are given by the legal objectives, there are various methods as shown below.

Planning Area	**Spatial Comprehensive Planning**	**Landscape Planning**	**Scale**
State	State Spatial Plan	Landscape Program	1:500.000 - 1:200.000
Region (Regional District and County)	Regional Plan	Regional Landscape Plan	1: 50.000 - 1:25.000
Community	Land Use Plan	**Landscape Master Plan**	1:10.000 - 1:5.000
Part of Community	Master Plan	Open Space Master Plan	1: 2.500 - 1:1000

Table 2.1: The relationship of landscape planning to spatial comprehensive planning

Based on a common agreement to work on a 1:10.000 scale the Landscape Master Plan (LMP) - respectively pertinent Forest Management Plans - are the adequate planning tool to develop guidelines for FORAM Design (see ../mmgis/article.htm for the objectives and the functions of the LMP). Since 1990 another planning tool has gained more and more importance in landscape planning - the Environment Impact Assessment. The EIA is object related and therefore it is often regarded as an economical alternative to the LMP.

Status of Landscape Planning in Germany

- Less consideration of psychological and aesthetic landscape aspects.
- Limited public participation in the planning process. In Germany planning documents are currently available for viewing only at the City Hall, and only for a limited time period which results in a low public participation in the decision process.
- Increaseof computerised tools for landscape analysis and design (GIS, CAD, Image Processing Systems).
- Persistence of conventional methodologies for the presentation of design options to decision makers and to the general public (largely restricted to the use of hardcopy plotted maps, printed reports, etc.).
- Little, if any, use of multimedia technologies (including sound, animation, video) and interactivity, both of which could serve to more effectively communicate design options and consequences, and improve the quality of feedback from viewers.

2.2 Public Survey Concerning Forestry in the Landscape

According to PETERMANN (Germany, 1979) and PROEBSTL (Germany, 1988) questionnaire surveys as well as group discussions are two adequate methods of socio-empirical research for assessing the public attitude towards a problem which has to be investigated. While group discussions in certain cases are even a tool to assess the behaviour of the interviewees, it is not permitted to deduce the respondent's *real* behaviour from the results of a written survey.
To identify what the public preferences towards forest aesthetics and forestry are, a **quantitative** survey was chosen as suitable tool within the framework of the FORAM-Project in Germany. The complexity of the questions asked in the survey regarding the project themes was the reasoning behind the necessity of using group-discussions as a **qualitative** research methodology to investigate why the public like or dislike certain forest landscapes, silvicultural management methods and certain landscape elements which are mainly the results of forestry or agriculture.

2.2.1 Group Discussions

2.2.1.1 Introduction

During the 3rd Project Meeting held in Spain (May/June 1996) a decision is arisen from diverse discussions between all Partners that group discussions („Gruppenexplorationen") would be a supplementary tool for getting detailed and personal information about what preferences people have regarding forest aesthetics and forestry issues and where these preferences emerge from. This second aspect is quite important in view of further guidelines. As an „exploratory method" it is suitable for structuring a new problem which has not been clarified yet, and for gathering a person's deeper opinions and motives since these aspects need to be considered. The advantage is that the moderator has the possibility to first go more into the personality of each interviewee and second identify the reasoning behind preferences being stated. The discussion leader has to be a well trained and experienced psychologist in order to avoid that participants be influenced in their opinions, and has to be well informed about the theme which is to be investigated. Therefore several meetings should precede together with an expert in order to grant for a detailed information exchange and precise questions.

In co-operation with the **Consumer Research Institute** (Keppler-Konsumforschung GmbH Stuttgart, Germany) both group-discussions were professionally organised. It was decided to have *2 groups* at *different places* with people from *different locations („Quellgebiete“)*, i.e. urban and rural population. The number of panellists was limited to about 10 persons for each group. They were recruited professionally by the Consumer Research Institute according to the visitor profile (age, sex, education, etc.) of the Park which had already been assessed in a previous German research project (AMMER, U. ; PROEBSTLE, U.; THUMANN, W. and PLAUMANN, U.;1994). All panellists should be familiar with the region *Obere Donau* (Study Area I) to have a common basis for discussion.

Group	Location	Participants coming from	Group Size	Sex	Date
1	***Stuttgart*** *(Keppler-Institute)*	*city*	*10*	*Female: 3* *Male: 7*	*17. April 1997* 7:00 p.m to 10:0 p.m
2	***Beuron*** *(Nature Park House)*	*countryside*	*11*	*Female: 2* *Male: 9*	*02. May 1997* 4:00 p.m to 7:00 p.m

Table 2.2: Organisation of the two group-discussions in Germany

A main theme - ***„Gespraechs-Leitfaden“*** - for both discussions was elaborated together with a professional forest scientist from the *Faculty of Forestry/University of Munich (LMU)* in order to grant for the expert knowledge regarding forestry issues (see ../report98/keppler.gif in the annex). Both, the group of local population selected from the region Obere Donau and the group from Stuttgart were invited by the *Keppler Institute* for carrying out the discussions. In order to refund their expenses and to make the participation more attractive all participants got a dinner snack and received 50,00 GM, a booklet „Nature Park Guide“ and a weekend-voucher for the train „Naturpark-Express“.

2.2.1.2 Procedure of Group discussions

Both group discussions were led in the same way. Thereby the well prepared „*Leitfaden*“ was the main skeleton for the whole procedure which had been elaborated by the FORAM team in collaboration with Prof. Keppler whose expertise was indispensable to avoid mistakes and provide a scientific base for social-empirical research.

Procedure:

- Welcome by Prof. Keppler
- Short written survey questionnaire concerning personal data (to be filled out by participants)
- Introduction by Prof. Keppler
- Brief personal introduction by each Participant
- Discussion according to the main themes (forestry issues, forest aesthetics, forest experience)
- Slides: 7 images depicting forest scenes were to be described and evaluated on a paper by each participant (list of images see chapter 3.2.2, images see annex ../report98/fotos/..)
- Discussion
- „My beautiful forest“: a short description was to be described by all participants
- Discussion
- End of meeting and personal introduction to German FORAM-team

All participants were highly motivated and showed strong enthusiasm during the entire meeting. The written and spoken comments were recorded by a tape recorder to allow a later detailed analysis by Prof. Keppler in order to identify individual motivation and the reasoning behind the mentioned preferences of participants. In addition the first meeting at Stuttgart was recorded by a video camera. To avoid shyness and the feeling of being observed the camera was not installed for the „countryside-group“ at Beuron.

2.2.2 Public Survey

Usually a written survey is carried out with the help of a questionnaire which is sent to a limited number of persons. It was taken into consideration that the readiness for answering the questions only depends on the accompanying letter and the theme of the survey. One of the disadvantages of a written survey is that often there is a very low return flow rate. This fact might result in a falsification of the basic random sample and the elimination of the representativeness of the survey.
To compensate this problem it was decided by the German team not to send the survey questionnaires by mail, but to combine the written questionnaire with a brief personal interview in the field (introduction to theme *forest and forestry*, information about project and person) asking visitors and inhabitants in one of the three German study areas.

2.2.2.1 Questionnaire Structure

During the FORAM-Meeting in Greece 1997 it was decided to choose the region **Obere Donau** (Study Area *Upper Danube Valley*) for the surveying with the help of a questionnaire („Zielgebietsbefragung“). After a long initial period of survey development and deep discussions between Partners the final questionnaire (../report98/quest.doc) was well prepared and refined by Prof. Keppler (Stuttgart) following the experience of the first group-discussion.

The questionnaire included a series of images and two types of questions:

- Questions which are comparable between FORAM-Partner-Countries
- Questions which handle forest landscape issues specific to Germany

Questionnaire Structure:

0. Cover sheet (Title of Project, name of institute and university, date, location, number of questionnaire, name of interviewer)

1. Regional Question („Upper Danube Valley“) concerning landscape aesthetics

Q1: Preferences towards landscape elements

2. Common Questions regarding forests

Q2: Cultural importance of forests in Germany
Q3: Forest functions
Q4: Attitude towards amount of forests in Germany

3. Forest Visit

Q5a: Frequency of forest visits during the year
Q5b: Recent forest visit
Q5c: Reasons for not visiting forests more often
Q6: Activities and other reasons for going into the forests

4. Forest Aesthetics - Problems and Improvements - individual attitude

Q7: Feelings during visiting a forest
Q8: Factors of disturbation during forest visits
Q9: Improvements for forests

5. Tree species and Silviculture
(Questions combined with prototypical images)

Q10: Preferences towards the following silvicultural methods with regard to aesthetics
*“**Kahlschlag**“, Clear felling system*
*“**Saumschlag**“, Strip selection system*
*“**Schirmschlag**“, Shelterwood system (uniform)*
*“**Femelschlag**“, Irregular Shelterwood system/Group Selection system*
*“**Plenterung**“, Single tree Selection system*

Q11: Investigation of German forestry issues
-Tree species composition
-Form and structure
-Design of forest edges/mantles
-Forest interior (forest roads)

6. Willingness to pay

Q12: Willingness to pay

7. Personal Questions

Q13: Statistical data

Table 2.3: Structure of Questionnaire

2.2.2.2 Survey Procedure

The first days of May 1997 were chosen for carrying out the survey in the Upper Danube Valley because the 1st May is a National holiday in Germany which is very attractive for touristic tours and outdoor-activities. Followed by a week-end and good weather this date was predestined to be successful with regard to reach a lot of people for the survey in a touristic centre like the Nature Park. Within the selected location **255 persons** were answering the questions concerning forest aesthetics, forestry issues and silvicultural management methods in Germany. Different locations within the region of the Natupark Obere Donau were chosen for the „interviewing" in order to get a great number of respondents.

Survey organisation:

Date:	Thursday 1st **-** Sunday 4th **May 1997**
Interviewing team:	2 **FORAM-Team** Scientists 1 Professional **Forester** (Bavarian State Forest Research Institute, Freising: „LWF") 2 Research **Assistents** (Diplom-Forstwirte)
Locations:	**Naturparkhaus** (exhibition, in-house)
	around the **Jaegerhaus** (in front of or close to a restaurant)
	Knopfmacherfels (key view point)
	Lochenfels (key view point)
	Café Haertl (restaurant)
	private houses at Beuron

Table 2.4: Survey Organisation

All respondents were given a brief verbal introduction (instead of letter) before filling in the questionnaire. The images depicting typical forest scenes (see list of images in the annex: .../report98/fotolist.doc) were shown to each respondent to have them evaluated with regard to aesthetics. Both, the answering of the questions and the evaluating of the images was done independently by the respondants and without any manipulation by the interviewing persons. To avoid misunderstandings between interviewer and respondent and also latter complications when analysing the collected data, it was important to prepare and train the interviewing team carefully before and to discuss difficulties after a test phase of interviews.

2.2.3 Data Analysis

2.2.3.1 Data Analysis of Group Discussions

For gathering viable results from both group discussions it was of great importance for the FORAM-Project to involve external consultance in analysing the collected data of both group discussions professionally. The *Keppler Consumer Research Institute at Stuttgart* had already co-operated with our Institute at the University of Munich in many research projects. This expertise was of great importance for the project and for gathering valuable research results. The recorded and written data material - see procedure of group discussions - was analysed ***quantitatively*** and ***qualitatively***. All findings were put together in a professional report „Erlebnisqualitaeten des Waldes: Ansaetze für eine Kategorienbildung zur Aesthetik des Waldes".

The above mentioned findings were the basis for further processing with the **EXCEL 5.0** software. This mathematical and graphic program allows the generation of figures, charts and tables after sorting the collected numeric data adequately into simple tables (rows and columns).

2.2.3.2 Data Analysis of Public Survey

According to the decisions made between FORAM-Partners after several discussions the software package **SPSS (SPSS 7.5 for Windows 95)** was chosen as the most adequate statistical instrument for entering and analysing the data collected with the public preference survey.
At the beginning a coding key was developped for to enter and later analyse the complex data material. From 255 units of investigation (cases = respondants) a large number of relevant attributes (variables) were investigated. The complexity of the questionnaire as a whole as well as the complexity of single questions (see questionnaire in the annex of this report: .../report98/quest.doc) made it necessary to develop a huge input mask („Datenmatrix“) which was filled with the coded data. Each variable - either type ‘numeric’ or ‘string’ - different value labels were given according to the options which could be chosen within each question or sub-question. A great variety of frequency distributions and crosstabs with relevant statistical charts, figures and tables are the results of the long analysing procedure.

2.3 Alternative Species and Silvicultural Systems in Forest Landscape Planning and Design

Forest management has to preserve and increase the forest´s experiental value and protect the scenic beauty and typical character of our native landscape.
The public frequently judges silvicultural achievements by their visual appearance or aesthetical value. Silvicultural management based on natural conditions results in natural structures and lines which will be visually perceived as harmony and beauty. Such forests are *beautiful* according to the German philosopher KANT and the Romantic period and for its harmony it is *beautiful* according to the ideals of the ancient world.
Nowadays the perception of nature is well developed and in order to convince the public of the necessity of forests we have to design attractive scenic woodlands.
All proposals must regard that the historical term of *sustainment* in forestry should also be valid for the recreational value of forests as well as for the wooded countryside as a whole.

2.3.1 Relief, Geography and Land use in Germany

The physical maps (../report98/relief.jpg and ../report98/geology.jpg) give an impression of the relief and geology of Germany, file ../report98/landunit.jpg shows the national division into landscape units.

The *Federal Ministry of Food, Agriculture and Forestry* published results of recent development of land use in Germany (Old and New Federal States, 1993):

Agriculture	55.1%
Forest	30.4%
Other use (e.g. urban areas)	14.5%

Table 2.5: Landuse in Germany

2.3.2 Forests and Forestry in Germany

2.3.2.1 Distribution of Forests

Within the EU Germany is one of the most densely wooded countries. About 10.8 millions hectares are covered by forests which makes almost one third of the whole area of the country. The forests in Germany are unevenly distributed as shown in the map of fig. 6. There are regional fluctuations in percent of the forested area from a minimum of 3% in the district of *Dithmarschen* (Schleswig - Holstein) in the North to about 70% in the *Black Forest* (Baden Wuerttemberg) in the South of Germany. The map ../report98/forstmap.jpg informs about the forest distribution in Germany.
The growing understanding of the citizens for forests and the effective regulations of the Forest Law contributed to a reduction in the loss of forests in recent years. Since 1981 more areas have been afforested than have been cleared.

2.3.2.2 Species and Silvicultural Systems in Germany

The following table shows the tree species distribution in Germany (1995), see the definitions of the used classification and expressions in file ../report98/forstdef.doc.

	oak	beech and other hardwoods	pine and larch	spruce and other softwoods
Old Federal States	8%	23%	27%	42%
New Federal States	5%	19%	54%	22%
Total	8.5%	25.3%	30.8%	35.4%

Table 2.6: Tree species distribution in Germany (1995)

In order to get an overview within the European context regarding species and silvicultural systems the following table shall demonstrate the variety of tree species used in Germany.
The *Federal Forest Inventory* (1986-1990) in the Old Federal States of Germany provides a database regarding, for example, forest and tree species distribution all over the country. Unfortunately the inventory has taken place before the German reunion. This has to be taken into account.
In addition the tables below inform about the extension (in hectares, respectively %) of the most important tree species and tree genera, i.e. *abies, fagus sylvatica, larix, picea, pinus, pseudotsuga menziesii, and quercus* all over German forests. For most of the tree species it is not possible to give this information because their registration is impracticable for the total forested area as their occurrence plays a minor role related to quantity.

Tree Species / Genera			Character A = indiguous B = exotic	Area[1] (1986-1990)	
1. Broadleaves					
Scientific Name	German	English		ha	%
Acer campestre	Feldahorn	Field maple	A		
Acer platanoides	Spitzahorn	Norway maple	A		
Acer pseudoplatanus	Bergahorn	Sycamore	A		
Aesculus hippocastanum	Rosskastanie	Horse-chestnut	A		
Alnus glutinosa	Schwarzerle	Common alder	A		
Alnus incana	Grauerle	Grey alder	A		
Betula pendula	Sandbirke	Silver birch	A		
Betula pubescens	Moorbirke	White birch	A		
Carpinus betulus	Hainbuche	Hornbeam	A		
Castanea sativa	Esskastanie	Sweet chestnut	A		
Cornus mas	Kornelkirsche	Cornelian cherry	A		
Corylus avellana	Haselnuss	Common hazel	A		
Fagus silvatica	Buche	Common beech	A	1 216 166	16.5
Fraxinus excelsior	Esche	Common ash	A		
Ilex aquifolium	Stechginster	Holly	B		
Juglans regia	Walnuss	Common walnut	A		
Malus sylvestris	Holzapfel	Crab apple	A		
Populus spec.	Pappeln	Poplars	A/B		
Populus tremula	Aspe	Aspen	A		
Prunus avium	Vogelkirsche	Wild cherry	A		
Prunus padus	FruehbluehendeTraubenkirsche	Bird cherry			
Prunus serotina	Spaetbluehende Traubenkirsche	American black cherry	B		
Quercus	*Eiche*	*Oak*		708 006	9.6
Quercus petraea	Traubeneiche	Sessile oak	A		
Quercus pubescens	Flaumeiche	Downy oak	B		
Quercus robur	Stieleiche	English oak	A		
Quercus rubra	Roteiche	Red oak	B		
Robinia pseudoacacia	Robinie	False acacia	A		
Salix spec.	Weide	Willow	A/B		
Sorbus aria	Mehlbeere	Common whitebeam	A		
Sorbus aucuparia	Eberesche	Mountain ash	A		
Sorbus domestica	Speierling	True service tree	A		
Sorbus torminalis	Elsbeere	Wild service tree	A		
Tilia cordata	Winterlinde	Small-leaved lime	A		
Tilia platyphyllos	Sommerlinde	Broad leaved lime	A		
Ulmus glabra	Bergulme	Mountain elm	A		
Ulmus laevis	Flatterulme	Large-leaved elm	A		
Ulmus carpinifolia	Feldulme	Field elm	A		
	Sonstiges Laubholz	Other broadleaves		818 076	11.1
TOTAL				7 373 031	99,9

Table 2.7: Most important broadleaf tree species in Germany (../report98/specitab.htm and ../report98/specitab.doc)

[1] Results of the *Federal Forest Inventory* (Bundeswaldinventur 1986-1990) in the old Federal States of West Germany

Tree Species / Genera			Character A = indiguous B = exotic	Area (1986-1990)	
2. Conifers					
Scientific Name	German	English		ha	%
Abies spec.	*Tanne*	*Fir*		158 890	2.2
Abies alba	Weisstanne	White fir	A		
Abies grandis	Kuestentanne	Giant (silver) fir	B		
Abies nordmanniana	Nordmannstanne	Nordmann's fir	B		
Abies procera	Edeltanne	Noble fir	B		
Juniperus communis	Gemeiner Wacholder	Common juniper	A		
Larix spec.	*Laerche*	*Larch*		231 179	3.1
Larix decidua	Europaeische Laerche	European larch	A		
Larix kaempferi	Japanische Laerche	Japanese larch	B		
Picea spec.	*Fichte*	*Spruce*		2 748 256	37.3
Picea abies	Fichte	Norway spruce	A		
Picea omorika	Serbische Stechfichte	Serbian spruce	B		
Picea sitchensis	Sitkafichte	Sitka spruce	B		
Pinus spec.	*Kiefer*	*Pine*		1 333 871	18.1
Pinus cembra	Zirbe/Arve	Cembran pine	A		
Pinus mugo	Latsche	Dwarf (mountain) pine	A		
Pinus nigra	Schwarzkiefer	Black pine	B		
Pinus strobus	Strobe	Weymouth pine	B		
Pinus sylvestris	Waldkiefer	Scots pine	A		
Pseudotsuga menziesii	Douglasie	Douglas fir	B	119 520	1.6
Taxus baccata	Eibe	Common yew	A		

Table 2.8: Most important conifer tree species in Germany (../report98/specitab.htm and ../report98/specitab.doc).

Figure ../report98/waldbausystem.gif and ../report98/plenter.gif illustrate the commonly used silvicultural prototypes.

2.3.2.3 Land tenure and Forest Ownership

The following table shows the different types of ownership in the year 1989 and the situation after the German reunion 1990 (see forstdef.doc for details about the classification):

	Private Forests	State Forests	Corporate Forests
Old Federal States (1989)	45%	31%	24%
FRG in total (1993)	47%	34%	19%

Table 2.9: Different types of ownership in Germany (the situation 1989 and after the reunion 1990)

Almost half of the forests belong to private owners, more than one third to the State and about one fifth are owned by corporations (primarily communities and towns).
In Germany there are some 100 000 private forest owners. Most of them are farmers. Frequently they have small woodlots. Statistically the average size of these private forest areas is about 4.7 hectares, but most of them are small woodland parcels with an extent of less than one hectare. This splitting means substantial drawbacks in their management.
Forest owners receive free consulting from the State Forest Office. In different Forestry Schools (e.g. *Scheyern, Bavaria*) they are offered extensive basic and advanced training

opportunities. They also receive financial subsidies for silvicultural measures, road construction and forest mergers and they have the opportunity to join *Silvicultural Link-Ups*, e.g. Private Silvicultural Business Affiliations. These are private-law-combines of persons possessing land with the object of improving the management of their linked up forest areas and of the parcels of land assigned to afforestation; their further aims being, in particular, to overcome the disadvantages of small size, of unfavourable shape, of the fragmentation of holdings or of other structural deficiencies.
The present State Forests were formerly a part of the royal forests, owned by former nobility or were monastrial or ecclesiastical property which were taken over by the State during the secularisation of 1803. The average size of one forest-management-unit (forest district), so called "Forstamt", is about 2600 hectares forest owned by the State. Additionally each "Forstamt" manages a few thousand hectares of corporate or/and private forest. Extensive State Forests are found in the Upper Bavarian Alps as well as in the proximity of big cities like Munich and Nuremberg.

2.4 Forest Landscape and Recreation Design Guidelines

In Germany there are no official and obligatory guidelines for amenity design. According to relevant German laws (i.e. forest law of state, nature conservation law of state, official forest management plan) all official foresters and those people who are involved in landscape planning should regard all ecological and aesthetic requirements of landscape tending.
To meet these requirements there are a lot of recommendations and advises for natural forest management and amenity design, which will be demonstrated below. It is vital to know the historic and social background of forest design in Germany to further develop guidelines for recreation and forest design. The history of landscape design in German forestry (../report98/history.doc) reveals the attitude of German society towards forests since the 18th century until now.

2.4.1 Percentage of forests in terms of forestry and recreation

There is a big difference in forest percentage between landscape regions in Germany. The very Northern part has a low forest percentages, the mountain ranges in Middle and South Germany are densily wooded. In the Federal State *Schleswig-Holstein* not more than 9%; in *Hessen* which is located in central Germany 41% of the area is covered with forests.
According to Ammer & Proebstl (1991) every forest management requires a minimum percentage for woodlands. In order to fulfil various ecological, social and economical tasks which are expected from forests a minimum percentage of 30% should be granted. For urban forests and recreational areas a percentage of 30-40% is necessary to fulfil recreational requirements. A recreational area which is supposed to be attractive for its forests should have a forest percentage of at least 50%. Landscapes with high risk of soil erosion need a relatively high forest percentage in order to prevent damages caused by erosion, i.e. high mountains

According to different landscape units the public attitude towards an optimum forest percentage is different (Arbeitskreis Forstliche Landespflege 1991). In general there is a high acceptance of an increase in forested areas, especially if it is the result of natural regeneration. Considering the aspect of recreation, people in less forested areas (forest percentage < 20%) would prefer a forest percentage of 30-40%. In areas where forests are equally spread, people expect the best recreational effect (scenic effect of forest borders) with a forest percentage of 50%. Otherwise if there is no balance between different landuse types, a forest percentage of 60-70% is supposed to be the optimum. Landscape units which are associated evidently with woodlands by visitors and tourists - like *Schwarzwald* (Black Forest) and *Bayerischer Wald* (Bavarian Forest) - should have a forest percentage of 70-80%. According to the visitors' opinions, only then the landscape design is optimal.

2.4.2 Trends and Conflicts between Forestry, Nature Conservation and Recreation

In Germany there also exist plenty of problems concerning the *appropriate* forest management. The plurality of different interests as to the forest causes conflicts between the different land users as well as between people who are handling with forest for any other reason (e.g. forest owners, environmentalists, hunters, naturalists, people doing winter sports or other recreational activities, etc.).

In the last few years the controversy between forestry and nature conservation more and more got into public discussion. But forestry and nature conservation have much in common, and there are many modes of procedure inherent to the system which coincide with the aims of nature conservation. Saying, that forestry is applied nature conservation, however, is too simple and expressed in such short words even wrong. In many sectors of biotope and endangered species protection in the forest, much more can be done especially if mutual information and confidence increase.

Nature conservation and forestry have to be conscious about their responsibility also for those parts of nature which are neither directly used by man nor appear in lists for endangered species. Especially forestry's aims should not only be concentrated on anthropocentric concepts, even though its dealings - production of raw material that is environmentally friendly, utmost abstention from the use of toxic substances, and an operation that is altogether relatively natural - are less problematic than those of other land users (Ammer et al. 1989).

From the *viewpoint of nature conservation*, a number of demands are formulated with respect to forestry:

Forestry should not be restricted to timber production only; there has to be a development towards multi-functional forestry according to the laws of nature. In this sense, high value yields could be achieved; and yet close orientation towards natural tree species composition would be possible, thus satisfying both economical and ecological demands.

Forestry defined in such a way could offer structural multitude on a defined area and thus also a maximum of ecological and economical stability. The aspired structural abundance would make possible a profusion of small animal habitats and consequently also expanse for adventure and a high recreational value for people themselves.

For the public forests, nature conservationists and a more critical public are expecting realisation of their demands. In private forests, many of these wishes - yet not all of them - are fulfilled automatically as many large private forestry enterprises managed in accordance with the laws of nature have proved in the past. For the remaining services, private forest owners should be offered programs that are similar to those for landscape preservation of the *Bavarian Ministry for the Environment*, or respective plans of the *Bavarian Ministry of Agriculture* for farmers. Under such conditions, demands of nature conservation towards forestry could be fulfilled not only by the state forests but also on private woodlands without economical losses by their owners.

Another conflict potential cause the increasing leisure time activities. Because of the growing mobility more and more people are visiting forests to enjoy their outdoor activities such as mountain biking, skiing, horseback riding, canoeing, para-gliding and others or just to enjoy nature. In that way the social function of forest gets more and more important. Conflicts between forest administration and people looking for recreation in or nearby forests are unavoidable because of their different understanding of forest, forest management and timber production. The state forest administration could solve this problem by improving public relation activities and by informing the public in more detail.

The FORAM-Research Project was an essential opportunity of making international comparison regarding public preferences towards forest landscapes and forestry.
The basis of the survey questionnaire evolved from the list of forest landscape problems pertinent to each participating country. The table ../report98/probltab.htm or ../report98/probltab.doc briefly shows specific problems and possible solutions regarding German forest landscapes and German forestry and their presence on each FORAM study area.

2.5 Use of Computer Technology on Forest Landscape Planning and Design

The power of digital technologies continues to increase. During the last decade we have seen ongoing advances in GIS, CAD and Image Processing technologies, all of which can play important roles in landscape analysis and design. During the last several years we have also seen the emergence and rapid development of multimedia and Internet technologies.
These latter technologies offer new possibilities for the analysis, presentation and distribution of information, potentially allowing landscape planners to more effective research and communicate the options and consequences of various design options to both decision makers and to the public at large, and to reach a much larger audience than is practical with conventional planning methodologies.
In the scope of the FORAM objectives we explored new applications of these digital technologies for the landscape design process, on the example of the study areas Upper Danube Valley and Bavarian Alps. A full planning exercise using "digitally-rich" presentations and methodologies was developed and tested for the target geographical areas. Finally, a methodology and recommended procedures for a digitally-rich landscape planning and analysis process was developed and documented.
The following table lists the main hard- and software we used. They might be regarded as tools as well as the virtual objects of our research. Commonly used software like text processing or table calculation are not listed:

Hardware	Software	for the purpose of
UNIX Workstation DEC 3000	ArcInfo 7.0	generation of vector maps, geo-referenced images, polygon
WIN NT Workstation	ArcInfo 8.0	generation of virtual landscape models
PC Pentium 90 MHz with scanner (UMAX)	ArcView 3.0 with following extensions: • Network Analyst • Spatial Analyst • 3D Analyst	two- and three-dimensional analysis of raster and vector data, programming of presentation and analysis applications
	Photoshop 3.0	photorealistic manipulation of images
	GIF Animator	photorealistic GIF-animations
	Magic Scan 2.41	scanning photos and slides
PC 486 100 MHz with video- and sound card	Aviator Speed	digitising sound-videos
Notebook Pentium 133 MHz with sound card and external speakers	ArcView 3.0	digital presentation
	Netscape Navigator Gold 3.0	presentation of virtual landscape models, edition of web pages, presentation of GIF-animations
	WIN95 Multimedia Player	presentation of sound-videos
Video camera Handy Cam Hi8		recording analogue sound-videos
Minolta photo camera		recording analogue photos and slides
Overhead projector GEHA 400		overhead projection of laptop screen

Table 2.10: Used hard- and software

3 Results

3.1 Forest Landscape: Assessment and Planning in Germany

3.1.1 Critical Review of Methodologies applied to date

The methodologies used so far in landscape planning and in EIA are focused on ecological aspects and aesthetic factors only play a minor role. Although the significance of aesthetics for the well being of man has been stated frequently by landscape planners (Nohl 1996, Jessel 1996, Falter 1992). Its methodological implementation into the practical planning procedure has not been developed on a satisfying scientific level. Aesthetic expertise often misses a scientific background and consequently its validity is regarded to be questionable (Schwahn 1995). On the other hand scientific approaches are often very rigid and they do not take personal and subjective preferences into consideration. Instead they either work with quantifiable data or with ordinal numbers which arose from the planners personal assessment. We call this data „hard data“ since it seems to be measurable and objective. Working with hard data destroys any possibility for a personal landscape interpretation by people living in the landscape. Methods working with hard data are often accepted due to their scientific character, but they do not represent the landscape in its entity as it is. Instead the landscape is divided into analysable compartments, which will then be evaluated and summarised to a common aesthetic value (see Bishop et al. 1994, Bents 1974, Hartweg 1976). The methodology does not regard the synergy effect of different landscape phenomena nor does it assess the landscape perception holistically.
Another critical point is the inventory procedure. Traditional methods rely upon landscape features that can be mapped (see Bell 1993) to assess the aesthetic quality. So they do not take landscape elements like sound, movements, smell into account and consequently assess only a small portion of what we perceive from a landscape.
An important point for critics is the limited public participation in the planning process and the poor communication between planners and citizens. In Germany, planning documents are currently available for viewing only at the City Hall, and only for a limited time period which results in a low public participation in the decision process.
Recent studies have shown, that public participation in the planning process leads to a better acceptance (Otto 1994, Luz 1997) of the design proposals. Actual publications emphasize the importance of a transparent and „citizen friendly“ planning (Proebstl & Krieger 1996).
One way to involve people in landscape design are public surveys. Another way are frequent presentations and information meetings. Such meetings give the planner the opportunity to convince the community council, citizens and landowners of his proposals. Without the agreement of those groups, the Master Plan will not be approved and the design proposals will never be realised.
The communication deficit includes verbal and graphic methods of mediation.

3.1.2 Principals and Significance of Landscape Aesthetics and Perception

Analysing the interaction between man and landscape reveals a typical subject/object relationship: landscape as the object of man's scientific efforts to understand nature always leads to an subjective interpretation of its natural appearance. NOHL (1996) remarked that understanding this relationship needs a hermeneutic interpretation of the inter-subjective correlation between the observer and the landscape. With this in mind landscape aesthetics is more than those features listed by Bell (1993). Most frequently landscape aesthetics are the

reason why a certain landscape is so valuable for us! Therefore the assessment of the scenic quality always comprises social needs and demands, too. Consequently it is necessary to regard landscape aesthetics as an important rural resource potential analogue to the classic ecological potentials.
To develop adequate new methodologies to assess landscape from a holistic point of view, we first have to outline some facts in terms of landscape perception:
The human perception of landscape is very complex and occurs on different levels. Besides the pure sensual perception there is a cognitive and psycho-emotional process which is controlled by our mind, our experience, our education or social position. The results of the public survey at the Spitzing See (../report96/alpsrvey.htm and figure ../report96/chart3.jpg) also confirm that received information is an additional factor, which influences the aesthetic feelings of landscape observers. The study of Nohl (1990) has shown the same significant result.
The sensual perception is less complex than the psycho-emotional and better to control. Some scientists estimate that we receive our impressions of the world around us approximately as follows: 1 percent by taste, 1,5 by touch, 3,5 percent by smell, 7 by hearing, and 87 percent by sight (cited in U.S. Department of Agriculture 1972). KEPPLER (1997) critically mentions that the visual experience can most easily be expressed verbally by man. Even if this may expel the above numbers it is clear, that the visual sense is the most important for human beings to receive information from the landscape. Hearing plays another important role in perceiving the landscape. The process of the non-sensual „imagination“ of a landscape is much more complex and depends much more on the personality of the observer. Another relevant point is, that man perceives his environment not as the sum of single landscape elements but as a unity. This was confirmed by scientists of the Max Planck Institute for Brain Research in Frankfurt (Lehmann 1996).

3.1.3 Holistic Landscape Planning

The most common way to describe a landscape scientifically is by measuring all physical landscape elements. But measuring the (quantifiable) aesthetic quality of landscapes only by „hard“ data does not regard the individual landscape perception which is immanent for the above mentioned subject/object relationship. Nevertheless assessing the aesthetic quality by the quantity of certain landscape elements is necessary to obtain basic information about the visible infrastructure of a landscape. But to approach the ideal of a holistic landscape planning the basic inventory has to collect and describe all landscape features, including realistic views, noise, smell and other psycho-emotional factors, which we might call „soft data“. The combination of quantifying „hard“ data and qualifying „soft“ data is an alternative to the classic planning methods to represent landscape holistically. The assessment gets a new quality due to the consideration of „soft“ data. This new method also requires new planning tools to achieve the expected results. We will see in chapter „Use of Computer Technology“ how computers can assist the planner to do a holistic planning.
Other approaches to incorporate psycho-emotional data into the landscape quality assessment are public surveys and group discussions. They deliver individual feelings and preferences resulting from the mentioned object/subject relation between landscape and observer. So the findings of public surveys are another scientific basis for a holistic landscape design.

3.1.4 Environmental Mediation and Citizen Participation

The Landscape Master Plan (LMP) is a central element of the environmental planning in Germany (KIEMSTEDT 1994). However, the planning process and the contents of this twenty year old planning instrument is in a permanent state of development as planning conditions and circumstances have changed significantly over the years. The Master Plan has developed from

a “service-plan” which was completely designed by landscape architects to an instrument of public participation. It has become a forum for discussions on ecological subjects, guidelines and objectives and the way natural resources ought to be distributed.
The Bavarian Ministry for Landscape Development and Environment therefore regards democratic and “citizen friendly” planning as the central task for further development of landscape planning in Bavaria. Whether or not pre-defined planning goals are achieved is very much dependent on the way in which questions of landscape aesthetics and ecology, which compete with other public and private demands, are presented to the city council and citizens.
However, not only has the planning process changed but new demands on landscape planning have come into existence. Besides the demonstration of natural and scenic conditions, solving conflicts and developing long term objectives are essential tasks of the landscape planning process. Furthermore, there is an increasing amount of data to integrate into the planning process, for example, we have access to ecological information such as the extension and quality of biotopes, endangered species, water quality and soil conditions. An innovative landscape planning process should therefore meet at least the following two requirements:

- new standards in handling and analysing more complex data; and
- new standards in data presentation and mediation.

With respect to the idea of a democratic and citizen friendly landscape planning process (LUZ 1995), the use of GIS in connection with multimedia and Internet applications offers great potential for clear presentation and mediation of planning results. Digital data and inter-medial presentations enable planners, citizens and officials to communicate in a much better way.
This initial investigation into the use of Multimedia GIS uses the Landscape Master Plan of the community of Burggen (study area Bavarian Alps) and the Nature Park Obere Donau as its basis.

3.2 Public Survey Concerning Forestry in The Landscape

3.2.1 Results of Group Discussions

An expertise in German language (*„Erlebnisqualitaeten des Waldes: Ansaetze für eine Kategorienbildung zur Aesthetik des Waldes“)* concerning the two group discussions („group explorations“) was elaborated in co-operation with the Keppler Konsumforschung GmbH Stuttgart (Germany, 1997). The recorded and written material was analysed by a professional psychologist who himself took part in both exploration meetings moderating and leading the discussions according to a main theme („Gespraechs-Leitfaden“, see ../report98/keppler.gif).

The above mentioned report describes project objectives, research method, organisation and procedure of group explorations and contains ***verbal*** as well as ***numeric*** results. A short annex is added to the main report which includes the main theme (*„Leitfaden“*), a detailed description of all participants, the short questionnaire and the statistical analysis, the written evaluation of 7 no. forest images (slides) as well as the written description of the thema *„My beautiful forest“* which all participants had to write down very briefly.

The part „results“ is devided into four sections:
- *Categories of forest visitors*
- *Experience of aesthetic sense in the Upper Danube Valley*
- *Cognitive impressions and emotional effects during forest visit*

- *Consequences concerning forestry with regard to human quality*

3.2.1.1 Categories of forest visitors

Based upon the group explorations there are six different types of forest visitors:

1. walkers/hikers/forest visitors (single or in groups)
2. sportsmen and -women (bikers/mountain bikers, canoeists, climbers, joggers, etc. ...)
3. specialists (... for landscape formation, forest and tree species, fauna and flora, culture)
4. children
5. forest user
6. „anti-types“

The most intensive way to experience the forest is by walking or hiking as it causes a special feeling of integration by poly-sensorial perception in the forest. Thereby it is possible to enjoy nature and relax intensively. This specific psychic component plays a less important role for the second and third group as their direct activities are dominant during a forest visit. Determined by their age children (group 4) mostly accompany their parents for forest visits even if they would prefer alternative activities during their leisure time. Many parents belief that it was an important task for them to bring their children close to nature by walking and other interesting outdoor-activities.
A very interesting group is the group of „anti-types“ who exist as the „masses“ in the heads of people who really enjoy nature and forest (esp. groups no. 1 to 3). Their behavior is not adequate with respect to nature. Therefore most of the other groups want to dissociate from this type of visitor.
All together it can be stated according to the study that there is no fundamental difference in experiencing forest aesthetics between people who live and people who visit e certain region.

3.2.1.2 Experience of aesthetic sense in the Upper Danube Valley

Both discussion groups do not differ regarding their estimation: the *„Beuron“*-group is as impressed by the aesthetic value of the Upper Danube Valley as the *„Stuttgart“*-group. The experience of aesthetics is reflected by the following expressions stated by the participants: „awe, voicelessness, adventure, relaxation, reminisce, iterative visits, etc. ...“
Especially the high variety of landscape elements makes the high aesthetic value of this region and determines the outstanding sensual perception of nature: the deep river valley, the beech forests, rocks and castles of the *Upper Danube Valley*. Vegetation and animals are also important factors for the aesthetic perception as well as the landscape’s relief. Thereby it depends on the perspective from which the landscape or its elements are seen by the visitor - (rocks and castles) from a boat or from the valley, from key view points or directly from the forest interior.
A characteristic feature of the *Upper Danube Valley* and one reason for its outstanding beauty is the broadleaf forest. The light green colour of the leafy canopy of beeches and other deciduous trees causes a special impression in the visitors’ mind. People who are living in the Nature Park are conscious about the fact that these broadleave forests would be characteristic for this region and that attempts in the past to plant conifers instead of broadleaves would have been neither effective regarding aesthetics nor typical regarding landscape development.

3.2.1.3 Cognitive impressions and emotional effects during forest visit

<u>Cognitive impressions</u>
This part means the sensual perception of the surrounding world for which the poly-sensoric is typical. Indeed verbal descriptions primarily base on optical (visual) categories, but it is

obvious that also sound, sense of touch and emotion, respiration and smell, ground nature and quality during a walk, and other factors play an important role. When the visual dimension comes to the fore, according to the results of our investigations, then this does not automatically mean a dominance of it towards other sensual impressions. This is much more an artefact where smaller problems of verbalisation are decisively in the optical part.
Based on both group explorations a hypthesis can be deduced that the variety of sensual perception determines the experience of the aesthetics of a forest. This is described especially by the group „individualists“ and „lone wolves“ who get impressed with special attention and alert senses. Hereby the aesthetic perception of a forest can be described rather more by an alert attention and receptivity than by an active observing.

From the written statements of all participants polarities can be deduced, and single statements can be classified as positive and negative categories:

A) Positive categories:
- Emotional categories: harmonic, peaceful, atmospheric, safety, „cathedral“ (forest), mood
- Diversity, alternation
- Functional categories: ... for walking and other outdoor-activities
- Light, sun, brightness
- Different levels of vegetation (high forest structure, forest regeneration, but also ground vegetation like grasses, moss)
- Remarks towards forest management: close to nature, wild, natural, mixed, open forest landscape, natural regeneration, open canopy
- „Mixed“ age of forests, „family“, young and old, rejuvenation, lifely
- Colours, colour change sequences, contrast of colours, beautyful green

B) Negative categories:
- Productive forest, monoculture, intensive forestry, too much conifers, high density of forest
- Monotonous, symmetric, geometric, linear (forests)
- Unlively, uncharitable, dead, depressing
- Uniform forest structure, no young trees, „dreary“ ground, no fauna
- Same age, no community of life, no natural regeneration, sterile, dead
- Dark stems (bark), depressing, melancholy

<u>Emotional effects of cognitive impressions</u>
Cognitive impressions cause emotional experience which can be described by the expression „psycho-physical regeneration“. That means emotional tensions are reduced, one finds to oneself, feels in harmony with nature and can gather power for regeneration. A person who experiences respectively lives the aesthetics of a forest does not feel like an acting, watching subject, but much more like being part of a larger unity. In this larger unity the forest represents nature which includes and integrates this person.
The presence of different phases of development - from a young light-green plant to a mature big tree - is essential for the aesthetic experience of forests. All these phases project the experience of life and death, they give the impression of liveliness. One feels like being a member of all these „generations“. At the same time the forest can give spatial security - often expressed by terms such as „enter the forest“ or „the forest is like a dome“. In this sense the forest is symbol for a parent nature which causes awareness, acceptance of life and

regeneration. This is in contrast to the terms „big city, asphalt, stress, etc. ...“ which cause insensibleness and unconcern.
Women often feel a certain fear while visiting a forest, especially when it is a dark (conifer-) forest without identifiable trails or when they are alone. In this cases the feeling of security can change to depression.

3.2.1.4 Consequences concerning forestry with regard to human quality of forests

There is a high acceptance towards the necessity of forest management according to the opinion of both visitors and local people (Groups *Beuron* and *Stuttgart*). Though it is expected that **forestry follows** a few **basic rules**. These rules are as follows:

- Maintainance of naturalness, ie. to give nature the opportunity of self-regeneration
- Maintainance of the charactaristic landscape of this region, ie. renouncement of coniferous afforestations in the *Upper Danube Valley*
- Emphasis on ecological measures towards economical interest (forest functions)
- Development of a forest road system and facilities for visitors which are close to nature (amenity)
- Prevention of an uncontrolled spreading of non-domestic tree and other plant species as well as wild animals like chamois

It was stated by participants that in the past the forest administration (foresters and owners) more or less met the above mentioned requirements in the region *Upper Danube Valley*. Although forestry of today is much more sensitive and much closer to nature than in former times.
The *Nature Park Administration* finds acceptance as in the sense of the required demands for an adequate forest management all activities are seen as thoughtful regarding the maintainance of nature and of the typical landscape character of this region.
Forest owners are conceded to derive income from forestry but this economical aspect should always be less important than ecological and aesthetical objectives. Huge afforestations in straight lines encounter strict refusal as well as clear cutting on large areas especially when big machines (harvester, tractors, etc. ...) are used for harvesting. Instead natural regeneration of present forests is preferred. Critical estimation of the participants also meets possible damages of (remaining) trees and roads that occur after the felling and transport of the timbers.
People are aware of the economical problems concerning the development of timber prices on the market. Presently the prices are too low and forest owners have to tolerate financial losses which even increase after phenomena such as damages caused by frost, snow and wind. The result of such natural calamities is always a stronger crumbling of wood prices.

The felling of a tree has an emotional component, too: it causes the association of death as mentioned by the participants. One thinks about the age of the cut tree, the different seasons, temperatures, weather conditions and other factors that had determined its life.
People living in the region are aware about visitors being an important economic factor beside the income from nature. Even so they do not appreciate a strong increase of tourism in the region of the *Danube Valley*. Still they feel that there is plenty of occasion to find joy and regeneration during leisure time activities. Fortunately the study area differs from other touristic regions like the *Black Forest*, *Bodensee* or from most regions in the Alps which are almost „flooded“ by strong tourism. A good and effective measure would be the visitors’ guidance as already successfully practised by the Nature Park Administration of *Beuron*.

Evaluation of different forest images
An interesting issue was the evaluation of different forest images (slides) depicting diverse forest scenes in Germany:
7 slides were shown to the discussion groups which had to be evaluated (6 grades: 1=very beautiful ... 6=ugly) individually by each person with respect to aesthetics. The voting should be done spontaneously on a prepared paper which had to be filled out by every participant. The following questions were to be answered: description of image, what do you like/dislike, aesthetic vote (like the school system from 1 to 6).
The images can be seen in the annex (../report98/fotos/***.jpg) as listed in the table below.
The results are as following:

Images	**Image files (see annex)**	Stuttgart	Beuron	average
Plenterwald (single selection	../report98/fotos/plenter1.jpg	**1,7**	**1,9**	**1,8**
Mixed broadleave forest	../report98/fotos/sreich.jpg	**1,8**	2,1	**1,9**
Spruce with beech	../report98/fotos/swenig.jpg	2,6	2,1	2,3
Forest mantle (rich in structure)	../report98/fotos/rand1.jpg	2,8	2,5	2,6
Mixed forest close to nature	../report98/fotos/laub.jpg	3,3	2,2	2,8
Strip selection forest (winter)	../report98/fotos/saum3.jpg	3,4	3,5	3,5
Spruce monoculture	../report98/fotos/kahl1.jpg	**3,9**	**3,6**	**3,7**

Table 3.2.1: Evaluation of Images

As shown in the above table forest stands with a high vertical and horizontal structure are preferred towards those which are poor in structure or monotonous. The preferred forests do not only have a higher value with regard to aesthetics but also to their ecological potential. The results correlate with the verbal statements given during both discussions.

3.2.2 Results of Public Preference Survey

The public preference survey was carried out in May 1997 in the aesthetically very attractive landscape of the *Nature Park Upper Danube Valley* (Study Area II). Within the framework of this FORAM-survey **255 persons** were answering the questions of the German questionnaire concerning forest aesthetics, forestry issues and silvicultural management methods in Germany. In analogy to the group discussions in *Stuttgart* and *Beuron* the asked persons were visitors (tourists) as well as local people who are living within the Nature park area or close to it.

Altogether the asked persons were quite co-operative in answering the questions even though it took almost 30 minutes going through the whole questionnaire. As some of the questions were rather complex it was often necessary to explain them to the asked persons in more detail. For answering of question no. 11 and 12 the relevant images were individually shown to each survey participants in order to not influence others in their decisions. The survey was carried out both, in-house (private houses at *Beuron*, 2 restaurants, *Nature Park House*/exhibition) and outside, ie. at different key view points and in front of a restaurant which are locations tourists visit frequently.

Because of the detailed, partly complicated questions and the volume of the total questionnaire the entering as well as the analysis of the collected data were an extensive procedure. Many tables, figures and charts are the result of this detailed analysis. Compared to the results of the group explorations there is a high conformity concerning public preferences regarding the different forestry issues and recreation activities.

In the annex („../report98/spss/..“) a selection of tables, charts and other statistical material is available and can be opened with the help of „*Netscape*“ or any similar browser. There are files in „*.htm“ (tables) respectively „*.jpg“ (charts) format. Additionly there is a list of all the statistical documents regarding this chapter (../report98/spsslist.doc) available.

3.2.2.1 Personal data

- *Age and gender distribution*

52% of the asked persons were male, 48% female. Almost all age-groups show this same relation (see „../report98/spss/agesex.htm“ and „agesex.jpg“). The age structure reflects the common situation of this region as it was already documented in a former study (PROEBSTL et al, 1994). The most represented groups are „20 to 29 yrs“ and „30 to 39 yrs“ (25,8% respectively 23,7%). But also the next higher age group is represented with almost 19%. This result proves the recreational attractiveness of the selected study area for almost all ages.

- *Residence*

In „ort.htm“ is shown where the participants come from. About 70,6% live in the countryside or in towns and smaller cities (>5000 residents). Almost 30% come from big cities like Stuttgart. In this regard there is no significant difference between all age-groups („ort.jpg“).

- *Educational level*

Most of the participants have a high education level. More than 53% have attended the German „Oberschule“ (Gymnasium) which is comparable to a highschool, and almost one third (28%) are graduates from university. Thereby there are rather small differences between men and women („abschl.htm“ and „abschl.jpg“). Most women have the German educational level „Mittlere Reife“ (31,9%) which is a general certificate of education ordinary level (men: 15,3%)

- *Income level*

According to actual information of the *Statistisches Bundesamt Germany* the monthly brutto household income in Germany is 6034,55 GM (July 1994). The answer to this question was voluntary.
The chart „income.jpg“ reflects the income situation of the asked persons. 74% did answer this very personal question, 26% did not give an information about it. The majority of these households have a monthly income beyond this amount (31,9%). The income of 18,5% is around the German avarage, 18,1% of the households get more money, and less than 6% get much more than the avarage amount.

- *Interest in environmental (esp. forest) issues*

90% of the asked persons are interested in newspaper articles or television and radio programmes which are produced about environmental and especially about forest issues. Almost 60% follow them occasionally, 26% follow them regularly, and 4% make a special effort to follow all of them. Only for 10% these programmes and articles are barely of interest. This reflects the common situation in Germany as the environmental education of the population by radio, television, journals and newspapers has increased during the past years. People are and like to be informed about environmental issues such as forests and forestry.

3.2.2.2 General attitude towards forests and forestry in Germany

- *Estimation of significance of trees and forests in Germany*

Almost all participants agree with the statements that were made within the survey questionnaire concerning the significance of trees and forests. The statement regarding recreational use of forests since generations in Germany was only accepted by 85% of the population. This was suspected as the common changes of leisure time and recreational activities (which have increased during the last half century) in a country depend on social development.
See table ../report98/spss/state.htm in the annex.

- *Forest functions - today and in future*

The main part of the population rate the functions „recreation, ecosystem, protection of climate, soil, water and against emissions“ as *very important* at the present time. „Wood and timber production, landscape design“ and „work“ are rated as *important* whereas „food production and hunting“ are rated as *unimportant*.
According to the popultaion’s estimation regarding forest functions of the future the following results can be summarized: The future significance of forests as a place for „recreational use“ as well as for „protection of climate, soil,water and against emissions“ is rated as *increasing* wheras the significance for „wood and timber production, landscape design, work“ and as „ecosystem,“ is rated as remaining as important as it is at present.
See table ../report98/spss/function.htm in the annex.

- *Estimation of forest amount in Germany*

55,1% of the asked participants have the opinion that there are enough forest all over Germany against what almost 44% think that the amount of forests could increase and afforestations would be adequate. Not anyone of those asked rates the forest area as being to much.

Estimation of forest amount	**Absolute answers**	**percentage (%)**
no answer	3	1,2%
not enough forests in Germany	111	43,7%
enough forests in Germany	140	55,1%
too many forests in Germany	0	0%
total	**254**	**100%**

Table 3.2.2: Estimation of Forest Amount in Germany

- *Frequency of forest visits*

Around 46% of the asked people visit a forest once a week for recreational puposes. More than one third (35,4%) less than once a week, and 8,3% visit a forest only 2 to 10 times per year. For 9,4% of all those asked a forest visit belongs to the daily round. Only two persons never or less than once a year go into a forest.
See chart ../report98/spss/visits.jpg in the annex.
The distribution of the different age groups regarding the frequency of visiting a forest during leisure time can be seen in chart visage.jpg in the annex.

- *Reasons for not visiting forest more often*

The primary reasons pertaining to those who belong to the *category „I visit a forest 2-10 times a year“* (only 8,7% of the whole survey population) of the above question for not visiting forests more often are that they „don’t have enough time/they are too busy“ (68,4%) and that they „prefer other activities for spending their leisure time“ (36,8%). The results of this investigation confirm the high level of interest in forest recreation of the German population. The options „no own transport“ or „simply not interested“ have no relevance in this context at all.

· *Disturbances during forest visits*

Disturbances of people during visiting a forest can be caused by

1. other forest visitors,
2. infrastructure of forests, and
3. forestry

See table ../report98/spss/disturb.htm.
Most of the people feel disturbed by others, ie. bikers and especially mountain-bikers (55,9%), but also riders (30,7%) and hunters (29,1%). They are quite content with the overall infrastructure of German forests even though 37% think that there are not enough signposted walks and information boards.
Regarding forestry peolpe are more critical: Almost half of the population feel disturbed by damages caused by harvesting timber (46,5%), fences (measure against game browsing of young plants) (42,9%) and machines for felling and logging the timber (34,3%) within the forest. Some people dislike the overall forest structure (20,5%), dead wood in the forest (25,2%) and forest roads (26,4%) or feel other disturbances such as scattered waste, etc. (see table ../disturb2.htm in the annex).

· *Improvements for increase of forest visits*

Especially the options concerning silvicultural improvements featured absolutely high in the overall rank order (see table ../improv.htm in the annex). Most people put emphasis on improvements regarding tree species composition (81% request „high diversity in tree species“ and 76% „avoidance of monocultures“), forest structure (60% suggest an „increase of horizontal and vertical structures“) and forest shapes (55% request the „avoidance of geometrical forest borders“). The design of forest edges is to be imroved according to 39% of the population. They request to avoid „abrupt borders between forest and open landscape“. Regarding the infrastructure of forests more than half of the asked persons put emphasis on a basic equipment of recreational facilities and nature trails. One third request the improvement of picknick places and guided tours (by foresters and biologists).

· *Recreation activities during forest visits*

The following pursuits are engaged by most of the population in the following order, namely (1) walking/94,5%, (2) relaxing, enjoying peace and quiet/88,5%, (3) biking, mountain-biking/40,3% and (4) hiking, climbing/37,5%. Even 35,6% mention to visit a forest in order to also learn about nature and wildlife.
Other special „active“ pursuits including horse riding, hunting and fishing featured very low whereas picknicking, collecting berries, mushrooms and plants (both 25,3%) and photographing (23,7%) featured relatively high in the overall rank order.
See table ../report98/spss/active.htm in the annex.

· *Feelings and emotions*

Most of all those asked experience the forests during their visits with very positive (peace and quiet: 96,4% and delight: 52,2%) and positive feelings such as joy and happiness (82,8%) and safety (66,2%). A *mixed feeling* between tension and boredom, mystery and everyday, as well as between majesty and depression rank around 70 to 80%. Altogether forests cause quite good and pleasant feelings and emotions.

See table ../report98/spss/feel.htm in the annex.

3.2.2.3 Evaluation of forest images

One main theme of the public survey was the assessment of the public attitude towards the aesthetic component of **silvicultural management methods** used in Germany (question no. 11). As there are plenty of variations of systems applied all over German forests it was decided to investigate this aesthetic aspect of the five most important *prototypes* of the methods used. These five prototypical silvicultural methods are as following:
(German and English technical term)

- *Kahlschlag - Clear cut system*
- *Saumschlag - Strip selection system*
- *Schirmschlag - Shelterwood system*
- *Femelschlag - Group selection system*
- *Plenterung - Single selection system*

To each prototype 2 to 3 images were selected for aesthetic evaluation within the survey depicting different phases of forest (tree) development. All those asked had to give their individual aesthetic vote to each sytem (and not to each image). At least they should select the system preferred with regard to aesthetics.

In addition people were asked to evaluate four sets of images regarding **forestry issues** which are relevant in Germany Germany (question no. 12):

- *Tree species composition*
- *Shape and structure (of forest stand)*
- *Design of forest edges*
- *Design of forest roads*

The images of each set show 2 to 4 options of forest design concerning each issue. In question no. 12 people should chose the respective image they like best.

All images used are listed in the file ../report98/fotolist and can be opened in the directory ../report98/fotos/.. as „**.jpg*" files. The results have to be opened in the directory ../report98/spss/.. .

<u>3.2.2.3.1 Evaluation of silvicultural systems in Germany</u>

Basis of valuation was the mark system which is applied at German schools (6 marks from grade 1 „sehr gut"/excellent to grade 6 „ungenuegend"/insufficient) in order to simplify the voting procedure for all those who were asked. This German mark system was transformed to an aesthetic evaluation system including the following grades:

„1": sehr schoen	very nice
„2": schoen	nice
„3": befriedigend schoen	satisfyingly nice
„4": ausreichend schoen	sufficiently nice
„5": weniger schoen	less nice
„6": nicht schoen	not nice

- Kahlschlag - Clear cut system

Images: kahl1.jpg and kahl2.jpg
Results see in chart: clear.jpg

- Saumschlag - Strip selection system

Images: saum1.jpg, saum2.jpg and saum3.jpg
Results see in chart: strip.jpg

- Schirmschlag - Shelterwood system

Images: schirm1.jpg and schirm2.jpg
Results see in chart: shelter.jpg

- Femelschlag - Group selection system

Images: femel1.jpg and femel2.jpg
Results see in chart: group.jpg

- Plenterung - Single selection system

Images: plenter1.jpg and plenter2.jpg
Results see in chart: single.jpg

50,8% of all those asked prefer this method with regard to aesthetics, 17,7% prefer the method „*Femelschlag*" - group selection system and 11,8% prefer the „*Saumschlag*" - strip selection system. The remaining two silvicultural systems come off badly: less than 10% (6,7%) like the „*Schirmschlag*" - shelterwood system best, the „*Kahlschlag*" - clear cut system is preferred only by 2,8% of all participants. 3,1% of the asked persons like both methods the „*Femelschlag*" as well as the „*Plenterung*" best. Results see in chart: systems.jpg.

As it was expected the preferred silvicultural system type is the so called „*Plenterung*" which is a forest management method specific to Germany. It is a very special type of single selection system which gives the forest a typical frequency distribution of all tree ages (the respective chart is the so called „Plenterwaldkurve", MAYER 1992), a high diversity in structure and tree species composition and an irregular tree distribution pattern all over the forest stand. It is comparable to forestry based on natural conditions, the so called „*Naturgemaesse Waldwirtschaft*" in Germany. This management method longterm results in a permanent forest („*Dauerwald*") whose characteristics are a permanent stock, high vertical and horizontal structure, tree species mixture and single selection cuttings without any (or only with a very small) **visual** and **ecological** impact. The growing of valuable timber (so called „*Wertholzaufzucht*") in combination with negative selection cuttings („*Negativauslese*") all over the managed area make this method even to the best one with regard to **economy**. Because there are permanently many species and timber sorts available for being cut and sold the forest owner is not completely dependend on the timber market with regard to the felling time and has the possibility to get yield even spontaneously, as his forest's „stock in trade" is well sorted.

3.2.2.3.2 Evaluation of forestry issues in Germany

- Tree species composition

  Images: nadel.jpg: mixed coniferous forest stand
  laub.jpg: mixed deciduous forest stand

  Results see in chart: mixtur.jpg

Previous investigations regarding this forestry issue in Germany have already shown similar results like the FORAM survey does regarding public preferences towards tree species composition: Broadleaved and mixed (conifers and broadleaves) forests are preferred to coniferous ones. This was verified by 92,5% of the FORAM survey population who like a deciduous forest better than a coniferous forest (6.3%). It has to be taken into consideration that the images used for evaluation must differ concerning this single aspect (mixture) only. Probably the results had changed if the photos were taken during winter time (canopy effect).

- Shape and structure (of forest stand)
  Images: skeine.jpg: uniform spruce monoculture
  swenig.jpg: two-storied forest stand, spruce with secondary beech (after underplanting)
  smittel.jpg: well structured mixed forest stand with intermediate trees and understory
  sreich.jpg: highly structured lowland forest - s.c. *„Auwald“* with many different layers
  Results see in chart: structur.jpg

The majority of the asked people (55,5%) prefer the image depicting a highly structured mixed forest where almost all layers of trees are represented within a small part of the whole stand (sreich.jpg). The image projects a certain kind of „wild“ virgin forest, adventure and wildlife. Concerning forestry the ecological aspects are much more important than the economic objectives. Nevertheless 35% of all those asked made their grading of images in favour of another option: They prefer a well structured mixed forest stand with intermediate trees and understory - *„naturnaher Mischbestand“* - which yet reflects a certain order with respect to forest structure and remains manageable for the visitor (smittel.jpg).
6,3% are attracted by the second image (swenig.jpg), a two-storied stand of spruce overstory and beech understory (created by underplanting of beech), and only 2,4% prefer the regular „clean“ spruce monoculture which reflects uniformity and clearness (skeine).

- Design of forest edges
  Images: rand1.jpg: optimal forest edge design with high structure and diversity
  rand2.jpg: forest edge design with less structure and diversity
  rand3.jpg: forest edge without any structure - „spruce wall“
  Results see in chart: edges.jpg

Another issue concerning forestry in Germany which was to be assessed is the public attitude regarding the design of forest borders towards the open landscape - the forest edges. Three different images were selected to be presented during the survey: In analogy to question 12/2 (forest shape and structure) the preferred forest edge image shows an optimal design with high structure and species diversity (rand1.jpg). 67,3% of all participants decided to select this ideal option for forest edge design. Almost 22% prefer the design with less structure and diversity (rand2.jpg) and after all around 10% like the „spruce wall“ (rand3.jpg) without any edge structure created by shrubs and secondary tree species.

- Design of forest roads
  Images: strasse.jpg: stone covered forest road

gruen.jpg: stone covered forest road with green centre stripe („semi-natural")
natur.jpg: more or less natural forest trail (rack/hauling trail)
Results see in chart: roads.jpg

The mostly liked image regarding forest road construction - whereas the asked persons associate the purpose of recreation during a forest visit - is the natur.jpg (84,1%) which depicts a more or less natural forest trail within a dense „Plenterwald". 2,8% prefer the stone covered forest road (strasse.jpg) and 13,1% prefer the intermediate option, the stone covered forest road with green centre stripe (gruen.jpg).

3.2.2.4 Willingness to pay

People were asked about their attitude towards paying for the maintainance or an increase of forest aesthetics in the landscape through an extra tax, for example a so called „forest recreation tax". The money should be given to (private) forest owners who would have losses in their income from forestry caused by any measures being applied in order to realize the above stated objectives with regard to the public welfare.
In the table below the people's attitude toward this issue - Willingness to pay - is shown.

Annual amount (options)	**absolute number of answers**	**percentage (%)**
nothing	57	22,4
1-5 GM	10	3,9
5-10 GM	27	10,6
10-50 GM	**85**	**33,5**
50-100 GM	47	18,5
100-200 GM	15	5,9
200-300 GM	3	1,2
more than 400 GM	2	0,8
no answer	8	3,1
Total:	254	100,0

Table 3.2.3: Willingness to Pay

74,5% of the asked people have answered this question positive: They would pay an annual ammount for the above mentioned improvements. 33,5% - the majority - are willing to pay 10 to 50 GM per year, 18,5% would pay 50 to 100 GM, and almost 8% would even pay more than 100 GM to compensate losses of income of (private) forest owners.
The analysis of the collected data concerning both sexes have shown that there is quasi no difference between male and female participants regarding this question. See also chart in file „pay.jpg" in the annex.

3.3 Alternative Species and Silvicultural Systems in Forest Landscape Planning and Design

3.3.1 Classification of Silvicultural Systems and Tree Species in Germany

In order to get an overview over the variety of used silvicultural systems in Germany we classified all management methods due to their forest morphology and management objectives. See figure ../report98/silviclass.jpg or ../report98/silviclass.doc which is a flowchart of the classification of common silvicultural systems.

Since there is a very close correlation between silvicultural systems and the suitable tree species, i.e. the use of certain species is restricted to certain management methods, we researched the systems in more detail. Figure ../report98/silvisysb.jpg or ../report98/silvisysb.doc is a methodological classification to list the tree species due to the adequate system. The figure is a flowchart of silvicultural systems and corresponding tree species in Germany

The table below (see file ../report98/silvitab.htm or ../report98/silvitab.doc) applies the methods and shows a classification of *prototypes of silvicultural systems* and the *most important* tree species being managed through these systems in Germany. The information is based on the books „Waldbau“ (H. Mayer, 1992), „Grundriss des Waldbaus“ (P. Burschel, J. Huss, 1987), as well as on the Federal Forest Inventory of Germany (1986-1990).
Nevertheless there are many forests in Germany managed in a manner which can not be assigned to any of the below named silvicultural systems. These are rather prototypes.
The process of rating each species and silvicultural system according to their aesthetic, ecological and economic value is quite complex and depends on the very individual situation of each forest stand. The reason behind this is that you have to take into account different factors (mixture, site conditions, *Potentially Native Vegetation*). This complexity of influencing factors makes the rating procedure very difficult, especially because there is a broad variety in species, silvicultural systems, and mixture rates existing in Germany.
The economic value of species also depends on different aspects such as ownership (kind, structure, and size), site conditions, former silvicultural management, provenance of species, etc. ...
The classification follows the structure shown in figure ../report98/silvisysb.jpg where the following indices are used:

A: **‘Cut and Plant´ Systems**
B: **Natural Regeneration Systems by Compartment**
C: **Forest Management by Individual Trees and Small Groups of Trees**
D: **Coppice with Standards System**
E: **Simple Coppice System**
(F:) **Silvopastoral Systems (not used in Germany)**
G: **Not managed Forests and Native Forests**

I: Pure Stands
II: Mixed Stands

The table category „Not managed Forests“ includes
- Nature Forest Reserves

- The internal zone of National Parks (*Kernzone)*
- Abandoned forests
- Not managed forests of the high alpine mountain zone (e.g. *Latschenfelder* - Dwarf mountain pine forests, etc....)
- Native Forests

The evaluation columns „aspects“ had been proposed by the Spanish FORAM-team. They are left empty, because the proposed evaluation methods have caused many controversial discussions based on the above mentioned reasons. The development for a valid economical and ecological method for all forests in Germany as a whole would go far over the limits of our research. The „landscape“ aspect was finally evaluated by the results of the public survey but it has to be taken into consideration that all findings in this regard must not be seen as general allocations to single tree species. A detailed table which assesses the scenic quality of common species and their ecological parameters has been done by the *„Arbeitskreis Forstliche Landespflege“* (1991, p. 131 - 143).

Categorie	Sylvicultural System		Tree species			Character A =indigenous B = exotic	Aspects 1=very low, 2=low, 3=medium, 4=high		
	German Name	**English Name**	**Scientific Name**	**German**	**English**		**Landscape**	**Ecology**	**Economy**
AI	**1. Kahlschlag**	Clear Cutting							
	a) Grossflaechiger Kahlschlag mit Kunstverjuengung	Large-sized Clear Cutting with Artificial Regeneration	Picea abies	Fichte	Norway spruce	A			
			Pinus sylvestris	Waldkiefer	Scots pine	A			
			Populus spec.	Pappel	Poplar	A/B			
AII	b) kleinflaechiger Saumkahlschlag	Small-sized Strip Clear Cutting with Artificial and Natural Regeneration	Abies alba	Weisstanne	White fir	A			
			Abies grandis	Kuestentanne	Giant fir	B			
			Abies nordmanniana	Nordmannstanne	Nordmann's fir	B			
			Acer pseudoplatanus	Bergahorn	Sycamore	A			
			Acer platanoides	Spitzahorn	Norway maple	A			
			Alnus glutinosa	Schwarzerle	Common alder	A			
			Alnus incana	Grauerle	Grey alder	A			
			Betula pendula	Sandbirke	Silver birch	A			
			Betula pubescens	Moorbirke	Pubescent birch	A			
			Carpinus betulus	Hainbuche	hardbeam	A			
			Fraxinus excelsior	Esche	Common ash	A			
			Larix decidua	Europ. Laerche	European larch	A			
			Larix kaempferi	Japanische Laerche	Japanese larch	B			
			Picea abies	Fichte	Norway spruce	A			
			Pinus strobus	Strobe	Weymouth pine	B			
			Pinus sylvestris	Waldkiefer	Scots pine	A			
			Populus tremula	Aspe	European aspen	A			
			Populus spec.	Pappel	Poplar	A/B			
			Pseudotsuga menziesii	Douglasie	Douglas fir	B			
			Robinia pseudoacacia	Robinie	False acacia	A			
			Salix spec.	Weide	Willow	A/B			
			Sorbus aucuparia	Eberesche	Mountain ash	A			
			Sorbus domestica	Speierling	True service tree	A			
			Sorbus torminalis	Elsbeere	Wild servive tree	A			
			Tilia cordata	Winterlinde	Small-leaved lime	A			
			Tilia platyphyllos	Sommerlinde	Broad leaved lime-tree	A			
			Ulmus glabra	Bergulme	Mountain elm	A			
			Ulmus laevis	Flatterulme	Large-leaved elm	A			
			Ulmus carpinifolia	Feldulme	Field elm	A			
	2. Schirmschlag	Shelterwood Systems							
BI	a) Klassischer Schirmschlag	Uniform Shelterwood System	Fagus sylvatica	Rotbuche	Beech	A			
			Pinus sylvestris	Waldkiefer	Scots pine	A			
			Quercus petraea	Traubeneiche	Sessile oak	A			
			Quercus robur	Stieleiche	English oak	A			
BI	b) Großschirmschlag	Large-sized Uniform	Pinus sylvestris	Waldkiefer	Scots pine	A			

		Shelterwood System							
BII	c) Großschirmschlag	Large-sized Uniform Shelterwood System	Quercus petraea	Traubeneiche	Sessile oak	A			
			Quercus robur	Stieleiche	English oak	A			
			Fagus sylvatica	Rotbuche	Beech	A			
			Carpinus betulus	Hainbuche	Hornbeam	A			
	3. Saumschlag								
BII	a) Schirmsaumschlag	Shelterwood-Strip System	Abies alba	Weisstanne	White fir	A			
			Acer spec.	Ahorn	Maple	A			
			Fagus sylvatica	Rotbuche	Beech	A			
			Larix decidua	Europ. Laerche	European larch	A			
			Picea abies	Fichte	Norway spruce	A			
			Pinus sylvestris	Waldkiefer	Scots pine	A			
BII	b) Blendersaumachlag	Selection Border Cutting	Abies alba	Weisstanne	White fir	A			
			Fagus sylvatica	Rotbuche	Beech	A			
			Picea abies	Fichte	Norway spruce	A			
	4. Femelschlag	Selection Systems							
BII	a) Bayerischer Femelschlag	Bavarian Femel Coupe	Abies alba	Weisstanne	White fir	A			
			Fagus sylvatica	Rotbuche	Beech	A			
			Larix decidua	Europ. Laerche	European larch	A			
			Picea abies	Fichte	Norway spruce	A			
			Pinus sylvestris	Waldkiefer	Scots pine	A			
BII	b) Badischer Femelschlag	Baden Femel Coupe	Abies alba	Weisstanne	White fir	A			
			Fagus sylvatica	Rotbuche	Beech	A			
			Picea abies	Fichte	Norway spruce	A			
			Pinus sylvestris	Waldkiefer	Scots pine	A			
BI→ BII	c) Kuenstlicher Femelschlag	Artificial Femel Coupe (advanced artificial reproduction)	Abies alba	Weisstanne	White fir	A			
			Fagus sylvatica	Rotbuche	Beech	A			
			Picea abies	Fichte	Norway spruce	A			
	5. Kombinierte Naturverjuengungs-verfahren								
BII	a) Saumfemelschlag	Strip Selection Cutting	Abies alba	Weisstanne	White fir	A			
			Fagus sylvatica	Rotbuche	Beech	A			
			Picea abies	Fichte	Norway spruce	A			
BII	b) Schirmkeilschlag	Shelterwood-wedge Coupe	Abies alba	Weisstanne	White fir	A			
			Fagus sylvatica	Rotbuche	Beech	A			
			Picea abies	Fichte	Norway spruce	A			
			Pinus sylvestris	Waldkiefer	Scots pine	A			
CII	**6. Plenterung**	Single Tree Selection System							
			Abies alba	Weisstanne	White fir	A			
			Fagus sylvatica	Rotbuche	Beech	A			
			Larix decidua	Europ. Laerche	European larch	A			
			Picea abies	Fichte	Norway spruce	A			
			Pinus sylvestris	Waldkiefer	Scots pine	A			

			Quercus spec.	Eiche	Oak	A			
			*	Sonstiges Laubholz	Other broadleaves	A			
CII	**7. Naturgemaesse Waldwirtschaft**	Forestry based on Natural Conditions							
			Abies alba	Weisstanne	White fir	A			
			Fagus sylvatica	Rotbuche	Beech	A			
			Larix decidua	Europ. Laerche	European larch	A			
			Picea abies	Fichte	Norway spruce	A			
			Pinus sylvestris	Waldkiefer	Scots pine	A			
			Pseudotsuga menziesii	Douglasie	Douglas fir	B			
			Quercus spec.	Eiche	Oak	A			
			*	Sonstiges Laubholz	Other broadleaves	A			
D	**8. Mittelwald**	Coppice System with Standards							
			Acer pseudoplatanus	Bergahorn	Sycamore	A			
			Alnus glutinosa	Schwarzerle	Common alder	A			
			Alnus incana	Grauerle/ Weisserle	Grey alder	A			
			Betula spec.	Birke	Birch	A			
			Carpinus betulus	Hainbuche	Hornbeam	A			
			Corylus avellana	Haselnuss	Common hazel	A			
			Fagus sylvatica	Rotbuche	Beech	A			
			Fraxinus excelsior	Esche	Common ash	A			
			Larix decidua	Europ. Laerche	European larch	A			
			Picea abies	Fichte	Norway spruce	A			
			Pinus sylvestris	Waldkiefer	Scots pine	A			
			Populus spec.	Pappeln	Poplars	A/B			
			Prunus spec.	Kirsche	Cherry	A			
			Quercus petraea	Traubeneiche	Sessile oak	A			
			Quercus robur	Stieleiche	English oak	A			
			Tilia spec.	Linde	Lime tree	A			
			Ulmus spec.	Ulme	Elm	A			
E	**9. Niederwald**	Simple Coppice System							
			Acer pseudoplatanus	Bergahorn	Sycamore	A			
			Alnus glutinosa	Schwarzerle	Common alder	A			
			Betula spec.	Birke	Birch	A			
			Carpinus betulus	Hainbuche	Hornbeam	A			
			Castanea sativa	Edelkastanie	Sweet chestnut	A			
			Fraxinus excelsior	Esche	Common ash	A			
			Populus tremula	Aspe	Aspen	A			
			Populus spec.	Pappeln	Poplar	A/B			
			Quercus petraea	Traubeneiche	Sessile oak	A			
			Quercus robur	Stieleiche	English oak	A			
			Robinia pseudoacacia	Robinie	False acacia	A			
			Salix spec.	Weide	Willow	A			
			Tilia spec.	Linde	Lime tree	A			
			Ulmus spec.	Ulme	Elm	A			
G	**10. Unbewirtschafteter Wald und Naturwald**	Not managed and Native Forests							
			Acer spec.	Ahorn	Maple	A			

			Alnus glutinosa	Schwarzerle	Common alder	A			
			Alnus incana	Grauerle	Grey alder	A			
			Betula spec,	Birke	Birch	A			
			Carpinus betulus	Hainbuche	Hornbeam	A			
			Fagus sylvatica	Rotbuche	Beech	A			
			Larix decidua	Europ. Laerche	European larch	A			
			Picea abies	Fichte	Norway spruce	A			
			Pinus cembra	Zirbe/ Arve	Cembran pine	A			
			Pinus mugo	Latsche	Dwarf (mountain) pine	A			
			Pinus sylvestris	Waldkiefer	Scots pine	A			
			Populus spec.	Pappeln	Poplar	A/B			
			Quercus spec.	Eiche	Oak	A			
			Robinia pseudoacacia	Robinie	False acacia	A			
			Salix spec.	Weide	Willow	A			
			Sorbus spec.	-	-	A			
			Tilia spec	Linde	Lime tree	A			
			Ulmus spec.	Ulme	Elm	A			

Table 3.3.1: Silvicultural systems and corresponding tree species in Germany

3.4 Forest Landscape and Recreation Design Guidelines

In Germany there are a lot of recommendations and advises for natural forest management („naturnahe Waldbewirtschaftung“) and amenity design.
These non-obligatory guidelines target three major objectives:

1. forest interior
2. exposed sites and adjacent natural objects
3. exterior areas

3.4.1 Design of the interior of woodlands

This task comprises the creation, management and conservation of natural woodlands, which are suited to site and climate and which fulfil all necessary functions for society (i.e. social, ecological and economical). Please see for the following examples ../report98/prototyp.gif.

Common silvicultural design and regeneration systems in Germany.

Example 1: ***Clear cut***
Primarily for unstable spruce stands which don’t fit to site and climate conditions. According to the Forest Law of the State Baden-Wuerttemberg (Southwest-Germany) clear cuts bigger than 4 hectares have to be approved by the forestry commission; for clear cuts bigger than 5 hectares an environmental impact assessment („Umweltvertraeglichkeitspruefung“) is mandatory.
Example 2: ***Seed tree method by compartment***
Primary method for regeneration of beech (fagus sylvatica) and oak stands (quercus robur, quercus petraea). Selective cuttings open the stand by interrupting the leaf canopy. Natural regeneration is controlled by light and shade.
Example 3: ***Strip selection cutting***
Primarily for mixed spruce stands. This method favours the intolerant trees with light demander like spruce (picea abies) and scotch pine (pinus sylvestris).
Example 4: ***Group selection cutting***
Creates optimal light conditions for shade trees and intolerant trees in mixed stands.
Example 5: ***Regeneration under selection system***
Traditional forest management for private owned forests in regions of South-Germany and Switzerland. Favours shade trees in mixed fir-beech-spruce-stands (abies alba, fagus sylvatica, picea abies).

All of these 5 examples demonstrate the different visual impact on the environment and show the important influence of silvicultural systems on amenity design.

3.4.2 Design of exposed sites and adjacent natural objects

This task comprises the design and creation of exposed sites like forest mantles, visible rocks or natural monuments like old single trees. Please see for the following examples ../report98/waldrand.gif

Types of forest mantles

Example 1: Steep edge of beech and spruce stands in geometrical forms spoil the scenery, have less habitat quality and endanger the stand stability.

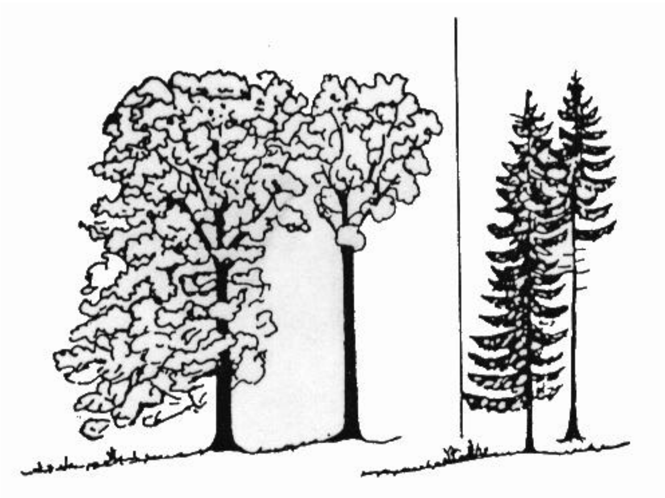

Figure 3.4.1: Steep edge of beech and spruce Stands in geometrical forms

Example 2: Optimal forest mantle with different tree species, zones of bushes and herbaceous vegetation. Width 25 to 45 meters. The structure of the mantle grants stable stands and good habitat conditions. Nevertheless those designing concepts often fail due to economic interests of the land owners. See detailed plan of a forest mantle with an ideal structure (..report98/edge3.gif).

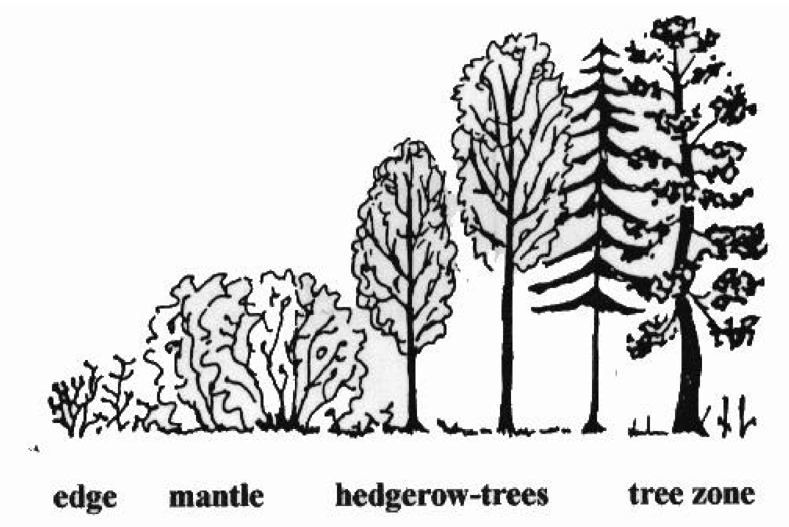

Figure 3.4.2: Ideal forest mantle graded on the area with a high diversity of tree species

3.4.3 Design of exterior areas

This task includes afforestations of open land and the design of visual landscape units. We demonstrate the methodological approach with the help of the example of the Upper Danube Valley, where design guidelines which handle the overall appearance of the landscape were developed.

In so far they do not regard forest interiors but aesthetic and amenity issues described in ../report95/probltab.htm. Hence the concept focuses primarily apparent landscape changes like afforestations of pasture land and valleys. The study is devided into the following five steps:

1. Selection of Visual Landscape Units in the Study Area
2. Assessment of local outdoor activities
3. Preliminary Landscape Amenity Assessment
4. Assessment of local afforestation pressure
5. Graphic development of preliminary prototypes for all landscape units

3.4.3.1 Selection of Visual Landscape Units

The selection of Visual Landscape Units is primarily based on morphological differences in the Study Area. The detailed classification into 8 units reduces the problem of generalisation of guidelines and presents a profound basis for a landscape unit based design. All landscape units of the Study Area (the cliff zone in the west is missing and will be added in later versions) are shown in the following *„Map of Visual Landscape Unit“* (see ../report96/donau10.jpg):

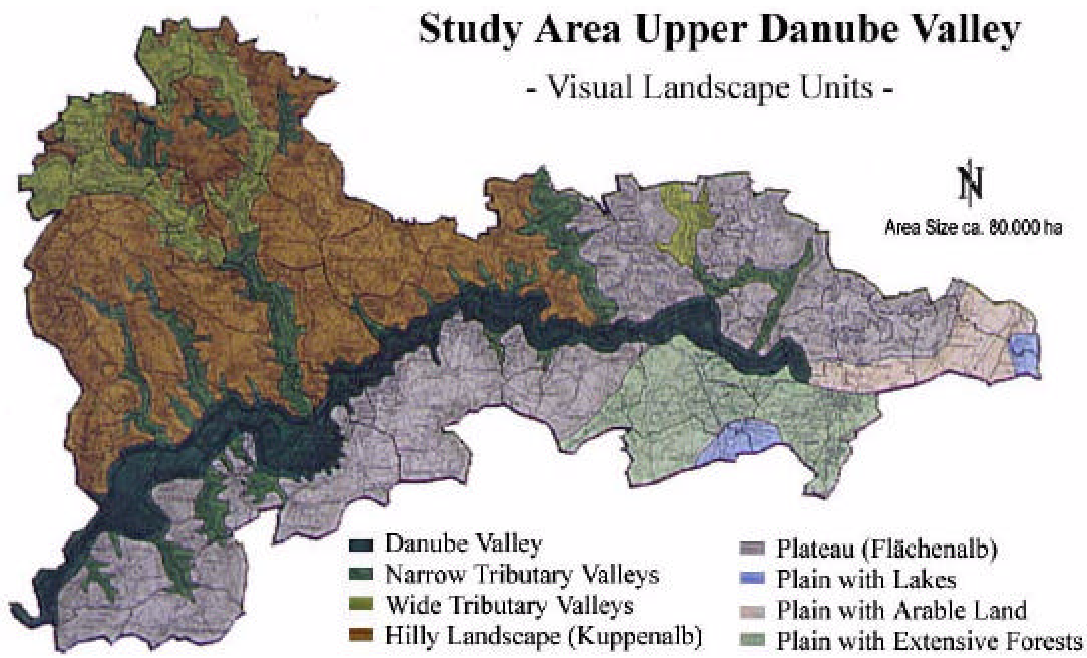

Figure 3.4.3: Map of Visual Landscape Unit

3.4.3.2 Assessment of Local Outdoor Activities

The map *"Concentration of Outdoor Activities"* (see ../report96/donau40.jpg) is based on data acquisition by observations and visitor census. It indicates which places and areas in the study area are preferably visited. The attractiveness of those preferred places depends on amenities and facilities for day trippers and holiday makers. Scenic places which are additionally good for various outdoor activities are preferred destinations which often show high visitor pressure. Landscape units concerned have to be designed with respect to their present natural attractiveness and to expected future conflicts of competing landuse.

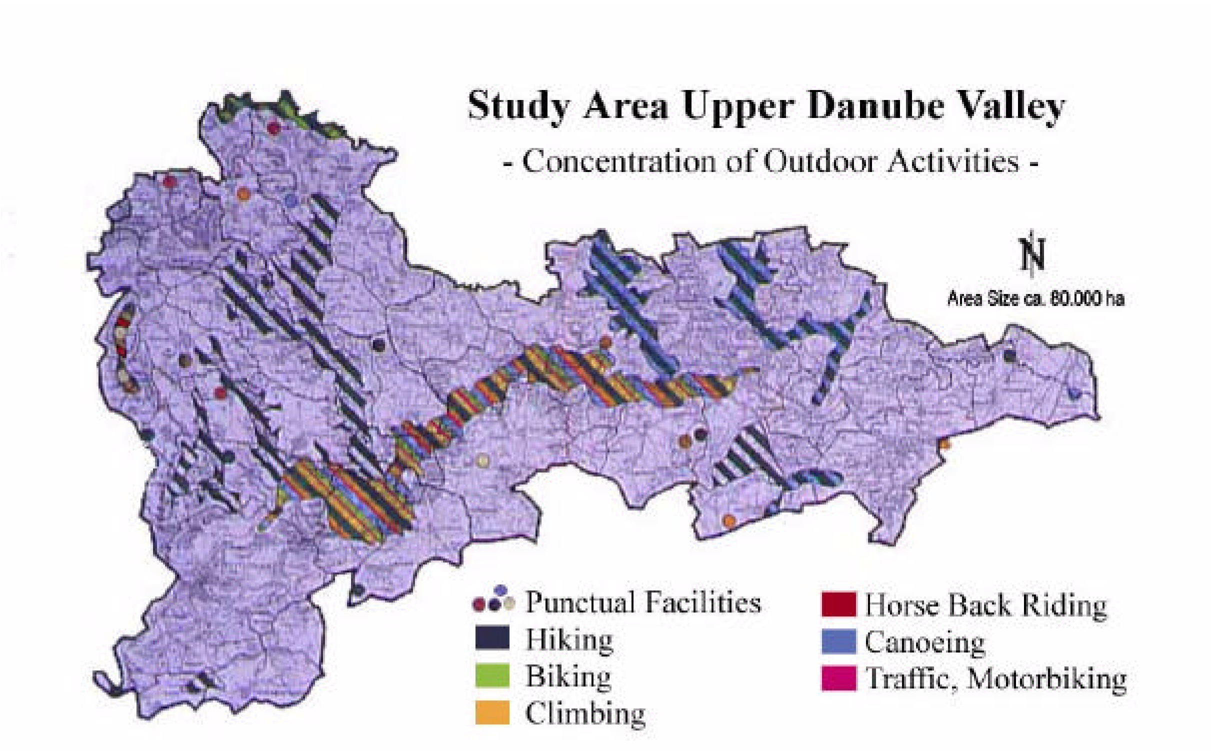

Figure 3.4.4: Concentration of Outdoor Activities

3.4.3.3 Preliminary Landscape Amenity Assessment

The third map *„Preliminary Landscape Amenity Assessment"* (see ../report96/donau20.jpg) is an interpretation of the two previous maps. It shows areas with high, medium and improvable amenity, due to scenery, different landscape features like rivers or outstanding rocks, etc., and recreation facilities like bicycle trails, etc.. In this regard the aesthetic component plays a significant role. Hence Amenity Design Guidelines have to

- conserve areas with high amenity
- improve areas with medium amenity and
- develop areas with amenity capable of improvement.

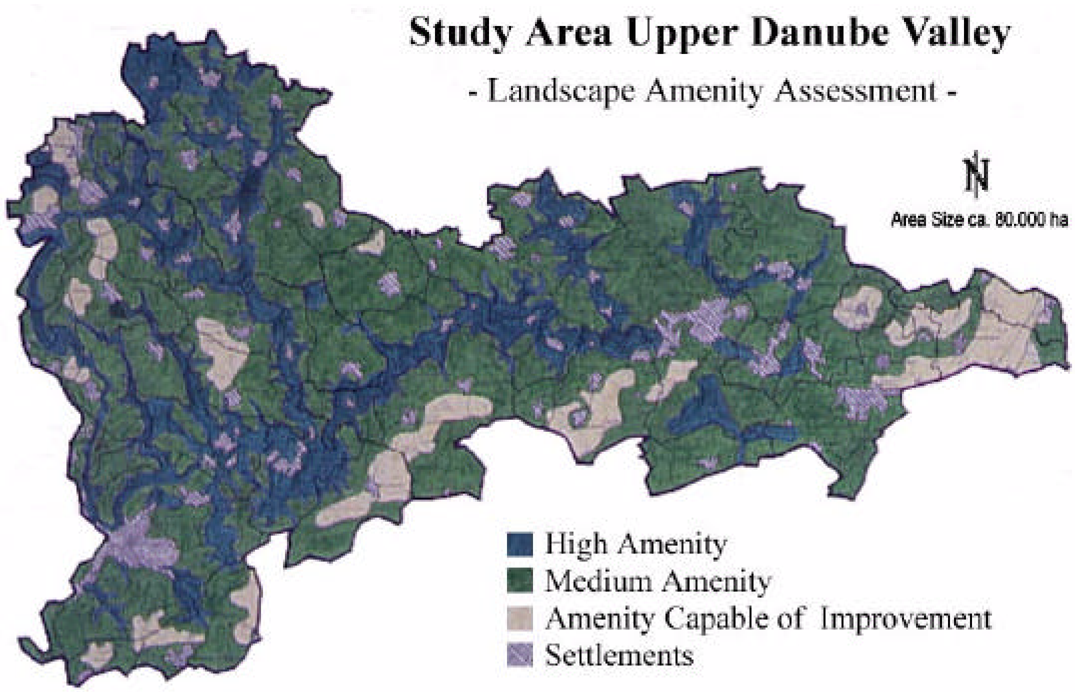

Figure 3.4.5: Preliminary Landscape Amenity Assessment

3.4.3.4 Assessment of Local Afforestation Pressure

The last map „*Assessment of Local Afforestation Pressure*“ (see ../report96/donau30.jpg) shows the amount of afforestations in all community districts in the Study Area during a period of 15 years. The map indicates communities with different increases of afforestations (from less than 5 ha up to more than 100 ha). The numbers refer to afforestations of arable land, which has been planted preferably with fast growing spruce. On the dark green areas there is still a very high afforestation pressure with effects on aesthetics and amenity. Consequently there is a high priority to develop appropriate design proposals for the landscape units concerned.

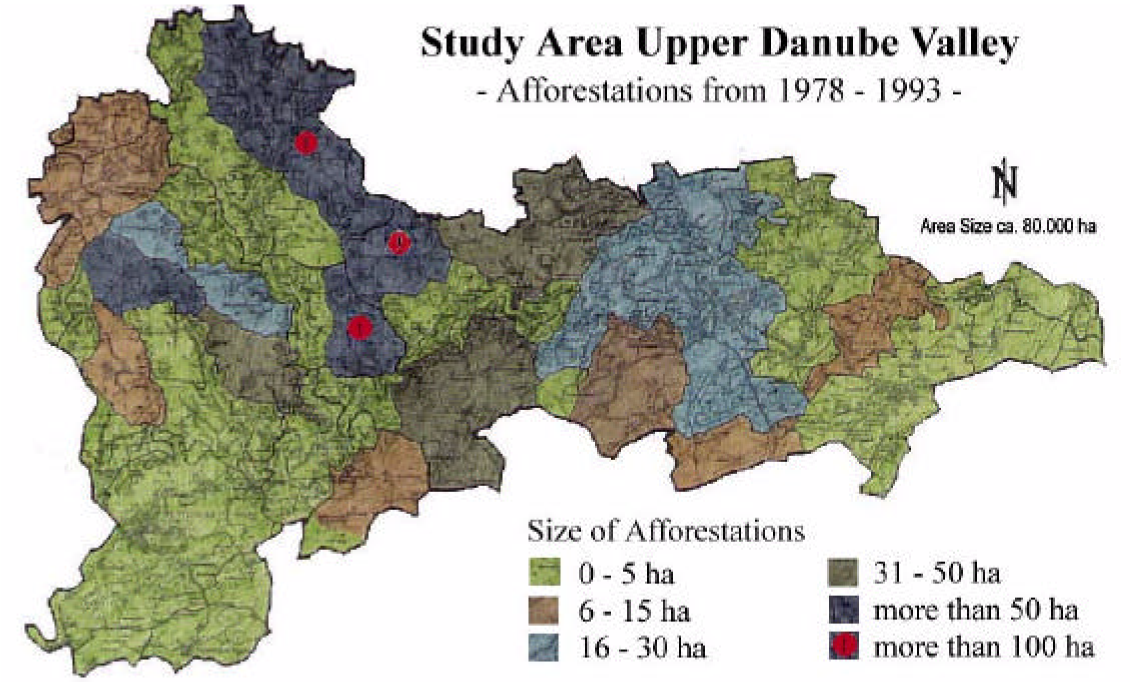

Figure 3.4.6: Assessment of Local Afforestation Pressure

3.4.3.5 Graphic Development of Preliminary Prototypes

Prototypes of Landscape Units are an adequate mean to develop Amenity Design Guidelines. They correspond to the heterogeneous morphology of previously described Visual Landscape Units. Beside the primary visual aspect the prototypical design approach also manages ecological and economical issues in terms of amenity design. All findings of the first steps have to be taken into consideration for an adequate landscape design.
Amenity Design Guidelines may therefore contain verbal and graphic descriptions of prototypical landscape units, based on the results of the public preference purvey and ecological and economical needs.
The following draft shows manually done graphics of prototypes for the landscape units "Danube Valley" and "Plateau Flächenalb", which handle the problem of afforestations and their aesthetic and ecological effects. The study can be completed using the computer methodologies demonstrated in detail in the next chapter to do:

- photorealistic prototypes for all landscape units (Photoshop/GIS)
- visibility analysis for selected prototypes (GIS)
- overlays of the economical and ecological situation (GIS)

3.4.3.5.1 Prototype for Landscape Unit "Danube Valley"

Aesthetic maintainance of status quo. See figures ../report96/dondrw1a.GIF and ../report96/dondrw1b.GIF.

Figure 3.4.7: Status quo

Figure 3.4.8: Aesthetic maintainance of status quo

Design of forest mantles for existing afforestations. See figures ../report96/dondrw2a.GIF and ../report96/dondrw2b.GIF.

Figure 3.4.9: Existing afforestations

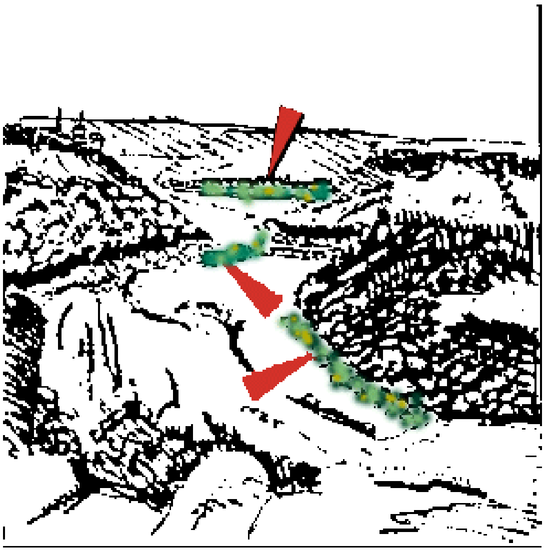

Figure 3.4.10: Design of forest mantles for existing afforestations

Reforestation of present afforestations. See figures ../report96/dondrw3a.GIF and ../report96/dondrw3b.GIF.

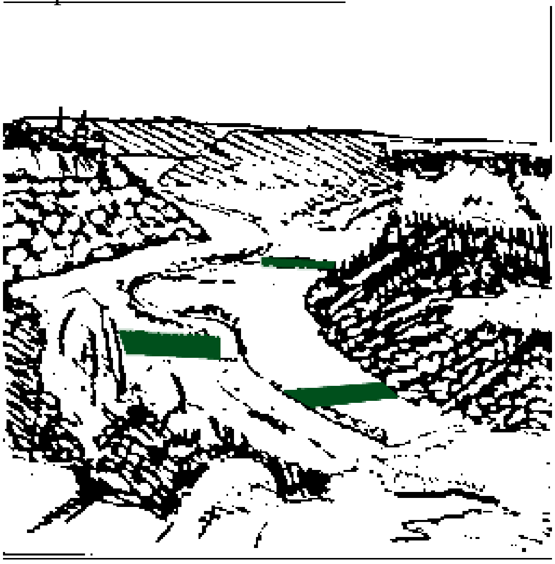

Figure 3.4.11: Status of present afforestations

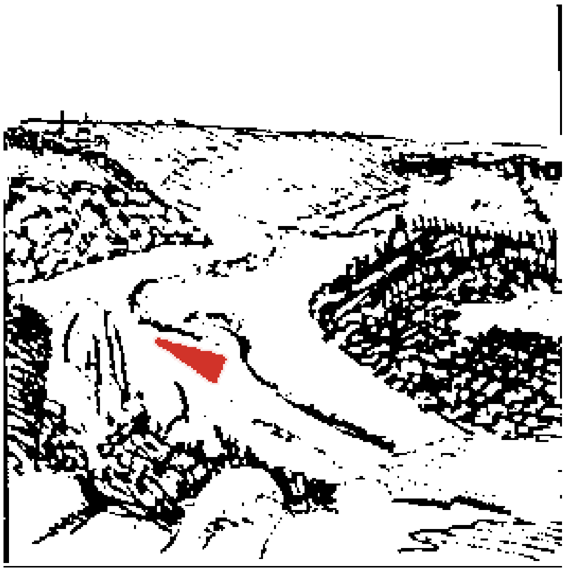

Figure 3.4.12: Reforestation of present afforestations

3.4.3.5.2 Prototype for Landscape Unit "Plateau (Flächenalb)"

Afforestations to structure „agricultural deserts". See figures ../report96/pladrw1a.GIF and ../report96/pladrw1b.GIF).

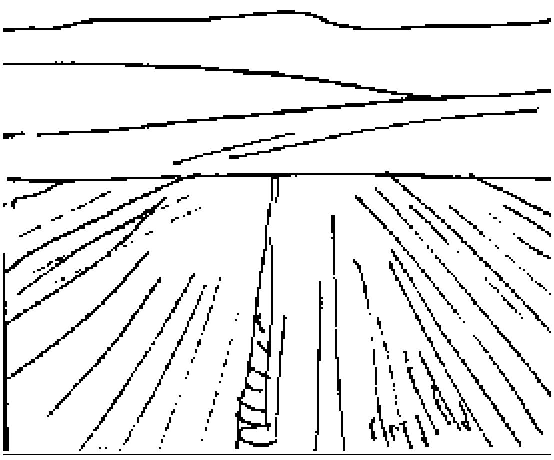

Figure 3.4.13: „Agricultural deserts"

Figure 3.4.14: Afforestations to structure „agricultural deserts".

Afforestations of intensively used arable land. See figures ../report96/pladrw2a.GIF and ../report96/pladrw2b.GIF.

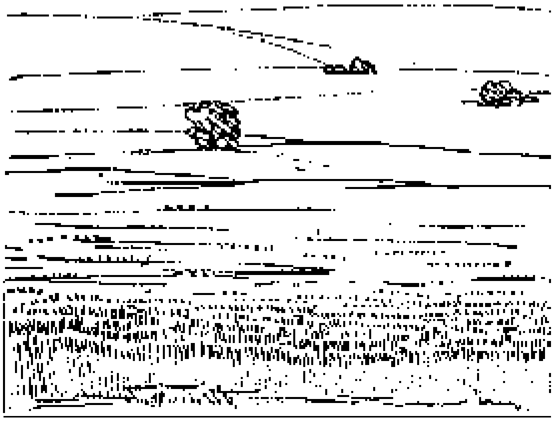

Figure 3.4.15: Intensively used arable land

Figure 3.4.16: Afforestations to structure intensively used arable land

3.4.4 Recommendations to handle afforestation applications

3.4.4.1 Basic information for landuse planning:

Planners get basic information for natural and sustainable forest and landuse management from the forest site determination, so called „Standorterkundung“ (scale in general 1: 10.000) and the mapping of forest sites and adjacent open lands with important functions for the environment (scale in general 1:50.000). These areas are:

- Scenic areas
- Areas for fresh water protection
- Forests with climatic functions
- Forests designated to recreation, grade 1 and 2
- Forests for soil protection
- Forests for covering ugly landscape elements
- Forests for protection from emissions like air pollution or noise
- Protected native or traditionally managed forests

This information on a large scale results in variation and concentration of planning activities like recreation planning, aesthetic design or intense economical management etc.

3.4.4.2 Amenity Filters and Approval of Afforestation Applications

Following 3 criteria are suitable for an environmental impact evaluation of afforestations. They function like filters to demonstrate the different impacts. The initial position is hilly country with less productive sites and a bad infrastructure.

- Filter 1 refers to the climate
- Filter 2 refers to the scenery
- Filter 3 refers to flora and fauna

The result is the approval of applications for afforestations on sites which don’t reduce the natural capacity of the environment (see ../report98/filter.jpg).

Following recommendations to approve or refuse afforestation applications are adapted to the landscape unit:

Case Study 1: Low mountain range (see ../report98/mrange.gif)
forest percent 70%
afforestation application for 10 hectares
afforestation approval for 3 hectares

Case Study 2: Hilly country (see ../report98/hilly.gif)
forest percent 35%
afforestation application for 25 hectares
afforestation approval for 18 hectares

Case Study 3: Lowland (see ../report98/lowland.gif)
forest percent 10%
afforestation application for 5 hectares
afforestation approval for 4.7 hectares
additionally recommended: 6 hectares

3.5 Use of Computer Technology on Forest Landscape Planning and Design

The scientifically examined findings on how man perceives landscape leads us to the requirements concerning the performance of an adapted planning tool. We need a variety of illustration tools to describe the variety of natural phenomena. Concluding from the chapters above it is vital that we describe landscape as a whole. That means first of all we have to reproduce as much as possible of all natural stimuli. Secondarily we have to present the landscape as realistic as possible. Thirdly we have to inform the people on what they see and fourthly we should be able to illustrate spatial problems in a flexible way in a small or large scale.

The German computer research is focused on the development of adequate Geographic Information Systems, image processing systems and mulitmedial computer applications, which are qualified to measure and describe landscape in a realistic way. Those tools should also be able to calculate, analyse and simulate specific landscape conditions, in the past, in the present and in the future. Beyond this the presentation and mediation of planning results has to be achieved. Researching the planning tools helps to improve the communication between planners, experts and the publicity during the planning process to grant for the highest possible acceptance of the plan.

We researched different systems like CAD (Computer Aided Design), GIS (Geographic Information Systems) and a variety of Multimedia applications. In a very early stage of the project we found out, that a flexible and open GIS is better to achieve the FORAM objectives than object orientated CAD systems. Patrick Reidelstuerz from the co-operating Department for Landscape Information Systems and Remote Sensing (head: Prof. B. Koch) at the University in Freiburg has shown the performance of terrestrial photogrammetry and CAD

systems (Microstation from Intergraph) for the object orientated landscape design. (Reidelstuerz 1997).
We focused 3 systems to develop an innovative computer based method for landscape design in Germany:

- Geographic Information Systems
- Multimedia Applications
- Internet Applications

The interface between landscape and human mind are our sense organs and the capability of abstraction. So we can combine received information to an idea or an image of our environment. Landscape design always effects landscape in a holistic way. Single landscape elements are sensually perceived by the observer as a part of the entire landscape and not isolated from it. To this regard it makes sense to include as much landscape effects as possible into the planning process.
Digitising images, videos and sounds enables the computer to analyse what we see and hear from our environment. Additional information, geo-referenced to the relevant point on a digital map or image improves a realistic impression of our natural environment. Whenever we want we can reproduce this impression and make it available to everybody. By means of an interactive multimedial presentation we are able to demonstrate the complexity of nature in a transparent way to experts and laymen. Digital Planning improves public participation (by public computer terminals or via the Internet) and so the general acceptance of design proposals.

3.5.1 Geographic Information Systems

The system architecture and the basic functions of GIS is documented in detail in different standard publications (Burrough 1985 ESRI 1992, Haines-Young et al. 1993). The standard work from Peter Burrough „Principles of Geographical Information Systems for Land Resources Assessment“ describes all algorithms commonly used in digital landscape modelling.

3.5.1.1 What is a GIS

A geographic information system (GIS) is a computer-based tool for mapping and analysing things that exist and events that happen on earth. GIS technology integrates common database operations such as query and statistical analysis with the unique visualisation and geographic analysis benefits offered by maps. These abilities distinguish GIS from other information systems and make it valuable to a wide range of public and private enterprises for explaining events, predicting outcomes, and planning strategies.
Figure ../report98/GISoverlay_schema.jpg illustrates the classic overlay function of a GIS.

3.5.1.2 The 5 Components of a GIS

A working GIS integrates five key components: hardware, software, data, people, and methods. File ../report98/5compon.gif below illustrates the GIS concept.

Figure 3.5.1: The 5 components of GIS

3.5.1.2.1 Hardware

Hardware is the computer on which a GIS operates. Today, GIS software runs on a wide range of hardware types, from centralised computer servers to desktop computers used in stand-alone or networked configurations. Since one of the objectives of our research was to develop a user friendly computer based method for landscape design, we changed from Unix systems in the beginning to PC based systems which also work on mobile laptops. This facilitates the GIS work and makes it more flexible.

3.5.1.2.2 Software

GIS software provides the functions and tools needed to store, analyse, and display geographic information. Key software components are tools that support geographic query, analysis, manipulation and visualisation of geographic information. Another important component is the database management system (DBMS), which administrates geometrical data and feature properties of all landscape elements. Finally a graphical user interface (GUI) enables the landscape planner or an external user to access and control the tools. By means of a flexible GUI a GIS can be used as an interactive presentation system as well as a scientific analysing tool. We tested different GIS software packages like ArcInfo Rev. 6 & 7 (Unix), PC-ArcInfo Rev. 3.04D plus, ArcView 3.0 (PC) and Microstation Rev. 5.0 (PC) and we finally found, that ArcView is the most adequate system to perform multifunctional landscape design digitally. The widespread base module of ArcView combines input and query tools, with mapping and presentation functionality for a reasonable price (about 1.700 ECU in Germany).
The performance of ArcView 3.0 can be improved by so called extensions - commercial or self-written programs for a special operation task. The 3 standard extensions, provided by ESRI (www.esri.com) are

a) the Network Analyst
b) the Spatial Analyst and
c) the 3D-Analyst

(a) is for all network analysis like accessibility calculations, (b) is for cell based (raster) analysis, like DEM modifications or visibility analysis, (c) is for perspective calculations in 3D and for many other surface modelling tasks.

3.5.1.2.3 Data

Possibly the most important component of a GIS is the data. Geographic data and related tabular data can be collected in-house or purchased from a commercial data provider. A GIS will integrate spatial data with other data resources and can even use a DBMS, used by most organisations to organise and maintain their data, to manage spatial data. GIS data can be divided into 3 categories due to its data format:

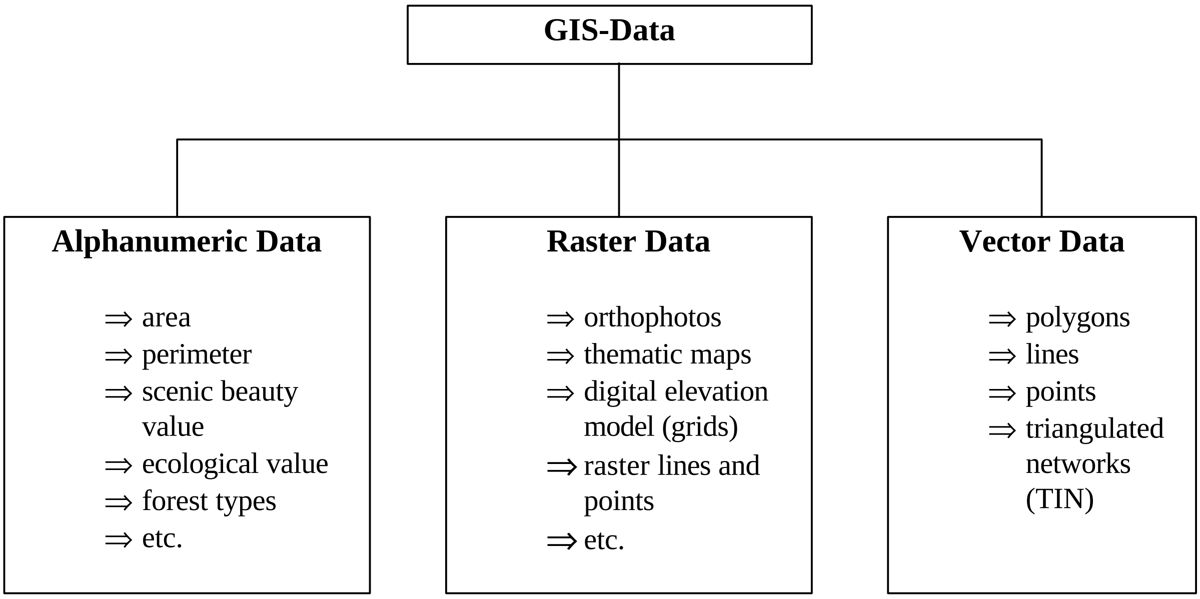

Figure 3.5.2: GIS Data Formats

The most important GIS characteristic is its capability to process raster or vector data. The two data formats are used for different tasks. The essential difference between raster and vector is the way the geometric information is saved. The geometry of a raster element is determined by the location of the pixels (Picture Element), the geometry of vector elements is described by a sequence of co-ordinate pairs. The qualitative information (like landuse, scenic beauty, elevation etc.) of raster elements is automatically encoded as a grey scale number and vector features has to be manually labelled. The essential difference between raster and vector processes is illustrated in the following figure (..report98/raster_vector_real.gif). The upper layer shows the raster format, the middle layer shows the vector format and the lower level represents the real world.

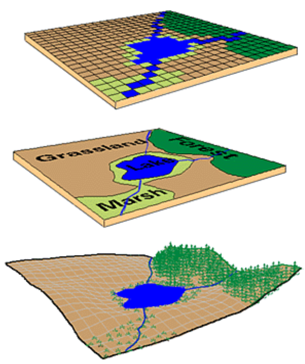

Figure 3.5.3. Differences of Raster and Vector GIS

3.5.1.2.3.1 Data Input

At the beginning of the planning process, the availability of digital data must be determined. The release of spatial digital data is still rare in Bavaria. Additionally, the price, distribution and licensing policy is often left unclear. The best spatial data can be found at the State Survey Branches of the different Federal States in Germany, which offer different thematic layers of the official topographic map in the common Drawing Exchange Format (DXF) format (e.g. in Bavarian Survey Branch in Munich) or other exchange formats like EDBS (e.g. Survey Branch in Stuttgart, Baden-Wuerttemberg). We used data from the official topographic information system (ATKIS) and from the official Digital Elevation Model. We could also integrate tabular data from the official biotope mapping. With the exception of this general data, almost all other landuse and ecology-related data had to be digitised by ourselves - a process which is still very time-consuming and expensive.
There are several different ways by which spatial data can be recorded:

Alphanumeric Data

- Key board input of descriptive information with text processing or data base software

Vector and Raster GIS Data

- Recording site geometry and site features by photogrammetric means (aerial stereo photos):
    - Digitising from a Stereo Plotter (e.g. SD 2000 from Leica or Planicomp from Zeiss) with CAD or GIS software by cursor input on the system screen.
    - Recording sites by means of an analogue stereoscope as a sketch map, which then has to be digitised on a digitiser board
- Recording geometry and features of sites from distorted aerial photos, or adequate terrestrial photos (Warner 1993), by means of the Monoplotting procedure on the screen or on a digitiser board.
- Digitising site geometry, and eventually site features, from orthophotos and aerial photo maps on the screen or on a digitiser board.
- In-house digitising of field sketches and maps
- Digital recording of site geometry and site features, in the field, by means of Pen computers and suitable software (Kias 1996)

The spatial accuracy of digitised polygons, points and lines is one of the most important issues in GIS. Accuracy here depends primarily on the quality of the available, basic information. The greatest accuracy can be achieved by digitising all sites from aerial stereo photos - something which is not always practical since the planner must integrate a variety of data sources and formats into the GIS. For instance, in addition to the photogrammetric landuse interpretation based on orthophotos or aerial stereo photo models, the mapping of landscape features from existing paper maps still remains necessary. Those maps are often not up-to-date. Further, their scale may differ from the scale of the used planning maps, and this can introduce additional inaccuracies.

3.5.1.2.4 People

GIS technology is of limited value without the people who manage the system and develop plans for applying it to real-world problems. GIS users range from technical specialists who design and maintain the system to landscape architects, who use it for their everyday work and all stakeholders of the planning who are informed about the planning by means of GIS. People are an important factor of the GIS research since they judge its usefulness, which is essential for the acceptance of computerised planning methods. The results of a public survey of landscape architects and citizens about the pros and cons of GIS and digital presentation methods (Weidenbach 1998 and Weidenbach & Pröbstl 1998) show a general - but also critical - acceptance of new digital media in landscape design. The future success of digital planning methods depends on the operator convenience of new systems and the transparency of the used methods.

3.5.1.2.5 Methods

For many users the computer is like a black box, because they do not know exactly how pushing a computer button effects the hard- and software. This ignorance often leads to invalid results. So the knowledge about GIS implemented system methods used to represent reality in a computer model is essential for a profound and valid application of GIS. The different mathematical algorithms and system properties which are commonly used in vector and raster GIS are described in detail in Burrough (1985) or Bill & Fritsch (1994) and many more publications. The question how surface models are derived from - often incomplete - digital elevation models is of special interest for visibility analysis and the assessment of the scenic value of a landscape (see below).
Once the system architecture has been properly understood, you can develop and apply computer based methodologies to assess the scenic quality or the amenity value of landscape units. We pursued two approaches:

- appraising approach by experts and
- a persuasive approach

The appraising approach is based on landscape assessment by advisory, i.e. all aesthetically relevant landscape elements are evaluated by the landscape architect with ordinal numbers. These numbers are often derived from scientific studies or based on quantitative parameters (like the frequency of landscape elements, relief energy etc.) or they are simply the result of the experts experience. Examples for the appraising approach are for instance the scenic beauty estimation of the test site Spitzing See. The model is explained in more detail under ../report96/compwork.htm, where you also find the basic forest inventory map (..report96/map14.jpg) and the SBE map (../report96/map15.jpg).
The experts approach is a rigid method, which evaluates single landscape features in a very subjective way without regarding the synergetic effect. Because of the unsatisfying results of this method we tended to put more emphasis on a descriptive method, which led to the development of the persuasive approach. The objectives of this approach is not primarily the assessment of the landscape by means of a final number, but the best possible way to digitally reproduce landscape aesthetics in order to have a basis for an open and flexible interpretation of it. This requires a holistic inventory and GIS functionality to represent landscape aesthetics in realistic way.
The individual perception of landscapes is primarily controlled by our eyes and it is influenced by information received. So it seems to be vital that a GIS combines:

- the visual presentation and
- the data management and query

Both are classical functions of a GIS, which now becomes the perfect platform for the appraising and persuasive approache. Following we demonstrate the practical application of GIS in 3 dimensions.

3.5.1.3 GIS one-dimensional (alphanumeric GIS)

The first dimension of GIS comprises its capabilities to store information as text or as numbers. All landscape elements can be described quantitatively or qualitatively with site related data.

The data is stored in tables and can be queried related to the landscape element, like the name of species found on a site, the ecological condition of biotopes, etc..

3.5.1.3.1 Aesthetic 1D-Index

The number, size and percentage of different features of a visual landscape unit is a common index that can be used to describe a landscape character by means of alphanumeric GIS-Data. We calculated the numbers for the forests of the northern and southern part of test site Burggen North and South (see ../report98/burgmap.gif).

	Burggen North	Burggen South
Number of Forests	52	105
Medium Size	4,39 ha	4,75 ha
Forest Percentage	11,23 %	21,23 %

Table 3.5.1: Aesthetic 1D-Index of test site Burggen

3.5.1.4 GIS two-dimensional (planimetric GIS)

A two-dimensional GIS includes the classical functions to describe points, lines and polygons graphically in two dimensions by a sequence of pairs of geographical co-ordinates. Describing the landscape in two dimensions is an approved method of the traditional geography. It is useful to analyse and locate landscape features without the need to describe the 3rd dimension, hence it is limited to aesthetic issues. The analysis of aesthetics is restricted to the location and 2-dimensional extend of different landscape elements.

3.5.1.4.1 Aesthetic 2D-Index

The quotient of the perimeter and the area of forests can be used as an index to describe the aesthetic edge effect of forest stands or afforestations. propose an. For linear features like rivers, the quotient of the nearest distance from start to end point to the real length gives an index of the irregularity of the element (Weidenbach 1990). We used the index proposed by Forman & Godron (1986, p. 189) to describe the shape of forest patches in Burggen North and Burggen South (see ../report98/burgmap.gif). A small number represent uniform shapes, i.e. a circle has an index of 1. The 2D-indices in Burggen reaches from 1,05 to 4,94.

	Burggen North	Burggen South
Average of all Forest Quotients	2,11	1,67

Table 3.5.2: 2D-aesthetical Index of Burggen

3.5.1.5 GIS 3-dimensional (volumetric GIS)

One of the problems of computerised landscape modelling is the constraint to display 3 dimensional objects on the 2-dimensional screen. Hence perspective illustrations and the shading of objects is a useful method to give a 3-dimensional impression, like the illustration of the Upper Danube Valley (../excurs95/donaupanorama.jpg). Following we demonstrate how a landscape can be analysed and visualised with GIS in 3 dimensions.

3.5.1.5.1 Used Data

The base data for the surface models is the Digital Elevation Model (DEM) provided by the survey branch. The DEM is a tabular data set with 4 columns. The first column contains the

point-id, the 2nd , 3rd and 4th columns contain the the x-, y-, and z-values. The DEM points are interpolated to a regular grid with 50 (survey branch Baden-Wuerttemberg and Bavaria) or 25 meters (only Bavaria) resolution. The elevation accuracy depends on the natural relief and ranges from 2-3 meters on a slightly sloped surface to a higher fault on a very irregular relief. Depending on the applied photogrammetric method, the DEM represents either the ground surface (the natural relief) or the vegetation surface (based e.g. on the roof of the forests). This difference is essential for all visibility analysis working with the DEM data. The DEMs from the Bavarian survey branch represent the surface without forests, afforestations or settlements, i.e. they had to be modified to calculate a model which is adequate to calculate the visibility shading of the landscape.
Another way to generate a digital surface with GIS is by digitising contour lines from topographical maps (done for test site Spitzing See) or by means of a photogrammetric system like the analytical systems from Leica (SD 2000) or from Zeiss (Planicomp).

3.5.1.5.2 Surface Concepts

Another component of surface models are the interpolation methods for the measured elevation data, which are used to represent the landscape relief as good as possible in a digital model. Common interpolation methods are Inverse Distance Weighted, Spline, Kriging and Trend. The spline interpolator is best for gently varying elevation surfaces.
We used two different models to represent surfaces: Grids and TINs (Triangulated Irregular Network).
Grids represent surfaces using a mesh of regularly spaced points. One can estimate a surface value anywhere within the mesh by averaging nearby mesh point values, giving more weight and influence to those that are closer (see figure ../report98/gittermethode.jpg).

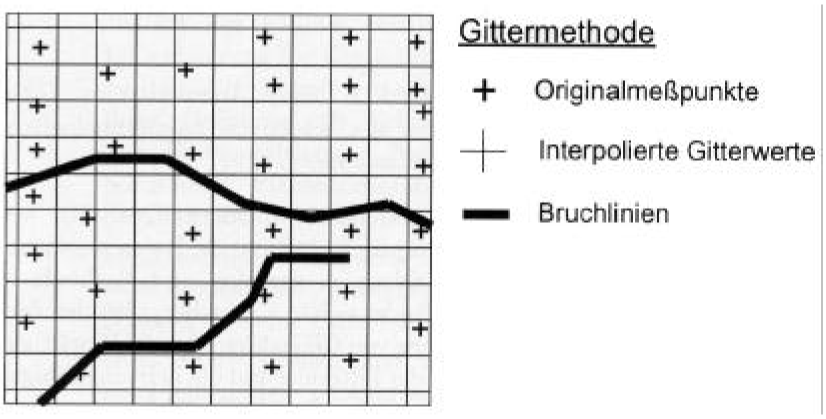

Figure 3.5.4: Concept of the GRID method (Gittermethode) with measured field points (Originalmeßpunkte), interpolated grid points (interpolierte Gitterwerte) and breaklines (Bruchlinien).

The smaller the distance between points (the finer the resolution) the more detail the model picks up. The grid model is simple and processes on them tend to be more efficient than those on other models. Well established algorithms, originating primarily from the image processing community, exist to process grids. Elevation data in gridded format is relatively abundant and inexpensive. On the other hand, since the rigid mesh structure does not adapt to the variability of terrain (losing information between mesh points), source data may not be captured and reflected properly in resulting analysis like interpolation. The mesh structure also prevents linear features from being represented sufficiently for large-scale applications.

Triangulated irregular networks (TINs) represent surfaces using contiguous, non-overlapping triangle facets. One can estimate a surface value anywhere in the triangulation by averaging node values of nearby triangles, giving more weight and influence to those that are closer (see figure ../report98/dreiecksmethode.jpg).

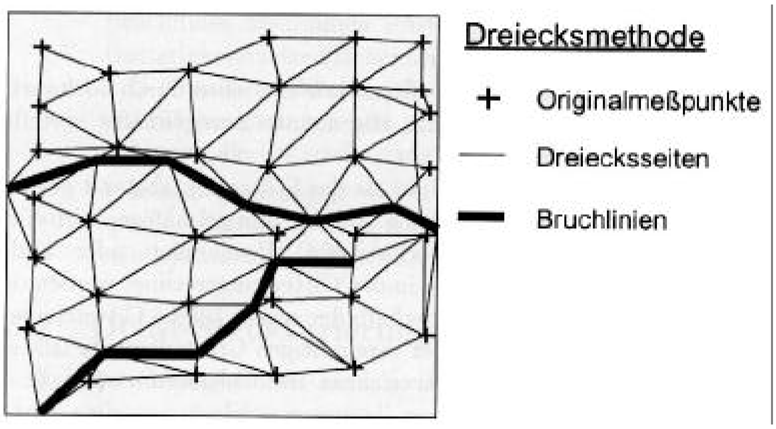

Figure 3.5.5: Concepts of the TIN method (Dreiecksmethode), with measured field points (Originalmeßpunkte), triangle edges (Dreieckseiten) and breaklines (Bruchlinien).

The resolution of TINs can vary, that is, they can be more detailed in areas where the surface is more complex and less detailed in areas where the surface is simpler. The co-ordinates of the source data are maintained as part of the triangulation so subsequent analysis, like interpolation, will honour the source data precisely; no information is lost. We can represent linear features like roads and streams accurately by enforcing them in the model as triangle edges.

While TINs do have their benefits, they also have their drawbacks. They tend to be expensive to build and process. The cost of obtaining good source data can be high and processing them tends to be less efficient than grids. Grids are usually used more for regional, small-scale applications, while TINs are used for more detailed, larger scale applications. We used the grid method for the test site Burggen and the Upper Danube Valley, where the source data's positional accuracy isn't very high and where we did not represent linear features like roads and streams exactly. We tested the tin method for a more detailed scale of test site Spitzing See, where the source data is more accurate and where we needed to represent linear features. Based on these fundamental concepts we could use the generated surface models to visualise and analyse the landscape.

3.5.1.5.3 Visualisation

The visualisation capabilities comprise a 2.5 dimensional illustration and a real 3D visualisation. The 2.5D illustration is created by the shading of the generated surface model, which uses different parameters to set the light source. 2.5D does not provide any perspectives The file *../report98/visdemo1.jpg* shows the shaded 2.5D surface model (without vegetation and buildings) of test site Burggen.

The real 3D illustration is a calculated perspective view. By means of the 3D functionality different views from different observer positions can be calculated and displayed on the screen. This virtual view can be shaded by a hypsometric model. All landuse forms with a relevant z-value like forests can easily be added to the model (see figures *../report98/smalltin1.jpg*, *../report98/smalltin1c.jpg* and *../report98/3D-demo3.jpg* of the test site Burggen).

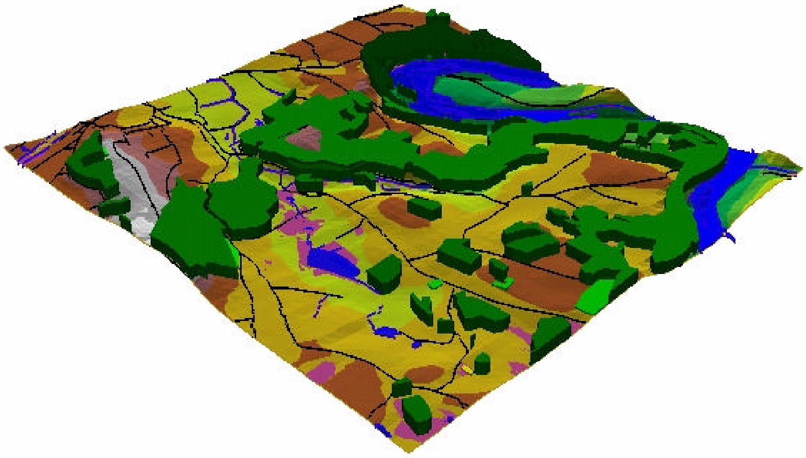

Figure 3.5.6: Real 3D illustration of southern part of test site Burggen

The figure *../report98/3D-demo6.jpg* shows the hypsometric model of the test site Spitzing See and in figure *../report98/3D-demo7.jpg* forest stand with different tree heights are added to the model. The model can be overlayed with geo-referenced raster data, like orthophotos or topographical maps. Figure *../report98/3D-demo5.jpg* shows the test site Spitzing See with information from the topographical map, figure *../report98/fbkarte-spitz.jpg* combines the surface model with information from the forest master plan. The use of colour photos like colour infrared (CIR) aerial photos produce an almost photorealistic impression (*../report96/map07.jpg*).
We also tested the overlay of terrestrial photos in common planning scales. The process is very difficult because the needed detailed DEM information is normally not available, the process to geo-reference the photos and the calculation of the observer position - which has to correspond to the photo recording point - is a source for aberration and ascertainment errors. In figure *../report98/jghdrpe1small.jpg* a photo taken from the key view point Knopfmacher Fels in study area „Upper Danube Valley" is draped over the hypsometric surface model. Figure *../report98/jghdrpe2small.jpg* shows the combination of an draped orthophoto, the top. Map, the terrestrial photo and an anaglyph (see next chapter) image.

3.5.1.5.4 Analysis

The generated surface models are the basis for 3D analysis like visibility or volumetric calculations. Visibility analysis are an essential part of visual quality assessments. The first step is the control of the used surface model. If forests and buildings heights are not represented in the DEM, the surface model first has to be modified, i.e. the z-values for all areas covered with forests or buildings has to recalculated. This procedure was necessary for the Bavarian DEM.

- Figure ../report98/visdemo1.jpg shows the surface model based on the raw data of the DEM.
- Figure ../report98/visdemo2.jpg shows the landuse forms which has to be recalculated. Forest (green) are calculated with a height of 25 m, settlements (red) with 15 m and afforestations (yellow, see map in Annex) with 5 m.

- Figure report98/visdemo3.jpg illustrates the visibility process calculating the viewshed from one view point.
- Figure ../report98/burglva.jpg demonstrates the visibility from key view point „Burgberg" based on the original DEM from the survey branch (without forests and buildings). Figure ../report98/burgreal.jpg is the same analysis, but now based on the modified surface model (regarding forests and buildings). The comparison between both figures reveals the different results.
- Figure ../report98/karte_final.jpg (see below) is a map with the visibility analysis of test site Burggen calculated from 7 selected key view points (see also ../report98/visdemo4.jpg).

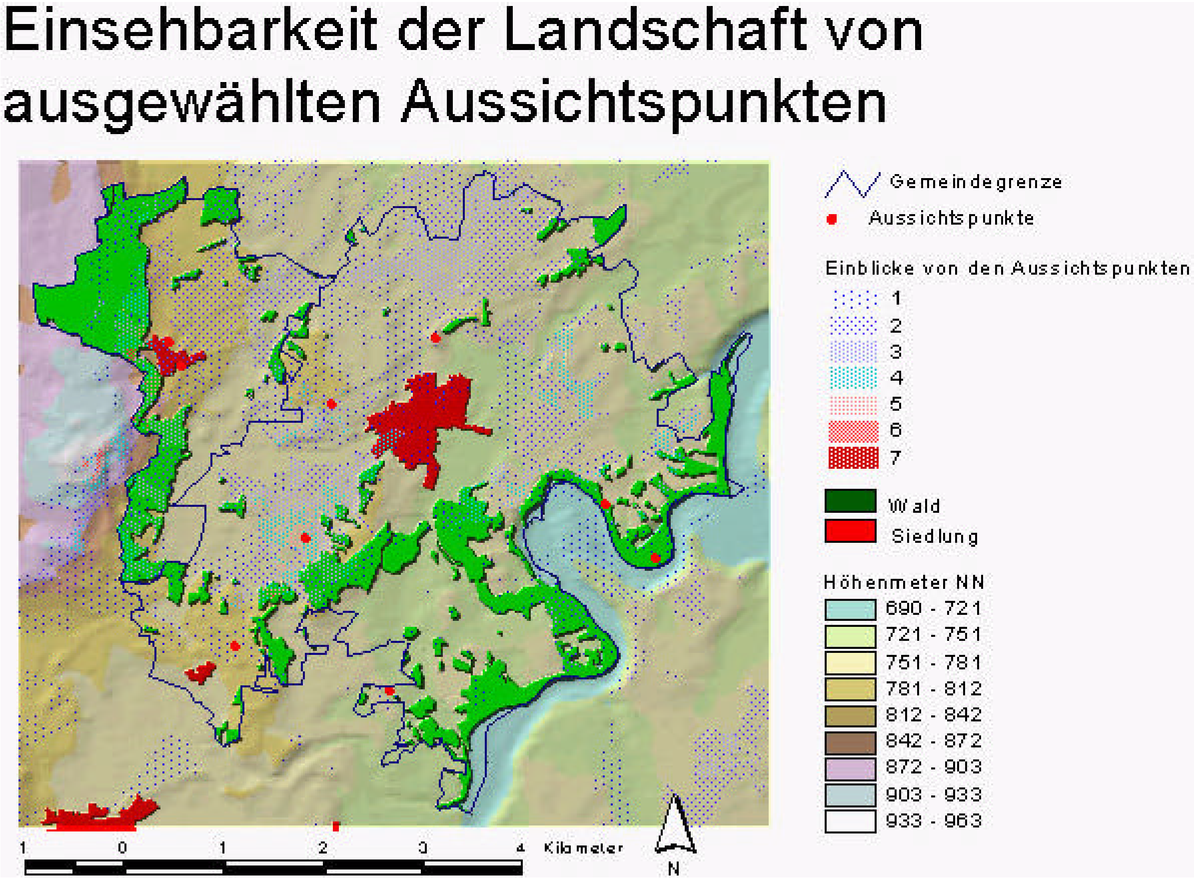

Figure 3.5.7: Visibility in test site Burggen calculated from 7 selected viewpoints (=Aussichtspunkte). Dotted areas are classified to their visibility from the view points(= Einblicke von den Aussichtspunkten). The German legend means: Wald = Forest, Siedlung = Settlements, Hoehenmeter NN = elevation above zero, Gemeindegrenzen = community district..

The assessment of the aesthetic quality of landscape units from selected key view points has always been a critical point throughout our research, because the results remain restricted to subjectively selected vista points. So we developed a methodology to do visibility analysis in a more flexible way. We programmed an ArcView extension called landvis.avx (see a detailed description of landvis.avx in German under ../report98/landvis.doc), the program works with existing *avenue requests* from the Spatial Analyst and it enables the user to choose between 3 different methods to do the visibility analysis:

1. from selected view points
2. from roads or paths
3. by a regular spaced grid (view-) points with a selectable grid resolution

Different variables can be set to control the analysis. The visibility analysis based on regular spaced (view-) points delivers results which can be examined with statistical methods.
The results of the visibility analysis can be used:

a. to find and plan interesting view points or „vista trails“
b. to select areas with a high aesthetic vulnerability
c. to map hidden areas with low visibility, adequate for urban/industrial buildings
d. to assess the scenic impact of proposed measures (afforestations, wind mills, etc.)

3.5.1.5.5 Aesthetic 3D-Index

By means of a volumetric GIS we can even quantitatively characterise the structure of landscape units regarding the 3rd dimension. The quotient of the planimetric surface area and the real surface area is a measure to describe the roughness of a landscape. It is vital to use DEM data, that considers all landscape elements with a z-value (like the modified surface models above). The 3D index represents the structure of a landscape corresponding to the graphical illustration of it.
Figure ../report98/3d-types.htm lists all calculated 3D indices and the corresponding relief types of Burggen. Figure *../report98/smalltin2lyt.jpg* shows the surface model of the southern part of the test site Burggen (see ../report98/burgmap.gif), which is a well structured rolling landscape form. The corresponding 3D-Index is 0,93. Figure *../report98/smalltin3lyt.jpg* shows the surface model of the northern part, which is a less structured agricultural area. The corresponding 3D-Index is 0,96. To examine the index in more detail we did the calculation with areas, which had been selected in the field due to its structure. The less structured areas of Burggen (*../report98/structin2.jpg*) have an index of 0,98, the well structured areas (*../report98/structin2.jpg*) have an index of 0,90. We finally state that areas, which are well structured have a lower index (< 0,95) than poorly structured landscapes (0.95 and higher). The 3D index changes with the increment of forests and buildings. Many isolated forests with a high edge effect depress the index, extended compact forest areas increase the index.

3.5.2 Multimedia Applications

The above described GIS programs are not able to reproduce sensual data in a satisfying way. We therefore researched a way to extend the GIS capabilities to develop a computerised planning tool, which improves „realism“ in landscape design. Multimedia applications offer a great potential to reproduce landscapes in a realistic way. Two media types were used:

1. **time independent media**
    - text documents
    - graphics and diagrams
    - images (maps, orthophotos, terrestrial photos, anaglyph images)

2. **time dependent media**
    - image animations
    - virtual surface models
    - full-video and
    - auditive media

We tested several hardware systems to explore the possibility to record, process and present multimedial data. A Sony Camcorder Hi8 system was finally selected to produce analogue sound videos. The hard- and software components of the video system Aviator Speed were used to digitise the videos. Unfortunately it is still not possible to produce well compressed video files in the MPEG (Motion Picture Group) format with an adequate quality for presentations. Therefore we stored the files in the Video for Windows format (*.avi), which is an uncompressed format and needs consequently a lot of storage space: a sound video sequence of 3 seconds is about 1 megabyte big. Some of the videos are transformed to REAL (www.real.com) streaming videos for presentations on the WWW: ../home/videos/koepfle.ram and ../home/videos/ducks.ram and ../home/videos/haslsee.ram.

By means of a standard photo camera with a 35 and 50 mm lens images were taken in the field and scanned afterwards with a scanner system from UMAX. Most of the files are stored as compressed *.jpg files, geo-referenced background images are stored as TIF files (tagged image file). We also researched the possibility to generate so called *Anaglyph Images* on the basis of stereo aerial photos to produce a 3 dimensional impression of the landscape. We used the software module EASI/PACE from PCI, an image processing system which gave us the best results. Poorer results were achieved by means of Photoshop, which does not have an image geo-referencing tool. The anaglyph process is based on the elimination of either the red channel or the green channel of a RGB (256 colours of a red, green and blue channel) images. By overlaying the red channel of one aerial photo of the stereo pair with the green channel of the other aerial photo produces a 3 dimensional impression if the observer uses glasses with a green filter for one eye and a red filter for the other eye (see the anaglyph image of the Upper Danube Valley in figure ../foram/report96/map11.jpg, and draped over the surface model in figure ../report98/anaglyph_3d.jpg).

The generated surface models (TINs) were transformed into Virtual Reality Models, which can easily navigated in real time even with web browsers (e.g. Netscape Gold 3.0) or on a standard PC. The surface model of Burggen is saved as ../mmgis/Burggen0.wrl and the one of the Upper Danube Valley is saved as ../mmgis/Beuron2.wrl
To enhance the possibility for realistic simulations we did different photo manipulations with Photoshop e.g.:

- ../report96/panox.jpg and ../report96/panoy.jpg illustrate the impact of ski lifts in the alps
- ../report98/dorf1.jpg and ../report98/dorf4.jpg and ../report98/dorf5.jpg illustrate different alternatives for urban planning
- ../report98/kulturo.jpg and ../report98/kultur1.jpg and ../report98/kultur2.jpg illustrate the impact of afforestations

To animate the manipulated images, we generated a image sequence in GIF format, which runs like a video an illustrates the landscape changes by afforestations in fast motion. The animation is small enough to be presented on common WWW browsers (../mmgis/ani101.gif).

3.5.3 Interactive Multimedia GIS: a Methodology for Holistic Landscape Design

While multimedia encounters the need to reproduce landscape features in a realistic way, Geographic Information Systems are suitable to locate and analyse landscape elements. The combination of both systems therefore enables the landscape architect to fulfil the requirements of a qualitative and quantitative landscape research and planning (figure ../report98/mm-system.jpg illustrates the Multimedia GIS concept).

3.5.3.1 Multimedia GIS

As mentioned above, a landscape design plan or a Landscape Master Plan (LMP) that is easily understood is essential for the acceptance of design proposals. A client-friendly analysis and presentation of planning results has become an important factor in successful landuse planning. A GIS which is able to simulate geo-referenced landscape stimuli is a suitable tool for creating a general awareness of the relevant planning issues. The multimedia computer presentation possible with such a system facilitates the illustration of often very complex planning goals and creates a sensitivity for landuse related conflicts. Sustainable implementation of a landuse plan can only be achieved if citizens are fully aware of all the issues and can make informed decisions. Figure ../mmgis/burgapr2.jpg (test site Burggen, below) and ../report98/avcapt1.jpg (study area Upper Danube Valley) are screen shots of the digital Multimedia GIS presentation.

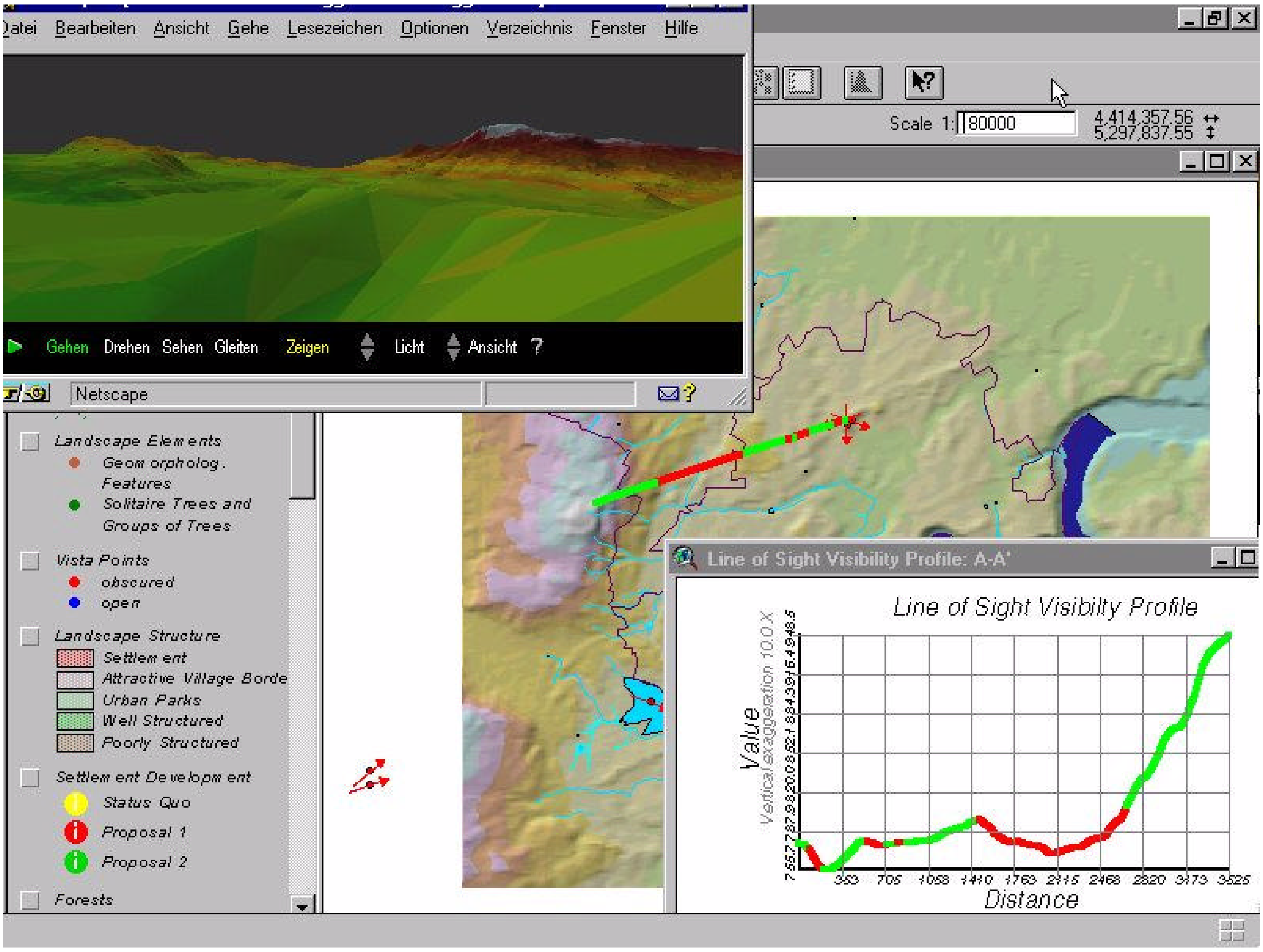

Figure 3.5.8: Screen shot of Multimedia GIS presentation

We selected the GIS software *ArcView 3.0* with the Spatial Analyst extension and *Netscape Gold 3.0* to present the data in the LMP of a rural community in Upper Bavaria. ArcView runs on Windows95 and encompasses all the multimedia functionality of the platform. We used a laptop computer with two external speakers for our presentation. To project the data on the screen we placed the removable LCD display of the laptop onto a standard overhead projector (see ../mmgis/gisdemo.jpg).

The following paragraphs describe the digital data components of the LMP. The various thematic and planning maps were presented as separate "views" using the ArcView software. The vector data were ArcInfo coverages, ArcView shape files and vectors in Drawing Exchange Format (DXF). The following data types were added to the vector data in ArcView:

- tables in *dBase* format - necessary for the display of site-specific data via a mouse click on the site;

- videos in *Video for Windows* format - used to provide a visual and acoustic landscape impression (the videos were related to the mapped recording point). See figure ../mmgis/burgapr3.jpg.
- images in JPEG, GIF and TIFF format - used as background information (b/w topographical maps and orthophotos) and illustrate areas of interest in a photorealistic way (terrestrial, site-related colour photos);
- image animation in GIF format - used to illustrate changes in the landscape over time. See figure ../mmgis/burgapr4.jpg with *Photoshop* simulation of growth of afforestations, which helps to illustrate future conflicts
- an ArcInfo Shaded Grid - gives a 3-dimensional landscape impression;
- an ArcInfo TIN (Triangulated Irregular Network) in VRML format (Virtual Reality Modelling Language) - describes space conditions in 3 dimensions and allows a realistic, interactive flight through the landscape even in the WWW. You can run the VRML model from the Internet using, for example, Netscape Gold 3.0 (www.lnn.forst.uni-muenchen.de/daten/foram/mmgis/Burggen0.wrl).See figure ../mmgis/burgapr2.jpg with three-dimensional landscape analysis with line of sight calculations (lower right) and a Virtual Reality Landscape Model (upper left).

3.5.3.2 Public Participation via the Internet

In this section we outline our vision for the future evolution of a persuasive landuse planning. Some of what we describe is already a reality. Other elements (such as an interactive Landscape Master Plan on the Internet) are likely to become a reality very soon, given the speed with which Internet technologies are evolving.
A key advantage of using digital data is the ability to rapidly exchange information over networks such as the Internet, as well as over Intranets and Extranets. The increasing network links between government authorities, landscape architects, communities and private Internet users, opens new avenues for public participation and communication between all stakeholders in a landuse planning process. The discussion focuses on three such groups:

- the authorities concerned with landscape design and nature conservation;
- the citizens who live in the study area; and
- the local communities and their representatives

The landscape architect frequently co-ordinates planning steps with the responsible authorities, and obtains the basic information required. In future, the use of digital data could facilitate the information flow between authorities and the planner via the Internet. Questions and disagreements over proposed measures could be handled verbally or graphically by e-mail, using the latest GIS online maps. The final Landscape Master Plan could be submitted to the responsible authorities digitally over the Internet, thus saving the costs of copying and mailing paper-based maps and other documents.

Normally, all citizens of a community in the study area are informed about the planning stages and procedures at public meetings of the community council. In the federal state of Bavaria, the LMP must be approved by the community council. There is a legal time limit for citizens to file any objections. If the proposed LMP were published on the Internet, access by interested parties would no longer be restricted to office-hours, public gatherings and official meetings late in the evening, as is now the case. Thus, Internet publication of the LMP, along with the time limit for public response, makes good sense. Even filing an objection by e-mail would be possible, although there are legal issues which would have to be addressed.

Public participation is also a point for the management of Nature or National Parks. We developed a WWW-GIS concept to disseminate information from the Naturpark Obere Donau (Study Area Upper Danube Valley) via Internet and GIS (see ../donau/index.htm and ../donau/konzept.htm).

Answers to the technical issues of Internet publication can be found on the Internet itself. The file formats currently in use on the World Wide Web (WWW) have now become reasonably standard, and can be read by a wide variety of computers and operating systems. Most Web Browsers are now able to process JPEG and GIF images, and replay sound (*.wav) or video (*.mpg, *.avi) files. The recent extension of Browser capabilities (through Plug-Ins, Java Applets and Scripts or Active-X), enables users to navigate 3-dimensional landscape models most commonly in the VRML-format in real time, to play sound and music, to make phone calls via the Internet, or to send e-mail messages directly through the Browser.

The ”helper” programmes and Java scripts required to display and interact with digital maps on the Web can be downloaded from the Internet. This includes, for example, the user shells from Autodesk (www.mapguide.com) and Esri (www.esri.com/base/products/internetmaps/internetmaps.html) which can be used to receive and read vector and image (*.GIF) data. The zoom command of these shells enables the receiver to ask for more detailed data from the server, which then delivers the information appropriate for the chosen scale. Additionally polygons and points on the online map can be linked to reports or tables.

4 Discussion

4.1 Discussion of Computer Work

Digital Technologies has become a common tool in landscape planning. Today the situation is determined by the

- Ongoing improvement of hardware & software performance and simultaneously decreasing hardware and data transfer costs, resulting in further proliferation of computers and digital technologies within both organisations and homes
- Ongoing improvements in GIS, CAD and Image Processing technologies
- Emergence and rapid development of new multimedia and Internet technologies, bringing new opportunities for the presentation and distribution of information
- Increasing data highway capacities (bandwidth), opening the way to practical delivery of interactive multimedia presentations over the Internet and over municipal networks, resulting in ongoing rapid growth of the Internet as a new communications medium

Based on this general conditions, the FORAM computer research covered three points: (a) the use of Geographic Information Systems, (b) the use of image processing systems (c) the use of multimedia applications and (d) the use of the Internet.

The results of all teams have shown, that GIS has become a most important tool in landscape planning. The computerised landscape analysis - like visibility analysis or the overlay of different landuse forms or natural conditions - enables the landscape architect to develop and use methods, which so far were not possible. The analysis of the 3rd dimension, the handling of various and huge data sets and the possibilities to present landscape digitally are the most innovative GIS functions.
The use of image processing systems (Photoshop) and multimedia applications are needed to do the planning in a (photo-) realistic way. The digital presentation of multimedia-enriched landscape data combines the realistic illustration of a landscape with the ability to obtain site-specific data in an ad hoc, interactive manner.
Digital technologies make it easier for landuse planners to manipulate data to suit their own ends. The use of manipulated images - or sounds and videos - must be looked at very critically. These technologies will play an important role in landuse planning only if planners use them with a sense of responsibility.

Using the Internet offers new ways to communicate with all stakeholders of the planning. Primary data like public preferences based on online public surveys can be obtained as well as secondary information like social or economical data about the study area.

Working with the mentioned digital technologies means an additional investment of time and money for the landscape architects. Although the computerised analysis of landscape took several months to complete, this can be expected to decrease considerably when digital working becomes routine part of landuse planning.
The expense of preparing a digital planning is justifiable providing the digital data is not converted back to India-ink drawings in order to make future revisions. The data must remain in its digital form for future processing, dissemination and presentation.

The computer is neither able to replace a field trip with a landscape architect, nor reproduce the complexity of an individual’s landscape perception in a satisfying way. But we can use computer technology as a tool to raise the public's awareness of the importance of nature and landscape protection, as well as to involve people in the planning process itself. If this can be accomplished, there is a much greater chance that the public will accept and be willing to support the implementation of landuse planning proposals.

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6 Sub-Annex: The Final German Project Report and the Technical Annex and the on the WWW

Please take cake care for the orthography of the filenames. The ftp program is case sensitive!

6.1 Directory of http://www.lnn.forst.uni-muenchen.de/daten/formam/report98

6.1.1 Subdirectories:

fotos: directory with *.jpg fotos used for public survey>
spss: directory with results from public survey (spss analysis) in *.jpg (charts) and *.htm (tables).

6.1.2 Files

Name of File	Size in bytes	Description
2_MAT&ME.DOC	80896	Final Report Chapter 2
3-1_LPL.DOC	19968	Final Report Chapter 3.1
3-2_SURV.DOC	3792	Final Report Chapter 3.2
3-3_SILV.DOC	57344	Final Report Chapter 3.3
3-4_GUID.DOC	6708224	Final Report Chapter 3.4
3-5_COMP.DOC	4564480	Final Report Chapter 3.5
4_LITERA.DOC	25088	Literature used in Final Report
comindis.doc	29184	Computer Intro. and Discussion
progress98.doc	23552	Progress Report Nov.-April 89
annexlist.doc	18000	This List of Web directory
3D-demo1.jpg	20165	
3D-demo2.jpg	25591	
3D-demo3.jpg	98482	
3D-demo4.jpg	27798	
3D-demo5.jpg	11272	
3D-demo6.jpg	15351	
3D-demo7.jpg	19967	
3d-typen.htm	2361	
3d-types.htm	2686	
5compon.gif	11080	
anaglyph_3d.jpg	275915	
avcapt1.jpg	552532	
blick_über_burggen.jpg	124797	
burglva.jpg	65371	
burgmap.gif	17575	
burgmap.jpg	75076	
burgreal.jpg	57711	
dorf1.jpg	83014	
dorf4.jpg	99437	
dorf5.jpg	98273	
dreiecksmethode.jpg	73768	
ecdemos.htm	3929	

edges.gif	289415	
edges1.gif	80520	
edges2.gif	61412	
edges3.gif	114949	
fbkarte-spitz.jpg	205514	
filter.jpg	157158	
forstdef.doc	20480	
forstdef.htm	6782	
forstmap.jpg	416135	
fotolist.doc	11264	
geology.jpg	472869	
GISoverlay_schema.jpg	55581	
gittermethode.jpg	113655	
hilly.gif	130965	
history.doc	17920	
history.htm	4358	
jghaus_3d.jpg	21101	
jghdrpe1.jpg	251791	
jghdrpe2.jpg	29852	
jghdrpe2small.jpg	24667	
jghdrpe3.jpg	228029	
jghdrpe4.jpg	271197	
jghdrpe4a.jpg	32456	
jghdrpe4asmall.jpg	21881	
karte_final.jpg	141357	
keppler.gif	232990	
kulturo.jpg	204226	
kulturo1.jpg	198992	
kulturo2.jpg	226418	
landunit.jpg	378398	
landvis.avx	1000	ArcView extension for specific visibility analysis
landvis.doc	1000	German Documentation for ArcView extension
lowland.gif	128776	
mm-system.jpg	110867	
mrange.gif	131731	
nordward2_3d.jpg	265969	
nordward_3d.jpg	266325	
ortho0_3d.jpg	238935	
ortho1_3d.jpg	249906	
ortho2_3d.jpg	257743	
plenter.gif	36694	
probltab.doc	24064	
probltab.htm	12154	
questeng.doc	36864	
raster_vector_real.gif	32558	
relief.jpg	440995	
silviclass.doc	29184	
silviclass.jpg	110107	
silvisysa.doc	20992	
silvisysa.jpg	84937	

silvisysb.doc	21504
silvisysb.jpg	82431
silvitab.doc	54272
silvitab.htm	
smalltin1.jpg	37644
smalltin1a-foto.jpg	
smalltin1a.jpg	98482
smalltin1b.jpg	91225
smalltin1c.jpg	205230
smalltin2.jpg	93668
smalltin2b.jpg	23092
smalltin2lyt.jpg	49069
smalltin3.jpg	89694
smalltin3b.jpg	17678
smalltin3lyt.jpg	42569
specitab.doc	30208
specitab.htm	20443
structin1.jpg	24729
structin1b.jpg	20838
structin2.jpg	14767
structin2b.jpg	17082
studarea.jpg	164563
systems.gif	191710
tk0_3d.jpg	344988
tk0_a_3d.jpg	381077
tk_a_wie_ortho2_3d.jpg	332396
tk_wie_ortho2_3d.jpg	328818
visdemo1.jpg	18562
visdemo2.jpg	33222
visdemo3.jpg	40776
visdemo4.jpg	76398
waldbau-raender.gif	40793
waldbausysteme.gif	140553

6.2 Directory of http://www.lnn.forst.uni-muenchen.de/daten/formam/report98/fotos

List of Images used for the Public Preference Survey

Question No. in Survey	**Description**	**File** (../report98/***.jpg**)
11/1	clear cutting: spruce forest interior	kahl1.jpg
	clear cutting: spruce, early phase	kahl2.jpg
11/2	strip selection system: mixed	saum1.jpg
	strip selection system: conifer	saum2.jpg
	strip selection system: winter aspect	saum3.jpg
11/3	shelterwood system: mixed	schirm1.jpg
	shelterwood system: mixed conifer	schirm2.jpg

11/4	single selection system: beech group	femel1.jpg
	single selection system: mixed group	femel2.jpg
11/5	Plenterwald: sunny	plenter1.jpg
	Plenterwald: shade	plenter2.jpg
12/1	tree species composition: conifers	nadel.jpg
	tree species composition: broadleaves	laub.jpg
12/2	structure: spruce monoculture	skeine.jpg
	structure: spruce with young beech	swenig.jpg
	structure: mixed mature stand	smittel.jpg
	structure: mixed broadleave (meadow)	sreich.jpg
12/3	forest mantle: good structure	rand1.jpg
	forest mantle: little structure	rand2.jpg
	forest mantle: missing structure	rand3.jpg
12/4	forest road: without green stripe	strasse.jpg
	forest road: with green stripe	gruen.jpg
	forest road: natural path	natur.jpg

6.3 Directory of http://www.lnn.forst.uni-muenchen.de/daten/formam/report98/spss

List of Tables, Charts and Other Statistical Material in the Annex of this Report Concerning Chapter 3.2.2

File name ../report98/spss/***.jpg** or ../report98/spss/***.htm**	**Description**
Personal Data	
agesex.htm agesex.jpg agetab.htm	Age and gender distribution
ort.htm ort.jpg	Residence
abschl.htm abschl.jpg	Educational level
income.jpg	Income level
General attitude towards forest and forestry in Germany	
state.htm function.htm visits.jpg visage.jpg disturb.htm disturb2.htm improv.htm	Significance of trees and forests Estimation of forest functions Frequency of forest visits Frequency of forest visits (age groups) Disturbances during forest visits Disturbances during forest visits Improvements regarding forests and

active.htm feel.htm	forestry Involvement in recreational activities Feelings and emotions during forest visit
Preferences towards silvicultural systems	
clear.jpg strip.jpg shelter.jpg group.jpg single.jpg	Evaluation of clear cutting system Evaluation of strip selection system Evaluation of shelterwood system Evaluation of group selection system Evaluation of „Plenterwald“
systems.jpg	Preferred silvicultural system
Preferences towards different forestry issues	
mixtur.jpg structur.jpg edges.jpg roads.jpg	Evaluation of tree species composition Evaluation of shape and structure Evaluation of forest edge design Evaluation of forest road design
Willingness to pay	
pay.jpg	Willingness to pay

6.4 List of Tables

6.5 List of Figures