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Development of an interactive service for wine-cultivation in the Swiss canton of Vaud

Développement d´un service interactif pour la viticulture dans le canton de Vaud.

MSc Thesis in Human-Computer Interaction

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Abstract
This diploma thesis describes the development of an interactive spatial service for the winegrowers in the Swiss canton of Vaud. The users can consult an interactive map containing different themes important for the wine-cultivation. Further the winegrowers can define their parcels of land with a specific grape-sort in the system and add important meta-data to the parcel. The system is developed according to Human-computer-interaction methods and theories.

Keywords: Wine-cultivation, GIS, interactive map, geoportal, database, parcel of land, Human-Computer-Interaction, HCI

Résumé
Dans ce travail de diplôme le développement d'un service interactif et spatial pour les viticulteurs du canton de Vaud est décrit. Les utilisateurs peuvent consulter une carte interactive contenant des différents thèmes qui sont importantes pour la viticulture. En plus les viticulteurs peuvent saisir ces parcelles de cépage dans le système et ajouter les meta-donnés importantes à la parcelle. Le système est développé selon des méthodes et théories de l'interaction homme-machine.

Mots clés: Viticulture, SIG, carte interactive, geoportail, base de données, parcelle de cépage –Interaction Homme-Machine, IHM

Sammanfattning
I detta examensarbete beskrivs utvecklingen av ett interaktivt och rumsligt system för vinodlarna i den schweiziska kantonen Vaud. Användarna kan konsultera en interaktiv karta innehållande olika teman som är viktiga för vinodlingen. Vidare kan vinodlarna rita in sina parceller med samma druvsort i systemet och bifoga meta-data som är viktiga till parcellen. Systemet är utvecklad enligt metoder och teorier från människa-dator-interaktionen.

Nyckelord: Vinodling, GIS, interaktiv karta, databas, geoportal, parcell, Människa-dator-interaktion, MDI

Zusammenfassung
In dieser Diplomarbeit wird die Entwicklung eines interaktiven Systems für die Weinbauern im Kanton Waadt beschrieben. Die Benutzer können auf einer interaktiven Karte verschiedene Themen, die für den Weinbau wichtig sind, konsultieren und visualisieren. Desweiteren können die Weinbauern ihre Parzellen mit einer Traubensorte in die Karte einzeichnen und wichtige Meta-daten der Parzelle hinzufügen.

Schlüsselwörter:Weinanbau, GIS, Interaktive Karte, Geoportal, Datenbank, Parzelle, Mensch-Computer-Interaktion, MCI

Abbreviations

CGI: Common Gateway Interface

EPFL: Ecole polytechnique fédérale de Lausanne (Federal Institute of Technology)

GIS: Geographical information systems

HCI: Human Computer Interaction

HTTP: Hypertext Transfer Protocol

LaSIG: Laboratoire de systèmes d'information géographique (GIS-lab)

PHP: Hypertext Pre-Processor

URL: Unified Resource Locator

WMS: Web Map Service Implementation Specification

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1 Introduction

1.1 Background

Since the 11th century wine has been cultivated to a bigger extend in the region that today forms the Swiss canton of Vaud. [1] The fertile and steep south-orientated slopes that rise from the lake of Geneva are an optimal growing-area for wine. On a trip from Geneva to Montreux the slopes covered by vineyards offer a spectacular view for the visitor.

Today wine-cultivation is very much dependent on spatial factors such as soils and climate, but also on economical factors that force winegrowers to produce as efficient as possible. Therefore modern information-technology has become more and more important for the wine-cultivation.

This thesis describes the development of a so-called geoportal for winegrowers, a spatial information system on the Internet aimed at making wine-cultivation more efficient. The development is based on the idea to combine two emerging technologies: Geographical information systems (GIS) and the Internet.

Geographical information systems have come through a rapid development. More and more application fields have been discovered and today GIS are a very powerful tool for spatial analysis. Even in the field of wine-cultivation GIS have become an important help for wine-farmers, but some disadvantages of these systems are that they are expensive and often only designed for one single user or a smaller group of user. Another problem is the compatibility with other software packages.

GIS have become integrated in innumerable Internet-applications as well, because of the well-documented benefits in terms of distributed access, centralized control for updates, and modest development cost. The users can get spatial information of all kinds and interact with these systems from all over the world.

1.2 Purpose

The purpose of this diploma-project is to use GIS in combination with the Internet for the development of an interactive spatial information-system in order to make the information editable and analysable from everywhere and without needing to install special software. The expected benefits of this idea are that all users can use the same system, that the development-costs are low and that the system easily can be extended and modified, e.g. to integrate other wine cultivation actors such as wine-producers, wine-sellers and wine-researchers. A possible use of such an extension is that it becomes possible to trace the way of the wine – from the grapevine on a specific parcel on the wine-yard to the cellar to the bottle to the consumer.

The system is developed according to human-computer-interaction (HCI) theories and methods. These theories are helpful for the design of the system, both regarding the functionality and the graphical layout.

Further this project is also a continuation of the project "Study of the wine-land of the canton of Vaud" (Etudes des terroirs viticoles vaudois) that was initiated by the Cantonal Office of Viticulture (Office cantonal de la Viticulture du canton de Vaud, OVV) and the Inter-professional Community for Wine cultivation of the canton of Vaud (Communauté interprofessionelle du vin vaudois CIVV). Data and reports from earlier projects within this cantonal project were available for the development of this system.

1.3 Structure of the report

The report is structured so that the main objectives of the project are listed in chapter one. In the second chapter the methods and theories used during the developing-process are described. According to the user-centred-system development the contact with the future users of the system is depicted, followed by the resulting user requirements and other functional aspects of the system. In the next chapter already existing systems are analysed in order to complete the users' requirements and to get an idea of how such a system can work and how it can be designed.

The sixth chapter illustrates the way in which the system has been designed – from conceptual models on to the implementation. After that the system is evaluated with the help of a group of future users. Problems encountered during the evaluation are listed and solutions for the future final version of the system are proposed. Finally the development-process is critically discussed and conclusions are made.

2 Objectives

2.1 Functionality

The goal of this project is the development of an interactive service for wine growing management. The system will serve as an information platform where winegrowers can consult thematic maps about their growing-areas such as maps containing the composition of the ground, water supply, microclimate, etc. The maps shall be navigable which means that winegrowers can view the maps at different scales and look up different regions of the maps. The maps are the central part in the information system – all other available information is connected to the maps.

Furthermore it is requested that the winegrowers can define the location and the spatial extent of their parcels by drawing polygons directly on the interactive map. The term parcel means in this project an area of land where the same sort of grape is grown. Then the wine grower can enter meta-data that is related to their parcels, for example:

- The sort of grape
- The date of plantation
- Maintenance
- Harvest information
- Exterminators

By entering information of this kind the geoportal (an interactive map-service) serves both as a database system for the single winegrower to store and manage his information, but also as a medium to communicate this information to other winegrowers.

With all this information thematic maps can be dynamically created showing the winegrowers activities and methods. Each winegrower will be able to choose which information is visible for other winegrowers and which information is visible for him only.

2.2 Design

To ensure the ease of use, the system will be designed according to human-computer-interaction methods and rules. This involves two important parts in the development of the system:

- The user is in focus of the design-process and therefore the system will be adapted to the users requirements regarding the functionality and the design.
- The adaptation of well-established design-principles based on research.

The goal of all the principles is: [2]

The reduction of the users' cognitive efforts when interacting with the system

By minimizing the user's cognitive efforts, the use of the system becomes as efficient and pleasant as possible and the usability is maximized. The term usability has been defined as

"The extent to which a product can be used by specified users to achieve specified goals with effectiveness, efficiency and satisfaction in a specified context of use."

It is therefore important that the user intuitively can understand what he can do with the system without consulting a help-file. The methods and principles applied in the development are described later in the method chapter. Further in the implementation-chapter these methods are used to motivate the choice of design for specific parts of the prototype.

3 Methods and theories

3.1 Overview

As described earlier, one goal of this project is to follow HCI guidelines. These guidelines are completed with other more project-specific theories and methods, such as cartographic principles and methods. The methods used in the development are:

- The user-centered system-development – a method framework that helps the developer to identify the user and the users needs
- Shneidermans Eight Golden Rules of good interaction design – eight rules based on empirical investigations that shall be followed.
- Cartographic methods and web-mapping

3.2 User-centred system-development

The model of the user-centered system-development will be applied in the development of the system to integrate the user in the design-process The development of a system starts with the identification of the users, e.g. in which situation the users would use the system and what the system could help the users with. Interviews or inquiries are examples for identification strategies. Further, the contact with the users must result in a specification of the users' requirements. The specification is a list of the desired functionality, but should also contain some reflections about the design and the technologies that can be used during the development. The next step is the development of one or more prototypes. These prototypes can finally be validated. If the users aren't satisfied with the final prototype the development process starts again with a new analysis of the users needs [2].

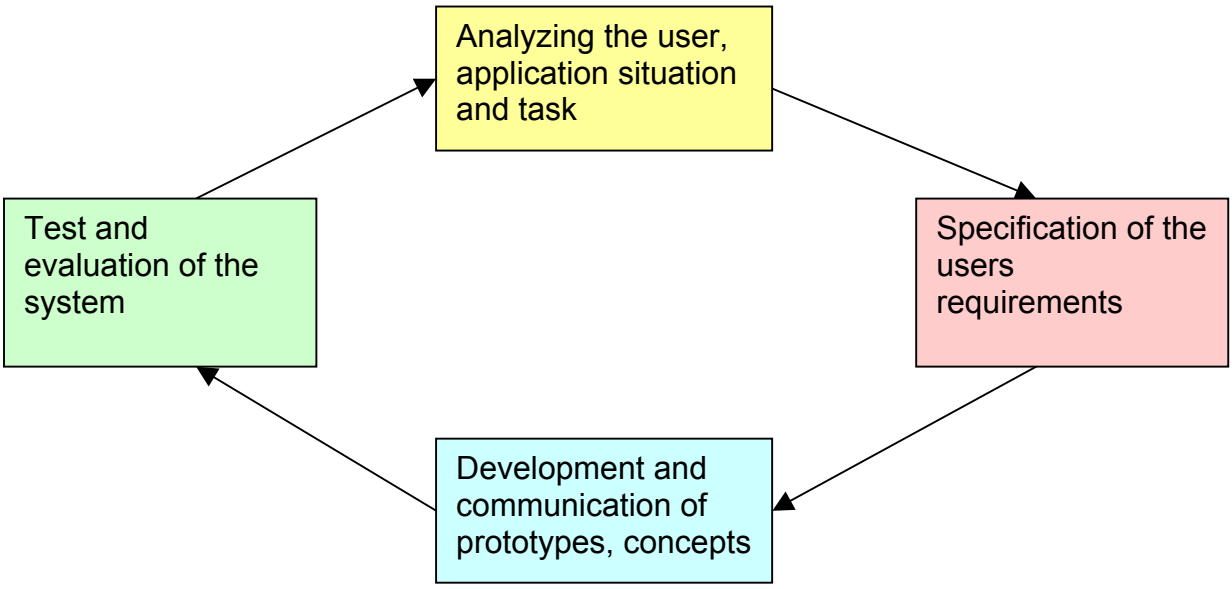


Figure 1: The user-centered system development

According to Gould and Lewis [4] system developers often believe that they can find the perfect design for a system from the first try, but in reality a good design involves continuous iterations of the design-model described. Further Gould et al. defined four basic principles for the development of usable software based on observations from projects within their company:

- Early and continual focus on users: designers must understand who the users will be by directly studying their cognitive, behavioral, anthrometrical and attitudinal characteristics, in part by studying the nature of the work expected to be accomplished, and in part by making users part of the design tem.
- Empirical measurement: intended users should actually use simulations and prototypes to carry out real work, and their performance and reactions should be observed, recorded and analyzed.
- Iterative design: a cycle of design, test and measure, re-design, repeated as often as necessary.
- Integrated design: wherein all aspects of usability evolve together.

A user-centred approach to system development and design should in all situations be preferred. There are two main reasons for this: [4]

- End users are experts on their work and therefore the only ones that can describe it.
- End users are the ones that are most suitable for testing and evaluating prototypes and systems that are developed for them.

3.3 Shneiderman's Eight Golden Rules

To improve the usability of an application it is important to have a well designed interface. Shneiderman's well-known "Eight Golden Rules of Interface Design" are a guide to a good interface-design [5]:

1 Strive for consistency.
Consistent sequences of actions should be required in similar situations; identical terminology should be used in prompts, menus, and help screens; and consistent commands should be employed throughout.

2 Enable frequent users to use shortcuts.
As the frequency of use increases, so do the user's desires to reduce the number of interactions and to increase the pace of interaction. Abbreviations, function keys, hidden commands, and macro facilities are very helpful to an expert user.

3 Offer informative feedback.
For every operator action, there should be some system feedback. For frequent and minor actions, the response can be modest, while for infrequent and major actions, the response should be more substantial.

4 Design dialog to yield closure.
Sequences of actions should be organized into groups with a beginning, middle, and end. The informative feedback at the completion of a group of actions gives the operators the satisfaction of accomplishment, a sense of relief, the signal to drop contingency plans and options from their minds, and an indication that the way is clear to prepare for the next group of actions.

5 Offer simple error handling.
As much as possible, design the system so the user cannot make a serious error. If an error is made, the system should be able to detect the error and offer simple, comprehensible mechanisms for handling the error.

6 Permit easy reversal of actions.
This feature relieves anxiety, since the user knows that errors can be undone; it thus encourages exploration of unfamiliar options. The units of reversibility may be a single action, a data entry, or a complete group of actions.

7 Support internal locus of control.
Experienced operators strongly desire the sense that they are in charge of the system and that the system responds to their actions. Design the system to make users the initiators of actions rather than the responders.

8 Reduce short-term memory load.
The limitation of human information processing in short-term memory requires that displays be kept simple, multiple page displays be consolidated, window-motion frequency be reduced, and sufficient training time be allotted for codes, mnemonics, and sequences of actions.

3.4 Cartographic methods and web-mapping

3.4.1 Standard cartographic methods and principles

As the map is the central part of the system cartographic methods are very important for the development. The aim of a geographical map is to be an image of reality, reflecting certain characteristics and to mediate this image to the user as close to the reality and as clear as possible. There is however a variety of different maps serving very different purposes. The map type that will be used in the future system is a so-called thematic map. [8] A thematic map is an extension to a “normal” map, showing more than just the landscape, the roads and buildings.

On a thematic map other information normally not or only barely visible in the reality can be visualized. Usually the thematic information is superposed on a “normal” map through the use of symbols, diagrams, colored or patterned polygons (so-called coroplethe-maps), lines and points. [6] Such an overlay is called a layer and together with the specific content that is visualized on the layer can be summarized as theme.

Map-design is highly subjected to human perception. The reality usually contains much more information that can be visualized on one single map; therefore it is necessary to generalize the reality by omitting less important things and summarizing similar things. [25]

When making a thematic map it is therefore essential to think of some basic principles [8, 25]:

- All important information shall be as visible as possible
- When using different statistical categories it is very important to choose an appropriate number of categories and to define the categories in an appropriate way for the intended use. Ill-prepared categories can lead to a misinterpretation of the map.
- When using colors, the choice of colors shall if possible have a connection to the displayed content.
- In general a map should contain a scalebar or a good visualization of the proportions, and also an orientation (for example a north-arrow).
- A thematic map must always contain a legend, explaining the meaning of the used symbols, diagrams, etc.

3.4.2 Web-mapping

Web-mapping can be considered as an extension of the “normal” cartography. It is a description for techniques to show maps on the Internet. There are basically two different ways of showing maps on the Internet: maps are shown as a non-interactive image (often paper based maps that are scanned in) and interactive maps. Today there are two different techniques for an interactive web mapping: [9]

- Maps are created on a central server and sent to the user’s web-browser as an image. This means that all geo-referenced data is stored and processed by the server. The user’s web-browser only displays the received image. This technique is the most common and the advantage is that it is compatible with almost all browsers. The disadvantage is the performance: big amounts of data are transferred (because a raster-image is transferred) and depending on the internet-connection such a system can become very slow.
- All data is stored on the server (mostly in a vector-orientated format). When accessing the map, the user downloads a little program or plugin that is able to

build the map. The data is sent by the server and after that the map is processed and built by the user's computer. This technique is less common due to compatibility-reasons, but the fastest web-mapping solution.

Further when designing maps for the Internet it is important to consider the advantages and disadvantages of computer screen and computers:

- A normal computer screen has even today a lower resolution than a normal map and sometimes even a lower color-depth. Also the distance from the user's eyes to the computer screen is normally bigger than to a paper map. Thus the creation of a good Internet-map is more dependent on a good choice of colors, legends and themes.[6]
- Computers are better at calculating, sorting and retrieving information than humans. By using a well-made interface the user can concentrate on other, more important things. [26]

The control and usage of a GIS often assumes expert-knowledge. The usage of an interactive map on the Internet (geoportal) shouldn't require this expert-knowledge. Expert-users of a GIS can manipulate all the accessible information in many ways. The users of a geoportal can only modify and visualize the accessible data within the framework that the developer defines. [9]

According to Hornbaek, Bederson and Plaisant [10] maps serving as interfaces can today be categorized into two groups:

- Overview+Detail interfaces present multiple views of a map on the same screen where some views show detailed information about the map and others show an overview. The user can navigate using the overview window.
- In Zoomable interfaces the user interacts directly with a single map, which means that both the interaction and the detailed information is shown on the map.

Sarkar and Brown describe in their article “Graphical Fisheye Views” [11] a way to design a zoomable interface that can be used for map-interaction. Similar to a fisheye-lens on a camera, objects that are nearby and in focus are magnified while other objects that are distant are shrunk. The technique builds on a categorization into objects and vertices that connect the objects. When focussing on an object the object itself is magnified and the vertices that connect the object to other objects are lengthened.

The advantage of this fisheye-view-technique is that all objects are visible at the same time. Objects of interest are in the viewers focus. The disadvantage of this viewing-technique is that a distortion occurs near the magnified focus. The further the objects are from the magnified focus the more diminishes the distortion.

A similar technique of magnifying objects that can be useful especially for thematic maps are Keahey’s Area-Normalized Thematic Views. [12]. As described earlier a classified theme can be visualized using colours, symbols, patterns, etc. Keahey’s approach to visualize a classified theme involves a magnification, respectively a shrinking of a classified area (= normalizing the area) according to the statistical data that lies behind the theme. The resulting thematic map is no longer geo-referenced in terms of showing all objects with their correct coordinates with a correct projection, but it is showing the classification of the theme in a different way. Such an area-normalized thematic map can be useful when then viewer is familiar with the area that is shown on the map. The distortion that is applied to the map forces the users attention.

Hornbaek et al. [10] compared in an experiment with key users the Overview+Detail interfaces with Zoomable interfaces and found that the users preferred the Overview+Detail interface. The problem with zoomable interface was that candidates often used the zoom-tool instead of the panning-tool.

Another question that was treated in the empiric experiment was the use of single-level maps and multi-level maps regarding the zooming-function.

A zooming-function on a single-level map can be compared to a standard paper-map where the viewer comes closer and goes farther – the size of all objects is dependent on how close the viewer is to the map. The advantages of single level maps are that no objects disappear at a higher scale and that the user directly can associate the map to a paper-map. The disadvantage is that the number of objects on the map can disturb the user at a higher scale.

However on multi-level maps the zooming-scale determines the number of objects shown on the map. To put it in another way: different maps that are optimised and generalized to a certain scale are superposed on each other. Depending on the chosen scale the map will change. The advantage is that the user always will see a map optimised to the chosen zoom-level. The disadvantage is that not all the objects at one scale will be visible at another level. This could cause distraction.

The investigation showed that users independently of the mode of interaction (overview+detail-interfaces or zoomable interfaces) preferred multi-level maps.

In the obtained software for a basic geoportal the structure of the map-usage was already given in a certain manner: the main interaction mostly takes place on the main map while the overview window mainly serves as indicator of the position despite the existing functionality to change the position of the main map by using the overview window It is however likely to assume that the user rather will use the main-map to navigate than the overview-window because of the fact that the navigation tools are integrated on the main-map.

4 Requirements

4.1 Identifying the user

A first step in the development process is to identify the user and the users requirements. At the time when this thesis was begun, the wine-farmers were harvesting, therefore the planning process began with the analysis of existing tools and solutions and literature about the wine-cultivation in the region.

To define the users of the system some initial question were formulated regarding the user of the system and their readiness to use the system.

- How familiar are wine-farmers with computers?
- Do they use computers to register data about their wine-cultivation?
- Do the users have a connection to the Internet?
- Do the users have experience in searching spatial information on the Internet?
- Which data are the users interested in?
- Which data are the users prepared to share?

In order to find answers to these questions an interview with a researcher, Vivian Zufferey at the federal wine-research station was made on 11.11.2003. The researcher is supervising 50 different wine-farmers in the region and he also collects data from the wine-farmers. Further an inquiry containing 14 questions about their computer-proficiency, their computer-systems, the data they are interested in and the data they are prepared to share was sent out to 35 winegrowers who had participated in the project “Terroirs viticoles” [13] in order to determine the user’s readiness to use the future system.

4.1.1 Results of the interview and the inquiry

During the interview with the researcher Vivian Zufferey at the federal wine-research-station [14] it became clear that the winegrowers are very interested in external data of their parcels, e.g. soil quality, water deposits and the climate. Vivian Zufferey added that wine-farmers normally don’t have any databases about their wineries, but

that it shouldn't be a problem that the wine-farmers enter the information on a homepage, although certain wine-farmers maybe wouldn't want to declare what the exact yield of each part of the parcel would be.

It would be interesting as well for the users to see where in the region other farmers plant the same type of wine or where in the region other farmers grow on the same type of soil.

28 winegrowers sent back the inquiry – one was sent back blank and two winegrowers didn't have access to the Internet. 25 were returned with the following result: (the whole inquiry can be found in appendix A and B)

93% of the winegrowers have access to the Internet; most of them (64%) via modem, and almost a quarter (24%) have a high-speed connection. A great majority was using Microsoft Windows as operating system (92%) and Internet Explorer (96%) as web-browser. 76% were already using their computer to register wine-related data and 68% had already used an interactive map on the Internet. Against these facts only 20% had used the computer before for drawing.

The users were mostly interested in maps containing information about their soils and about the water supply. Furthermore 59% wanted to have links to other sites such as communities or other wine-related pages and 37% were interested in an integrated forum to communicate and discuss with other winegrowers.

The answers were quite varying regarding the question of which information the winegrowers are prepared to share. For 74% it was no problem to specify the sort of wine-grapes planted, but on the other hand only 48% were ready to share the type of exterminator.

Last but not least some winegrowers added some comments to the inquiry (English translation)

- *"I wish for an easy and fast utilization; no advertising for example (that would be even worse)"*
- *"Sometimes nothing is as a good old folder… the time spent with the data-entry and the visualisation is shorter, especially for ongoing work"*
- *"Good work, I'm looking forward to the results"*
- *"Considering the small area that I'm exploiting, I'm not interested in sharing my data"*

Out of the results of the inquiry and the interview it was now possible to specify the user's requirements:

4.1.2 Resulting user requirements

Optimization according to the most common systems

- The system should be optimised to the computer-systems the winegrowers most often use, but it should also work on other platforms. Therefore the system will be optimised for Internet Explorer in Microsoft Windows and should be fast enough to use with a modem.

Optimisation of the parcel drawing function

- Because only 20% of the users specified that they had used the computer to draw, the drawing function, used to define the winegrowers parcel has to be intuitive and easy to use.

Classification of the data

- Based on the inquiry and the interview the information that is most interesting for the winegrowers has to be as visible as possible (for example by pre-selecting some information) Other information, less interesting, should not be visualized so that it hides the most interesting information. It is therefore necessary to make a classification of all the available data.

Restricted usage

- Due to the fact that some wine-growers do not want to share all their information it is necessary to restrict the usage of the system - each responsible for one or more parcels – wine-farmer or owner (if not the same person) gets a personal login for the system. Through a personal login it will be possible to display the winegrowers parcels in the system and it will ensure that he has the rights to add or modify the spatial extent of his parcels on the map. The winegrower shall also be able to define which data only he can consult and which data shall be visible for other winegrowers.

Links and forum

- Interesting links to communities, other information systems and sites containing interesting information for winegrowers shall be integrated in the system. The implementation of a forum shall be discussed later with the winegrowers. A forum could also be a possibility for the developer to find out if further improvements are required.

4.2 Functional requirements

A navigable map with the ability to visualize different themes

- A main part of this project is to provide a map that can be navigated with selectable navigation-tools (zooming in, zooming out and changing the map's center). By choosing different themes the content of the map will change. Depending on the selected themes the corresponding legend has to change.

Query function

- It shall be possible to query important objects on the map by clicking on them directly on the map. The query result shall give detailed information about the object queried.

Data entry

- The system shall be able to provide the possibility to enter both spatial data (the parcels geographical extent) and connected meta-data.

Multiple users at the same time

- It shall be possible for multiple users to access the system at the same time and to add or modify data.

4.3 Design requirements

The system shall be designed according to mentioned Human-Computer-Interaction principles and methods. The system has to maintain and visualize a great amount of data, therefore it is very important to find a good design and structure that doesn't disturb the user, but that gives the user a good overview of what he can get and what he can add.

5 Analysis of existing programs and methods

5.1 Introduction

In this chapter some existing wine-cultivation systems and geoportals are described in order to extract ideas for the development of the new system. The systems are analyzed with regard to the functionality and design. Concerning wine cultivation systems unfortunately no software was available for the project for testing, so the analysis mainly focuses on the product-sheets.

The geoportals described are just a small choice out of a variety of geoportals available on the Internet. Many of the geoportals on the Internet are serving as an information system for a community, a region or a country but also as an online atlas to find the route from one point to another. Most often they are not aimed to add specific data (both spatial data and metadata).

5.2 Examples of existing wine-cultivation programs

5.2.1 CDER informatique: Vitimap

Vitimap [15] is a stand-alone program for the wine-management. It permits visualization and printing maps at different scales and with different themes. With Vitimap the wine-farmers can define their parcels on a map and add other information to the parcels e.g. the type of wine, the plantation-date etc. Other functions permit the calculation of the rent for the parcel, the harvest and the official declaration of the harvest.

The system is mainly thought for one single-user or a group, using the same computer system and available for Microsoft Windows. The main program in Vitimap can be expanded by different modules e.g. wine cellar management or the grape harvest.

The design of Vitimap is according to images published in the leaflet very much focused on the map and reminds of other GIS-programs such as MapInfo or ArcView. The parcels are visualized directly on the map and can also be queried.

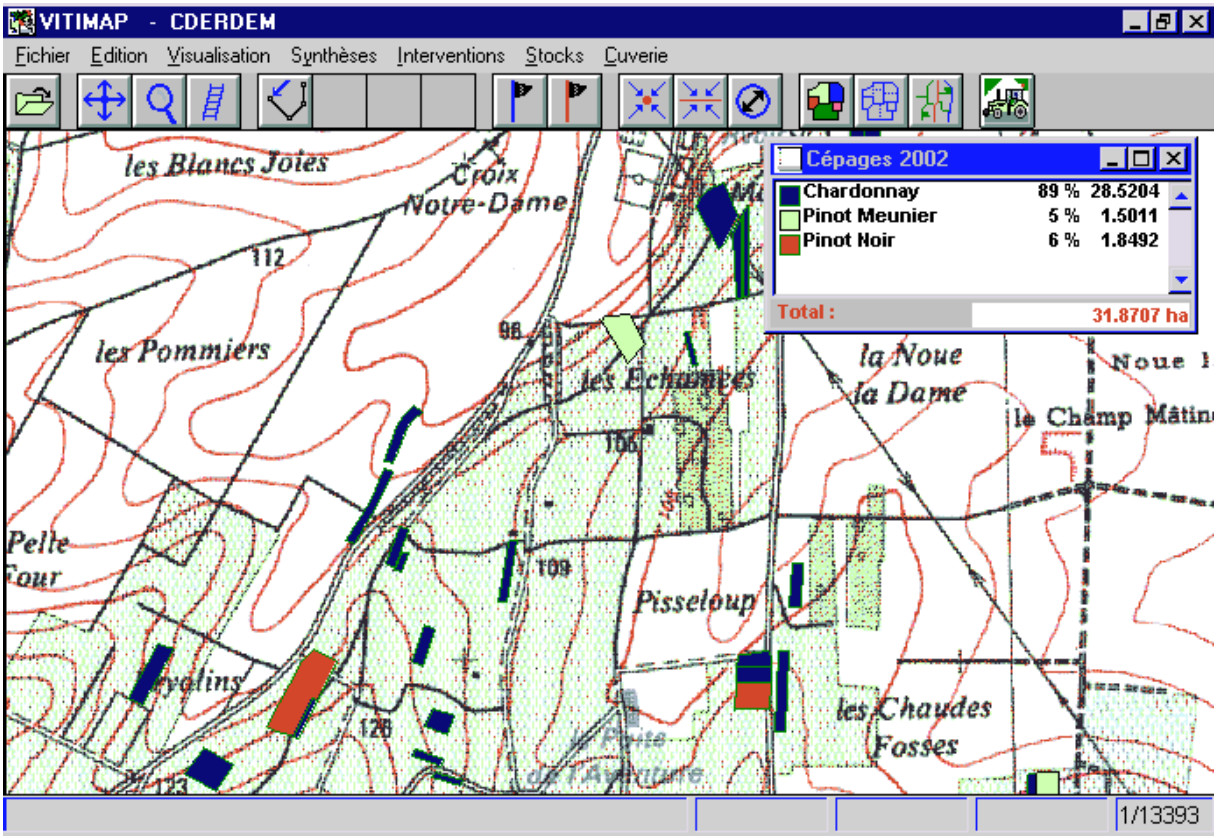


Figure 2 : CDER Informatique: Vitimap

5.2.2 SRVA- VITIS

In the Swiss canton of Vaud the SRVA (service romand de vulgarisation agricole) has developed a program for the vulgarization-management called VITIS. [16] The program's main task is the parcel-management. It is available for Microsoft Windows, in two different versions (light and full) and in two different languages (French and German). Like Vitimap also VITIS is a stand-alone system for one user or a smaller group of users.

VITIS permits the management of all activities related to the parcel. Unlike Vitimap, VITIS has no possibility to define the parcels spatial extent on a map.

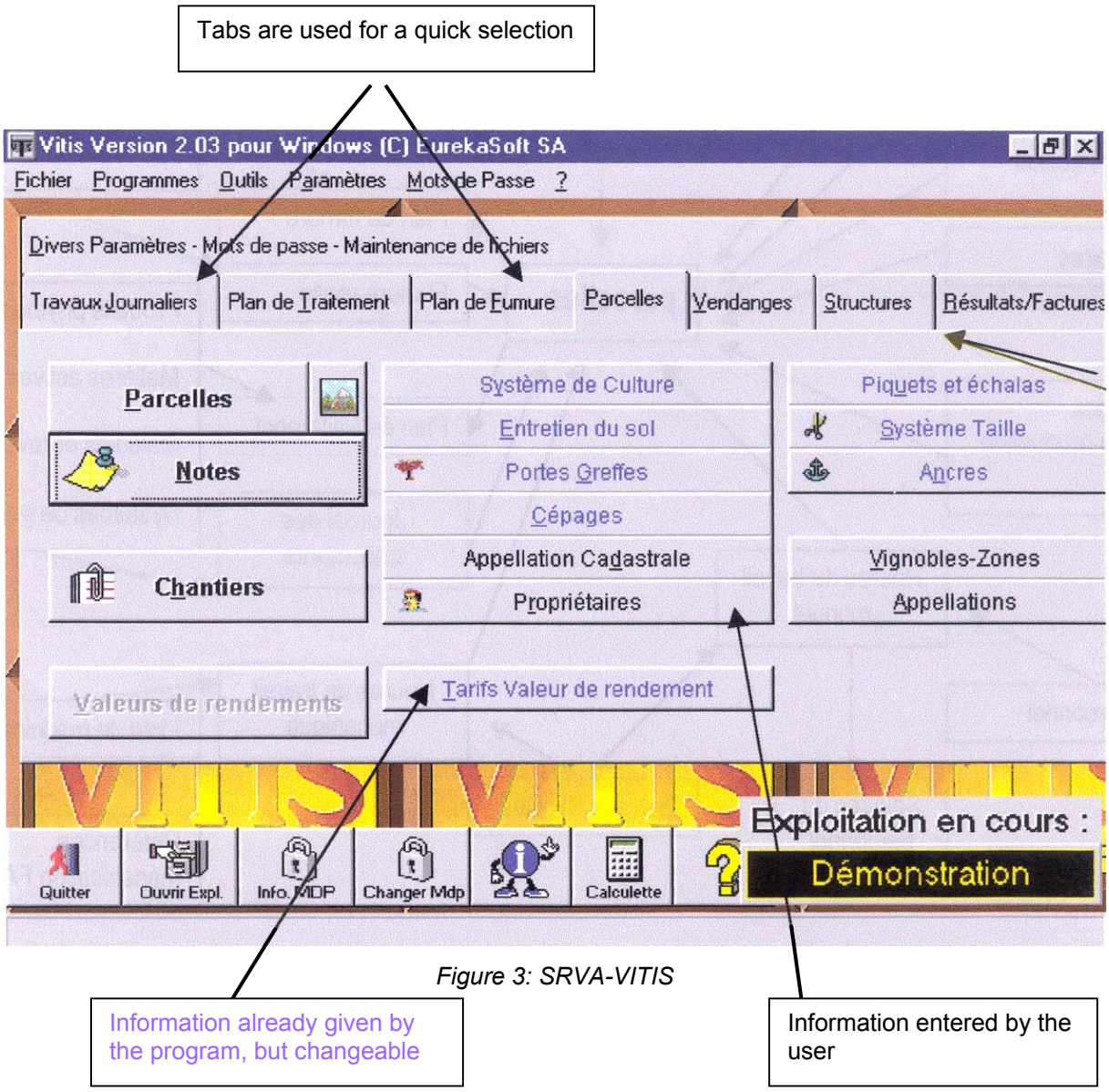


Figure 3: SRVA-VITIS

An important feature in VITIS is the detailed calculation of the costs (for machines, etc), benefits and taxes. Further an agenda and a calendar is implemented to schedule the work.

5.3 Examples for geoportals

5.3.1 Swissgeo (Swissinfo geographic tool)

Swissgeo [17] is the geoportal of Swissinfo, an information-service provided by the federal radio stations. It is developed for everybody who wants to find out things about Switzerland (both tourists and natives) and therefore the system is available in 10 languages. The system has the ability to query objects, to navigate on the map and to choose different layers. Further some search functions permit looking up a place on the map and even to search a route from A to B.

The design of the site is quite uniform – all map-navigation tools are concentrated on the left side and an explanation to each tool is given on top of the map. Some information, such as legends and query results are displayed in a popup-window. To manage the high number of themes, the themes are grouped by category (e.g. tourism, services and nature).

Unfortunately the system doesn't provide an overview-window to indicate which region on the main-map is visualized and a scale bar, but the map is a multi-level-map that is optimized to the selectable scales.

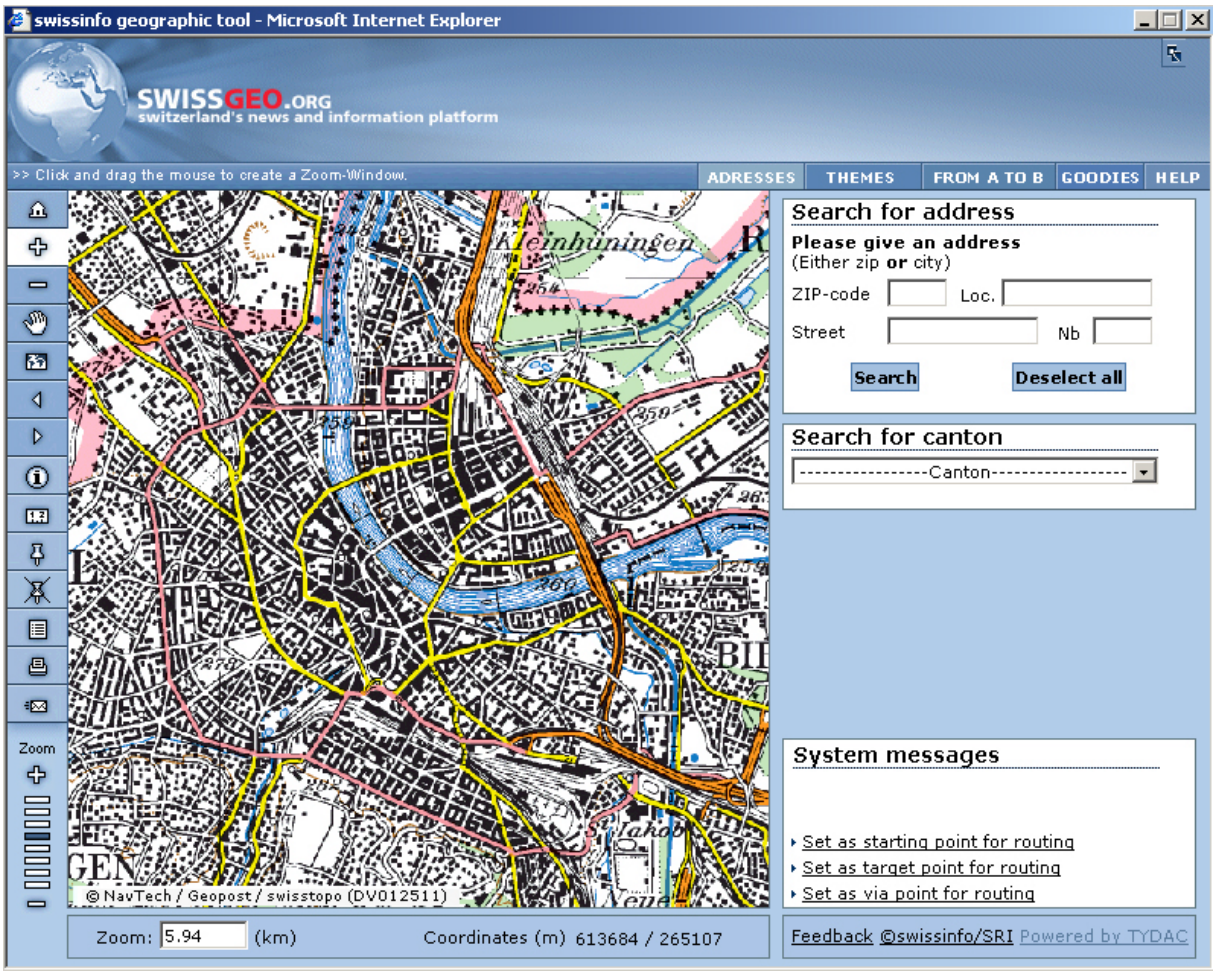


Figure 4: Swissinfo.org: Swissgeo

5.3.2 GéoPlaNet

GéoPlaNet [18] is an example for an interactive information system for the consultation of many kinds of data. The purpose of GéoPlaNet is to collect all spatial data connected to the Swiss canton of Vaud and to present it on the same site.

The structure of this information-system is quite different to Swissgeo. A startpage shows the different groups of available themes, from the cadastre to the fire blight. Each choice will launch a specific version of the information-system.

All versions of the information system have an equal design and functionality. Like Swissgeo GéoPlaNet superposes the relevant themes on a multi-level-map. It is possible to choose different themes within a category.

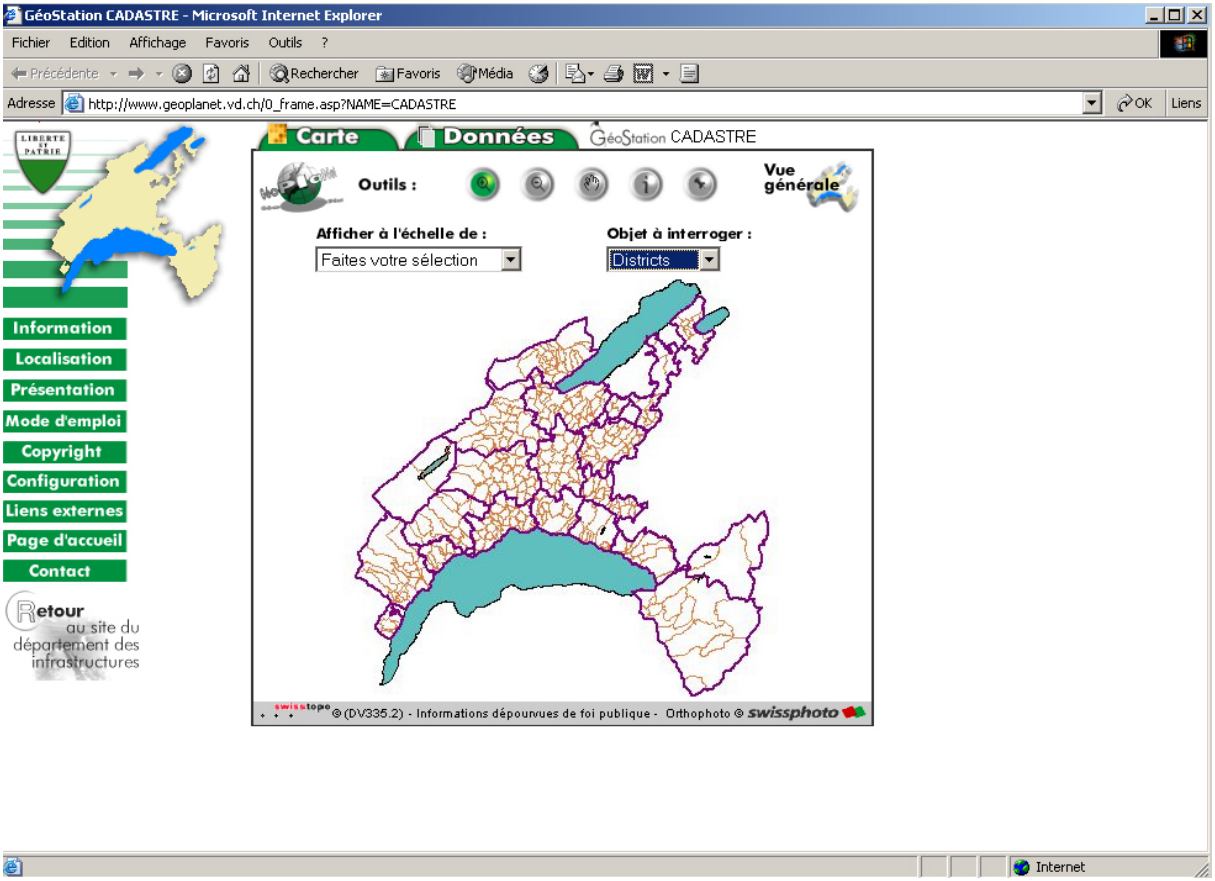


Figure.5: GéoPlaNet

One disadvantage of the system is that not all the chosen themes will be visible on the initial map (an overview map of the canton) due to the fact that all the symbols and layers would make the map illegible – at a lower scale the symbols become visible. This could be a problem for a first-time user because a modified choice of themes doesn't change the map. Further neither a scalebar nor an overview-window is integrated in the system. The scale on the map is only represented on the bottom of the window by numbers indicating the size of the view in reality (for example 2000*4000 meters).

6 Prototyping

6.1 Conceptual models

6.1.1 Information and data flow

The winefarmer interacts with the interface “Geoportail Terroir”. The interface makes the connection between the user and the data stored in the database in order to receive and to add spatial data and related metadata. Despite the fact that all data is stored on a central server the web-based interface permits the access to the database from everywhere.

All spatial data – both static (e.g. orthophotos, geo-referenced and equalized images shot from airplanes) and dynamic (the parcels spatial extent) is processed by a map-engine and displayed on the interface. Because of the dynamic structure of the database system the interface has to be implemented to automatically visualize changes in the database in a dynamic manner. From the point of interaction the interactive map is the most important part of the interface. The map serves both as a visualization area for spatial data, but also as the main navigation field.

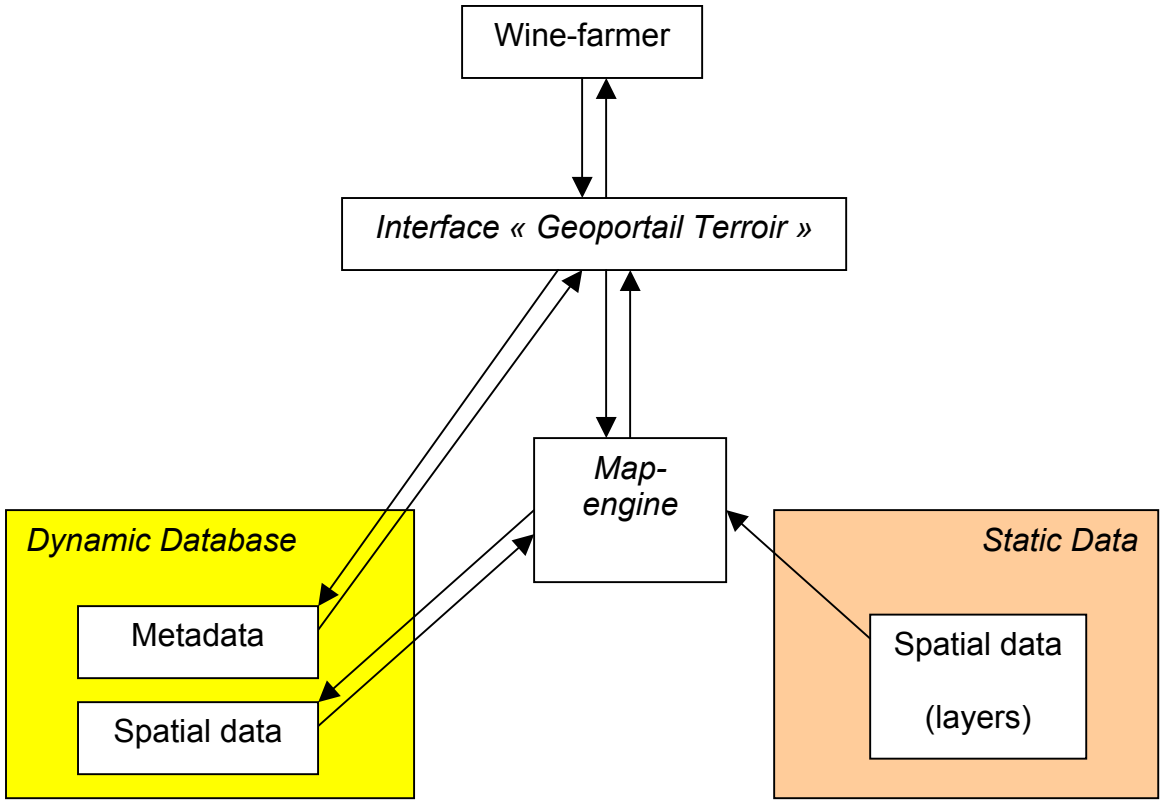


Figure 6: Information and data-flow

6.1.2 Technical concepts

When designing a system that can be used by many different users from different locations via the Internet on different operating systems it is necessary to make the system compatible to these systems. Factors that must be considered are:

- The performance of the users computer (in terms of CPU-speed, memory, graphic card and screen size/resolution)
- The users connection speed and the manner of the connection (e.g. modem users have to connect to the internet, every time they want to have access – and the longer they are online the more they have to pay)
- The operating system used (e.g. Windows, Macintosh or Linux)
- The web-browser used (e.g. Netscape, Mozilla or Internet Explorer)

Unfortunately many of these factors limit the adaptation of the all design-principles. Some reasons are that the certain adaptations of design-principles (e.g. the principle to give feedback on actions taken by the user) would require much more computer – capacity (both network and CPU/memory capacity). It is therefore never possible to implement the optimal design according to all design-principles, but the aim of this project is to find the optimal compromise.

Another important issue is the design for a computer screen where the screen is considered as a limited area to visualize a variety of information. It is never possible to visualize all the information in a system at the same time so that the user can use it – too much information would cause an “information overload” and stress the user. Too little information would result in an interface where the user has to take a lot of actions to get to the desired result.

6.2 Implementation of the prototype

6.2.1 Overview

The implementation of the prototype contains both the adaptation regarding the design, the content and the functionality of an existing dynamic web-visualization-system and new functionality that was added to the system.

6.2.2 CartoWeb

The obtained system, CartoWeb has been developed by the company Camptocamp SA in Ecublens, Switzerland. [19] It is a web-visualization system which builds on MapServer. MapServer is an open-source project, developed at the University of Minnesota. [27] Although MapServer is not a fully functional GIS-application, the software offers a wide variety of application possibilities in the field of Internet mapping. MapServer has been developed mainly for the use in Internet-applications and exists in different forms:

- as an independent CGI-script (Common Gateway Interface, an interface between HTTP-servers and local resources), or
- as an embedded module, accessible from other programming-languages such as Perl, Java or PHP

Further MapServer is available on several platforms:

- Linux/Unix,
- Windows and
- MacOS X.

CartoWeb uses MapServer as the central map-motor and controls it through PHP-scripts and java-applets.

From the users point of view the system consists of two modules:

- Cartoview: a module for the data-visualization and navigation and
- CartoGeoref: a module that uses a Java-applet for the edition of spatial data on the web.

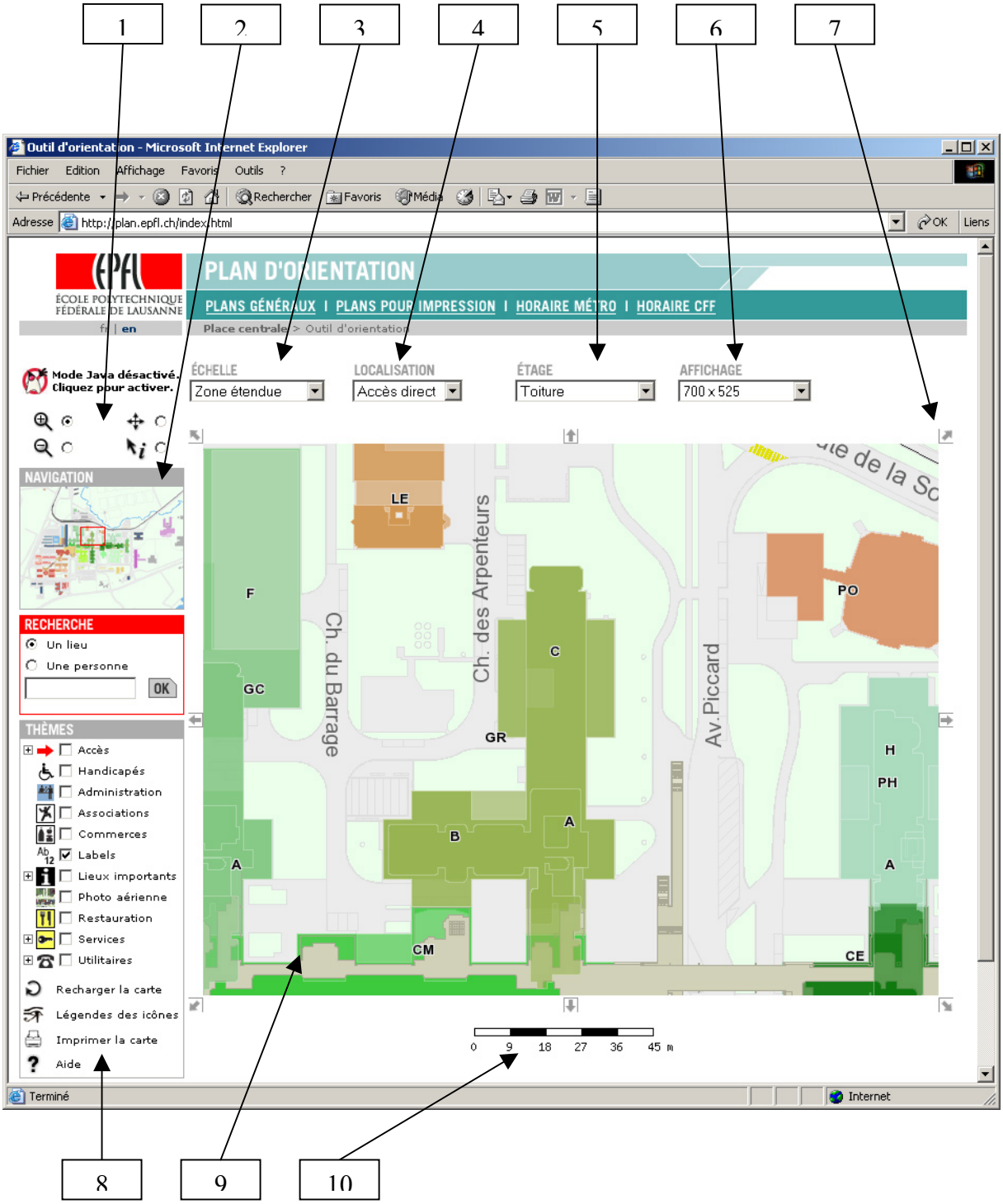
CartoWeb itself works as a server- client – system.

- CartoServer: the central cartographic engine, containing the MapServer-motor and the database
- CartoClient: a variety of PHP-scripts that control the server plus a variety of navigation tools

The communication between the CartoServer and the CartoClient is done via a protocol called XMLRPC – a specification that allows software running on different operating systems, running in different environments to make procedure calls over the Internet.

The advantage of this structure is that many CartoClients can access the server at the same time. The CartoClient-interface offers a variety of functionality – tools to recenter the map, zoom in and out, and a query-tool. Further the user can choose the different themes by clicking on checkboxes. The interface displays the scale of the map, a scalebar, and an overview map, showing the position of the actual map-clip. Figure 7 shows the graphical interface of CartoWeb.

The most important parts of CartoWeb are described in appendix G, together with the prototype-interface that has been programmed in order to enhance and control CartoWeb.



1. Selection of the navigation mode
2. Overview of the map
3. Scale of the map
4. Selection of specific places
5. Selection of the floor
6. Map size
7. Navigation arrow
8. Selection of displayed themes & tools
9. The map
10. Scale bar

Figure 7: The CartoWeb-interface

6.2.3 Technologies

The technologies used in the development of the system are all open-source based programming languages and projects. The basic CartoWeb was already developed with these programs and programming languages and so the further development and adaptation of the system used these technologies as well. PHP, a script-programming-language was used to make a connection between the database, and the map-engine and to generate dynamic web-pages. Further JavaScript was used to enhance the functionality of PHP and for the implementation of the module to insert spatial data into the database Java was exerted.

As a database system PostgreSQL [20] was used. PostgreSQL is an open-source database system that was started at the University of California at Berkeley. The reason why PostgreSQL was chosen was that the implementation is extensible with an add-in, called PostGIS [21] to store geographical objects in the database. PHP can access further PostgreSQL as well.

6.2.4 Data

As basis for the thematic maps orthophotos, together with digital Swiss national maps in the scales of 1:25’000, 1:50’000, 1:100’000 and 1:200’000 were used. On these maps all other layers are superposed. The layers came from the project “Terroirs viticoles” at the LaSIG and categorized according to the inquiry sent to the winegrowers. The available layers consisted of microclimate-layers (containing winds, thermal levels and solar radiation), a digital model of the terrain (containing highness-levels, slope veins and slope-directions), pedology (containing the soils water supply, the soils depth and the bedrock) and cadastre. A detailed structure of the theme-categories can be found in appendix F.

6.2.5 Modifications and enhancements of the basic CartoWeb application

6.2.5.1 Query function

CartoWeb permits the query of objects on the map directly by choosing the query tool and then clicking on the map. The query result is then shown in a table below the main map. Depending on the number of objects that was chosen by clicking the map, the table of results could become very long and so the user had to scroll up and down the table. Furthermore the table columns weren't adapted to all the parameters contained in the database.

The query function was modified and adapted to the query of parcels. In the new version the user gets the results of the query in a pop-up window together with an overview-image of the objects queried. Information that has been chosen as "not visible" by the owner of the parcel is declared as hidden in the pop-up window. All other information is visible.

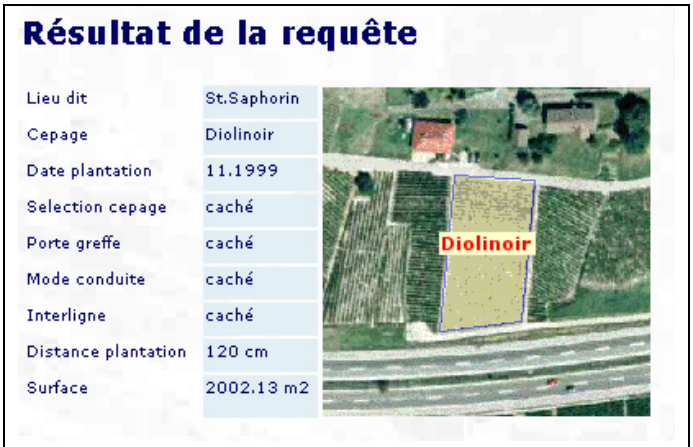


Figure 8: Result of a query showing the parcel and its meta-data

6.2.5.2 "Java-mode"

CartoWeb has one option to select the navigation-mode:

- with a Java-applet that permits zooming by drawing a rectangle on the map and
- without the Java-applet. The map zooms in by a simple click on the map.

The options were implemented to guarantee the use of the system on every browser.

The option "Java mode disabled/enabled" was considered obsolete because the user has to have Java to be able to launch the edit-applet and further the icon didn't say

anything about what the Java-mode is or what it does. Even the expression “java-mode” doesn’t say anything about its functionality. For the new system therefore only the java-mode was chosen.

6.2.5.3 Print map

Another icon that doesn’t do what it promises is the “print map”-icon. By clicking on the icon CartoWeb creates a new page with an overview and a detail-map of the previous map. A print-client is not launched. In the new system the text of the icon was changed and a hint for the user was added how he can print the map.

6.2.5.4 Legends

The basic CartoWeb-application didn’t permit having legends for classified themes, for example a theme that is classified by a parameter contained in the referred meta-data table. The only possibility that was given was the definition of an icon for each theme, symbolizing the visualization of the theme.

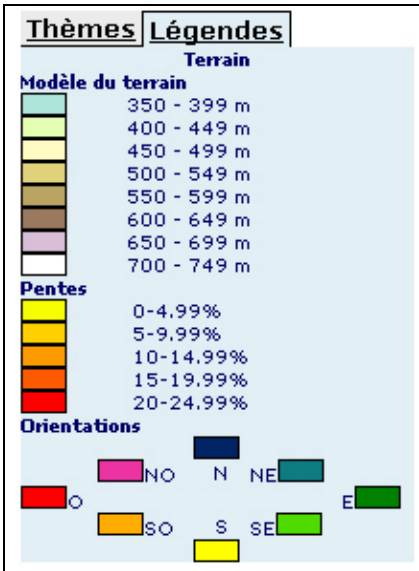


Figure 9: Legends

In order to display a classification legend of a theme the basic application was modified so that a menu lets the user choose between the themes and the referred legend. A similar modification of CartoWeb had been done for the geoportal of the Swiss canton of Neuchâtel and so some of the scripts controlling the legend could be obtained from the responsible webmaster.

6.2.5.5 Map size and performance

With CartoWeb it is possible to choose the size of the map in a roll-menu in the navigation-field. As the user often doesn't know how big a map compared to his screen just by knowing the number of pixels he has to test the size that fits best on his screen via the roll-menu. Another important thing in this context is that it takes much more time to download a map with a modem than with a broadband internet-connection.

The function was disabled and the size of the map was fixed. An idea for a further development is therefore to make two versions of the geoportal: one version with a small map (for slower computers with a slow internet connection or for computer screens with a low resolution) and one with a bigger map (for faster computers with a fast internet connection or for computer screens with a high resolution)

6.2.6 New functions

6.2.6.1 Start-screen

To introduce the user to the system and its functions a start-screen was created. On this start-page an overview of the most important functions and tools is listed. These are:

- the map navigation buttons and how to use them
- how to display a specific theme on the map
- how to create a user account in order to enter data
- how to access the users parcels

6.2.6.2 Two versions of the system

One requirement was that a winegrower could draw his parcels and enter related meta-data. But as the inquiry showed, not all winegrowers wanted others to have insight in all the data they entered.

To implement this requirement a menu with a user login was created. This design choice created two different paths to use the system:

- one public version where the user only can consult data and query objects, obtaining only information that is accessible for everyone and
- one personal version that permits the user to enter, modify or delete his own data.

A personal account can be created from the login menu. For each user a login-name and a password is required.

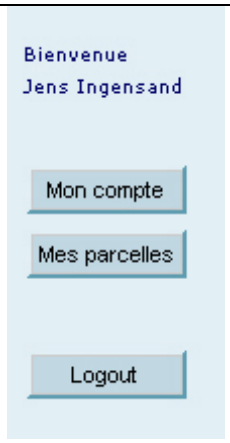


Figure 10: Personal menu

A new menu indicates in the left frame that the user is using the personal version by showing a welcome followed by the user's name. The menu contains further three personal menu-points that lead the user to the management of his parcels and to the management of his own account. If the user desires to log-out and leave the personal version he can simply click on the button "Logout".

6.2.6.3 Pages for data-entry

To give the winegrower the possibility to enter information about his parcels new dynamic pages were created. The main page is an overview of all parcels that belong to the user. The winegrower can add the information he wants directly on the pages and for all parameters (except for the sort of grapes) he can determine whether others can see this information. Parameters that are visible in the public version are displayed with a different colour than parameters only visible for the winegrowers.

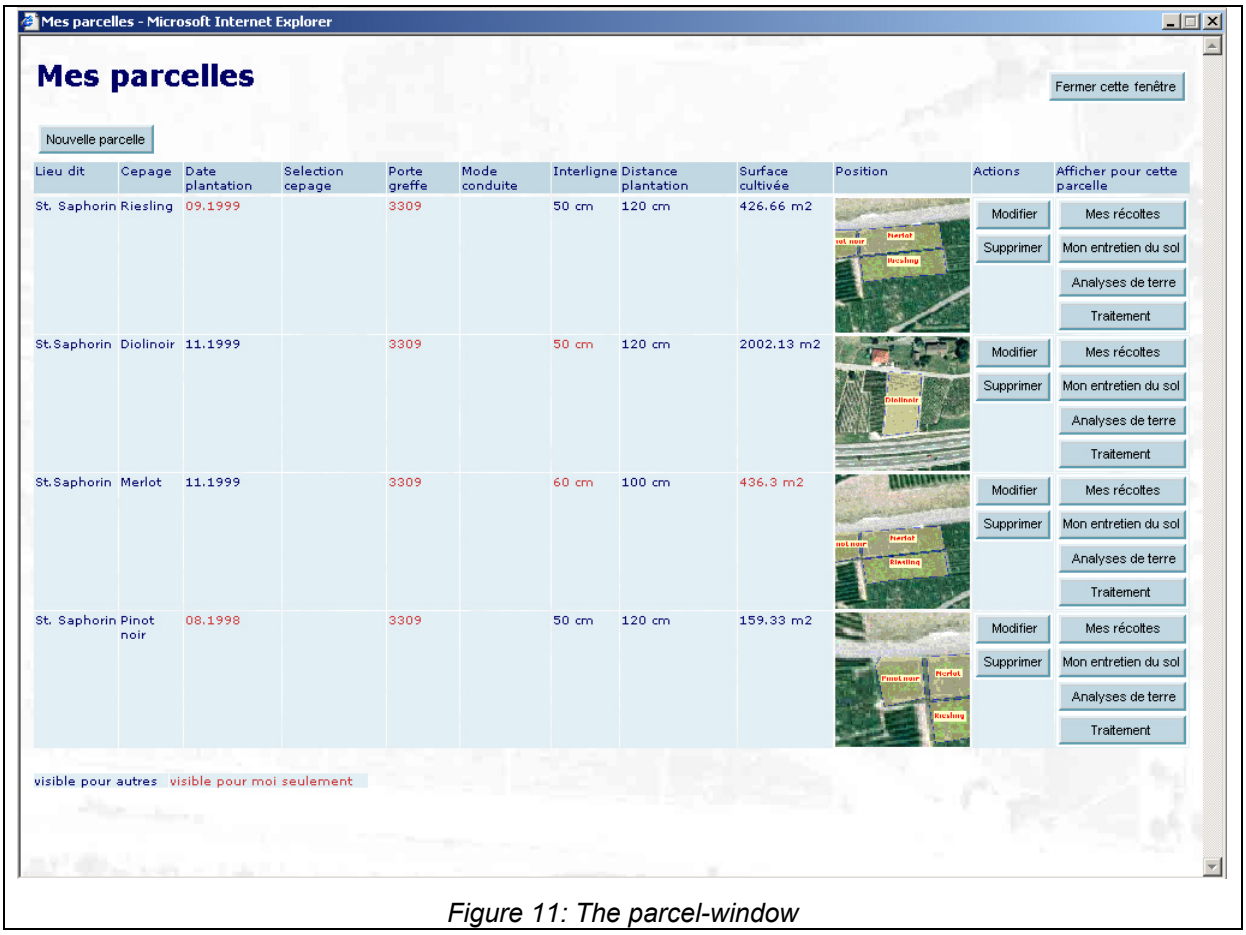


Figure 11: The parcel-window

As a new tool to facilitate for the winegrower to find the right parcel that he wants to edit, a little overview-map of each parcel is displayed in the window. The overview-window is automatically created by MapServer through a so-called WMS-call. WMS (Web Map Service Implementation Specification) is a project within the OGC, the Open GIS Consortium. A WMS-call is passed to the server by a specific URL containing all the desired features that shall be shown on the map (for example the size and the content of the map). The server then returns the map as an image. [22]

Also the java-applet (CartoWeb´s “Geo-ref”-module) that is used to draw the parcels on the map was embedded in the dynamic web pages. The java applet was however modified both regarding the functionality and the design. An important change in the functionality was that a winegrower only sees his own parcels visualized as editable polygons on the map. It is not possible for him to modify or delete other winegrowers’ parcels. The design of the java applet was also modified and adapted as much as possible to the design of the basic (public) map and of the whole system. Also the

terminology of the messages and text boxes was adapted to wine cultivation-terminology.

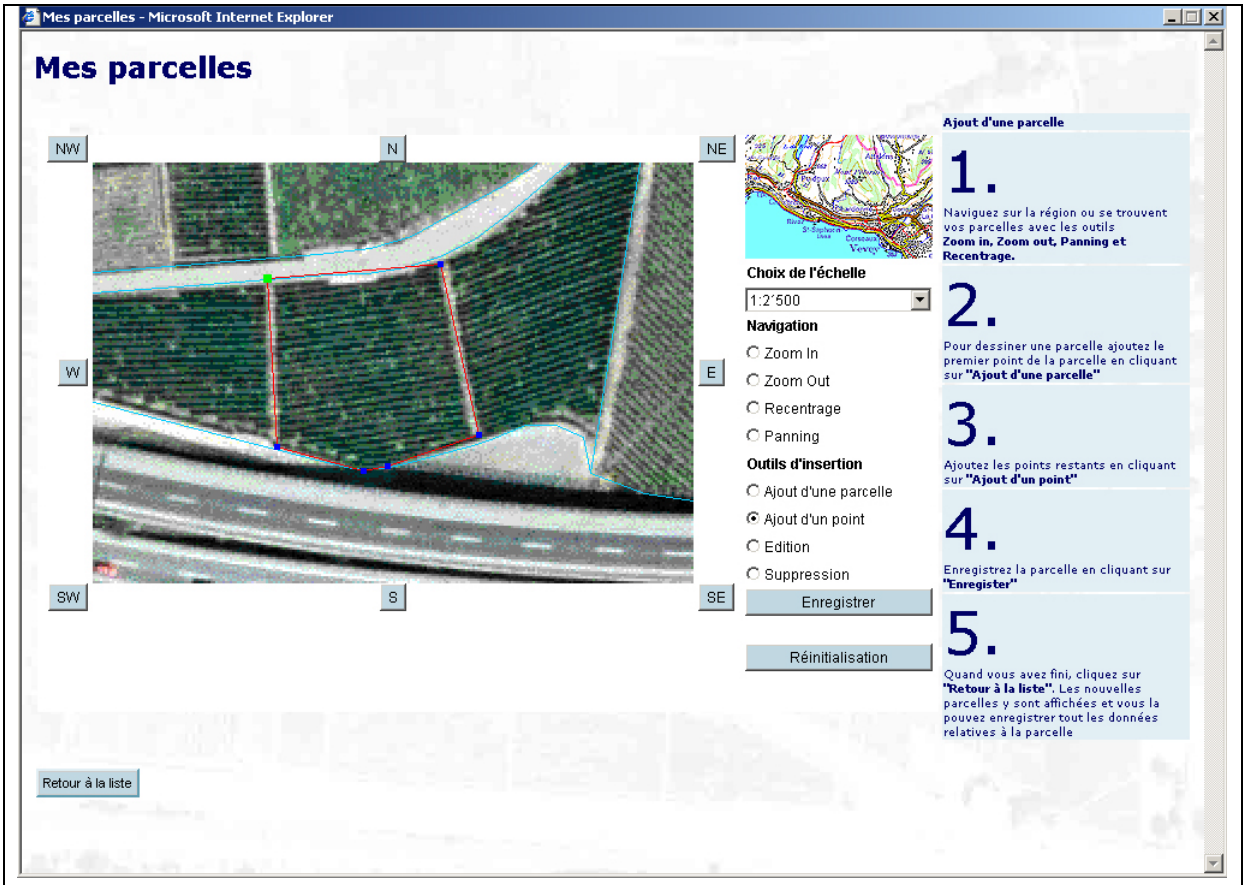


Figure 12: Adding a parcel

From the main parcel-page four buttons lead to dynamic pages where further information that is attached to the parcel can be entered; a page for the harvest collected from the specific parcel, a page for treatments (pest controls) executed on the parcel, a page for work done on the parcel and a page for the analysis of the soil texture. All the information on these pages is only visible for the winegrower and not for the public. On every of those four sub-pages an image of the parcel is displayed so that the winegrower easily can identify the parcel he is working on.

The main parcel-page also offers the possibility to delete parcels – but before deleting a parcel the user is asked if he also wants to delete all the sub-pages that are attached to the parcel he wants to delete (harvest information, soil analysis, etc.). This function also prevents the user from accidentally deleting a parcel.

The menu on the left side of the map also offers a point where the winegrower can change his data and also his login name and password if he wishes. As in many systems the user's password is always hidden so that no other person standing beside the user can see it. Therefore the winegrower always has to enter the password twice in order to ensure that he has entered the password correctly.

When the winegrower has entered all the information he wanted he can close the parcel-window and click on the "logout"-button in the menu. This will lead him back to the public version of the system.

6.2.7 Design

6.2.7.1 Consistency

Shneidermans first rule (strive for consistency) was considered as a very important rule for the design of the system. All buttons in the whole system have the same design and new ones replaced already existing buttons. Also regarding the terminology the system had to be consistent. As the system is designed for winegrowers, a terminology had to be found that permeates the whole system and that is understandable. A problem was however to translate the English informatics-terminology to French.

6.2.7.2 Feedback & error handling

The system always gives feedback to all the actions that the user is taking. The feedback is however given in different manners. In the public version of the system the user gets feedback by a changed map when choosing different themes to display. In the whole system all error messages are displayed in red colour. The error-messages are mostly short, but give a hint of what is the problem.

6.2.7.3 Design dialog to yield closure

All sequences of action in the system have a beginning, a middle and an end. For example, for creating a parcel the user clicks on the button to create a new parcel. Further, he creates the parcel on the following page. When finished a message tells

the user that the parcel is successfully created and that he can proceed to the next page.

6.2.7.4 Colours

Light-blue was chosen as main colour for buttons and fields where the user can take actions or where the user gets information from the system. Red was only used for error messages.

6.2.7.5 Segmentation of the interface

The whole system consists of blocks or segments where the user can take actions, and blocks where the user gets information or feedback. Some blocks already existed in the basic version of the CartoWeb-application and some blocks were added:

In order to get more space for the themes selection, the legend and the overview-map, the text size of the original CartoWeb was modified to a smaller level. Further the overview map, the scale choice and the theme/legend menu were placed on the right side of the map.

This design choice was made to put together the navigation tools (on the map) and the navigation tools outside the map and to build a counterpart to the new menu-frame on the left side. This resulted in an interface where the map is exactly in the centre of the user's attention – actions taken on the right side of the map will affect the map – actions taken on the left side of the map will affect the whole system. Another reason for this design choice is that the user is used to taking essential actions on the left side of the screen (for example the "File" menu in all programs is always on the left)

Further, the navigation tools on the map were increased and adapted to the chosen colours of the system in order to make them more visible.

6.2.8 Utilisation scheme

The first page that the user sees is the start-screen where the most important things are described. According to Shneidermans second rule (Enable frequent users to use shortcuts) a first-time user can read through this start screen and get some information on how he can use the system. Frequent users can easily jump over this start screen either by directly clicking on the start screen or by book marking the new public version of the system.

In the public version of the system the user can consult all information that is offered - both other persons parcels (and the information added to these parcels) and different map-themes. All information that is offered is printable. He can also create an account for the personal version of the system.

With this account he is able to enter the personal version of the system where he can manage his parcels. The public version always stays in the background of the personal version so that the user easily can switch between these two versions and consult his parcels together with the available themes (for example create a map showing the pedology together with his parcels in order to find out what kind of soil he is planting on).

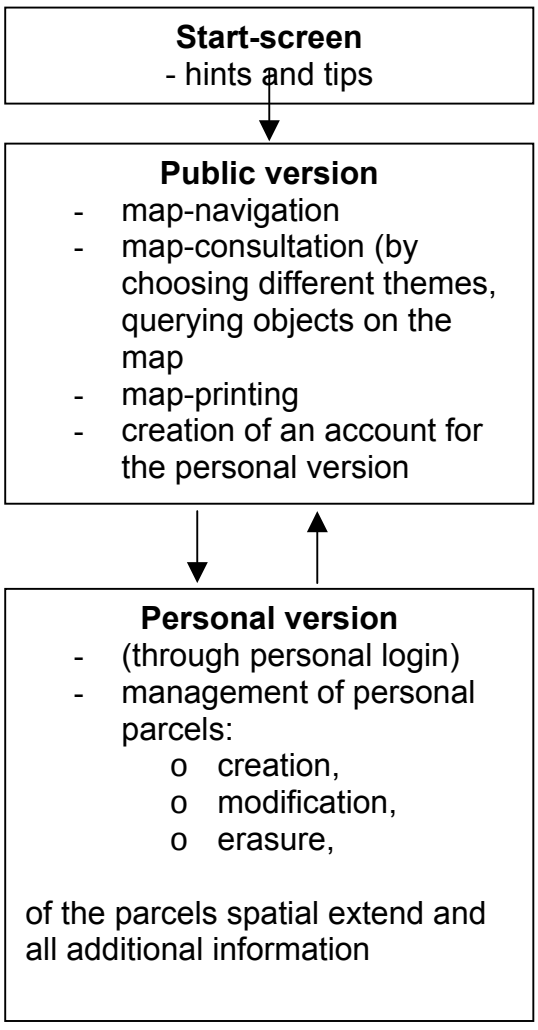


Figure 13: Utilization scheme

Furthermore the system is developed as a multi-user-system. Already the structure of CartoWeb is conforming to this principle. Concerning the interface this principle had to be adapted. Many users can access the system at the same time and add/modify/delete data. Every user who changes data in the system is registered in the database. All actions that a user takes are made through his registration. Through this design it is impossible to make the database inconsistent.

7. Evaluation and validation

7.1 First tests

In order to prepare the system for the evaluation with the winegrowers a first test with the researcher Vivian Zufferey from the federal station of wine-research was made the 9th February 2004. He was given some tasks that he had to solve with the system: navigating to a place on a map, showing different themes for this place, measuring a distance between two places, creating a printable map, querying a sample-parcel, creating a user account, logging on with this account and adding new parcels.

Problems encountered were:

- The map navigation tools had to be more visible due to the reason that they are displayed directly on the map and therefore less visible.
- The applet that is used to insert parcels was considered less intuitive due to the reason that one first has to add a parcel's first point and then all the other points with a different tool.
- The button that is used to print a map was also considered less visible – either its place or its extent should be modified.

Further, he added some comments (mostly orthographical comments) to the terminology used in the system and to the fields for entering data. A controversial subject was the term for creating a user account – he preferred the English term, "login" and added that the French translation of the word "account" would be unsuitable.

The improvements of this first evaluation were that the map navigation tools were increased so that they now are more visible. Due to the lack of time the part of the system where users can define their parcels by clicking on the map couldn't substantially be redesigned, but a help field was added on the right side of the map so that the users can read how to add their parcels and how to modify them.

The print map button was completely remade and is now placed at the bottom of the map. It was removed from the context of navigation tools and theme choice because it's functionality has less in common with the other tools.

The terminology of the system was adapted to his proposals. Unfortunately no better term for the user-account could be found and so the term is explained on the start-page.

7.2 The final evaluation

For the evaluation of the prototype the so-called Heuristic-Evaluation-method, also known as Expert-evaluation was used. The application of the method requires two or three expert-users. Expert users, according to the Handbook of User-Centred Design [23] preferably should be users who have an experience in Human-Computer-Interaction but this is not a necessary requirement. The method is often used to identify usability problems and to provide recommendations for design improvements.

According to Nielsen and Landauer's study "a Mathematical Model of Finding of Usability Problems" [24] two to three users are the optimal number of users for this evaluation method. Normally the expert users should evaluate the system independently of one another and should also be able to test the whole of the prototype without guidance by the developer.

At the beginning of the evaluation an introduction should be held in order to ensure the expert-users agreement to the test. The expert users should then work with the system independently and solve hypothetical tasks.

As a feedback the expert-users pass a detailed description of the problems encountered to the developer. The feedback should also include a ranking of the problems encountered.

For the evaluation of this system three winegrowers that participated in a previous project within the project "Etude des terroirs viticoles vaudois" were contacted in

agreement with the researcher Vivian Zufferey. For the final evaluation four winegrowers appeared (one was a colleague to a winegrower contacted) .

The developer held a short introduction of the system and then the winegrowers were given a set of tasks that they had to solve with the system. After each completed task the winegrower had to rate the task from easy to difficult. During this period of the evaluation the developer did not answer questions in order to not disturb the user and to let the user find the problems. After the practical test a discussion was held with the evaluator to find out other problems regarding the interaction and the design. All questions and tasks are listed in appendix C.

7.3 Results of the evaluation

7.3.1 General results

In general the evaluators were quite pleased with the interface. Especially the graphical design of the interface made a good impression. The evaluators were also very positive to the possibilities that the system offers for winegrowers. However depending on the evaluator's computer-habits the usage was more ore less easy. A statistical analysis of the tasks ratings can be found in appendix D.

7.3.2 Interaction

The navigation buttons were recognized, but sometimes the usage wasn't correctly understood; first after a while the users became used to the zoom functions. Especially the function to draw a rectangle in order to zoom in was found to not be intuitive. An idea proposed by one winegrower was to explain the zoom tools better. One winegrower used the scale choice menu and the arrows around the map to navigate, instead of using the zoom tools. Another winegrower wanted to have a panning function instead of a re-center function.
All evaluators had some problems with the measurement function. The symbol of a scale on top of the measurement button was less good recognized. It should be

remade and also bigger. Further the result of the measurement shouldn't be displayed in the status bar of the frame. It should be displayed at a more visible place.

The printable version was also criticized by two winegrowers – the evaluators preferred to have the button that creates the map for printout near the navigation tools and not under the map. Also some winegrowers criticized the printable map that appears on the screen after clicking the button: the overview map on top of the actual map disturbed the users. One recommendation was to let the user choose whether or not he wants to have an overview-map on top of the actual map.

Changing the map from the national Swiss map to the orthophotos caused no problems for the evaluators. Some visualization of categorized map themes (e.g. the type of soil theme) was considered too indistinct – the color difference between the different categories (e.g. between the different types of soils) should be better. However, one winegrower found it better if the map should automatically change when choosing a different theme without clicking each time on the reload-button.

The query function was recognized quite well and also the data that popped up after clicking was considered good. One possible enhancement of this function proposed by one evaluator was to create a new button that shows all parcels in the system on one page.

One winegrower wanted a better entry page for the system with a photo that directly takes the users attention and informs about what he can do with the system.

Because all winegrowers encountered some difficulties to find their parcels on the map that they just had created, it was proposed to implement some search functions in order to facilitate this operation.

One function that was desired from all evaluators was to automatically calculate the yield by dividing the total harvest by the surface.
One evaluator proposed another extension of the program, which would be suitable especially for wine companies. If the developer would implement the possibility to

create a super user account for the head of wine companies, it would be possible to control all winegrowers that are part of the wine company.

7.3.3 Data

The winegrowers were impressed by the themes that were already accessible in the system, some additional themes that winegrowers desired and proposed were

- The rain-amount in the region categorized by month
- The risk of hail
- The average temperature

A field that one evaluator wanted to have in his parcel view was fertilizing information.

8. Discussion

8.1 Development process

It was a challenge to unite the objectives of this diploma thesis together with the user's requirements and the design-principles and to finally implement the prototype. Although certain functionality already was given through the obtained CartoWeb-system it was sometimes not easy to change the already existing functionality and to add new functions to the system.

According to the user-centered system-development model a developer should begin with the user and then continue with the specification of requirements. In the beginning of the development-process it was however not easy to get in contact with the winegrowers because it was harvest-time, so I had to change my plans. The design process began actually with some implementation, some prototype-tests and the evaluation of already existing systems before the contact with real winegrowers was made.

Another problem that was encountered in the beginning was that not the whole of CartoWeb's source code was accessible and that almost no documentation existed for the basic system; only a tutorial-course for adding data to the system and some web pages explaining the functionality of MapServer, the core of CartoWeb.

The whole source code (especially the source-code of the Java-applet that permits to draw parcels) of CartoWeb became accessible first two months before finishing the prototype. The result was that the last months of the process became more stressing than the first months – also due to the reason that the first contact with the winegrowers was made in the same period.

The evaluation was quite interesting because some users used the system differently than the programmer intended (for example the idea to navigate on the map only using the arrows and the scale-choice). During the evaluation it has encountered that users often tend to say that they are less used to programs and computers as an

excuse for errors they have made. Users sometimes believe that the computer and the programs are perfect and that they are the reason why something went wrong.

The philosophy that results from interaction design theories is that the programmer is responsible for the user's errors and problems. If a user has a problem with the interaction, e.g. if he doesn't know what he can or should do, it's the programmer's problem to find a solution. Before beginning an evaluation this has to be made clear.

One experience that I made was that it isn't always easy to follow design-rules. Often one is forced to make compromises in order to obtain the desired functionality. There are two reasons for these compromises: one is the time factor: when a prototype has to be finished until a certain date, it is necessary to find quick solutions that also work. Sometimes some parts of the system were depending on just one function. In order to be able to implement these parts, a solution for this one function had to be found. Another reason for making compromises is the performance of the system. When transferring much data through the Internet the system becomes slower. One little test with a modem was made and it took about two minutes to load the map – this system would therefore be quite useless for most of the winegrowers who participated in the inquiry, because they are accessing the Internet via modem.

Another problem that had encountered during the development was the compatibility of different web browsers on different operating systems. If the correct version of Java is not installed, it is sometimes not possible to load the map or to load the applet that is used to draw the parcels.

8.2 Further development

As named in the introduction the possibility to trace the way of the wine would be an interesting enhancement of the whole system. The system could then also manage the wine producers wine cellars and automatically create the connection between the harvest that the winegrower delivers and the wine stored in the wine cellars. The development could go even further – also wine dealers could be integrated and consult the way of the wine – from the exact location of the wine yard together with all meta-data that is available via the cellar where the wine is aged on to the bottle.

For a further development the results from the user-evaluation have to be considered and if possible adapted. Problems with the interaction have to be solved and new functions have to be implemented. One bigger part of the further development is the optimization of the page where the winegrower can draw his parcels. The page should be designed so that the winegrower doesn't have to read the instructions in order to define his parcels. Also the design of this module has to be more adapted to the design of the principal (public) map. One first idea would be to substitute the existing check boxes for the choice of the navigation tools and the insertion-tools through the same symbols that are available on the principal map. Another idea would be to entirely substitute the principal map through the insertion-module.

Further the compatibility of the system has to be checked and evaluated on different systems. As Java is the biggest problem for the compatibility, an idea would be to either reprogram the java-applets or to give the user a hint to install Java on his computer.

Also the security of the system has not been considered in detail. Parameters (for example which person is accessing a parcel) are often passed from one page to another through the URL. This would make it possible for a hacker to access some parts of the database and maybe even to change some data. A possible solution to this problem would be to pass all parameters from one module to another through the server – another (maybe easier) solution would be to encrypt and the decrypt the parameters.

Another thing that has to be considered for a further development is the usage of CartoWeb as basic system. As CartoWeb builds on a structure where a central server creates all maps for all users and sends them as an image to the users web-browsers the system can become very slow. Although a faster server could solve this problem in a certain manner (the server for the development of this prototype was quite slow), more data would slow down the system again (especially when more and more parcels and meta-data will be added). A possible solution that should be considered is to build the final system on a system that lets the users computers calculate the actual maps and where all data is passed as vector-data. One system (mappy.fr) on the Internet that was recommended by a winegrower through the inquiry had such a structure and was much faster than all CartoWeb-implementations regarded.

An interesting idea for a further development of the system would be to adapt it to other fields of agriculture or to other regions of the world. I think that such a system could be quite interesting for a commercialization because of the reason that the system only has to be installed on one computer, or a minor computer-cluster. All users can access the system without needing to install expensive software. Further, also so-called precision farming systems that integrate GPS-navigation on the fields could be integrated in the system.

9. Conclusions

This diploma thesis resulted in the development and implementation of a functioning prototype where a winegrower can define his parcels and important information that is related to the parcels. The system is a web mapping service or a so-called geoportal, which means that the main part of the system is an interactive map where the user can consult and visualize different themes.

The model that was applied in the development-process is the user-centered system-development – a model where the user takes part of the whole development-process at different levels.

The system was further designed according to well known design principles and methods in order to maintain a usage of the system that is as agreeable and also as efficient as possible.

At the end of the prototyping process the system was tested, evaluated and validated by selected winegrowers. In order to develop a final system changes and enhancements of the prototype, based on the evaluation are presented.

The system represents an alternative to expensive stand-alone systems because it is mainly developed using open source programs and programming languages. Furthermore, the solution combines the advantages of the Internet and geo referenced mapping systems. A continuation of the development would be a enrichment not only for the Internet, but also for the wine-cultivation.

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Appendix

A: Inquiry sent to selected winegrowers

B: Result of the inquiry

C: Evaluation

D: Result of the evaluation

E: Database scheme

F: Theme categories

G: Important modules of the system and its connections

A: Inquiry sent to selected winegrowers

1. Avez-vous accès à l'Internet ?
   - O Oui
   - O Non (si non continuez avec la question 10 SVP)

2. De quel type est votre accès à Internet ?
   - O Par modem
   - O Internet à haut débit
   - O Je ne sais pas
   - O Autre :_____

3. Quel système d'exploitation utilisez-vous ?
   - O Windows 95 ou 98
   - O Windows NT / 2000 ou XP
   - O Macintosh OS X
   - O Macintosh OS 9.x
   - O Linux / Unix
   - O Je ne sais pas
   - O Autre : _____

4. Quel navigateur utilisez-vous ?
   - O Internet Explorer
   - O Netscape
   - O Mozilla
   - O Opera
   - O Je ne sais pas
   - O Autre : _____

5. Quel âge a l'ordinateur que vous utilisez ?
   - O Nouveau
   - O 1-2 ans
   - O 3-4 ans
   - O 5 ans et plus
   - O Je ne sais pas

6. Utilisez-vous l'ordinateur pour enregistrer des donnés relatives à la viticulture ?
   - O Oui
   - O Non

7. Avez-vous déjà cherché quelque chose sur une carte sur Internet ?
   - O Oui
   - O Non

8. Avez-vous déjà utilisé l'ordinateur pour dessiner ?
   - O Oui
   - O Non

9. Avez-vous utilisé un des services suivants sur Internet ?

- O Swissgeo.org (service pour rechercher des adresses)
- O Pages blanches /pages jaunes
- O GéoPlaNet (Service de l'information sur le territoire de l'Etat de Vaud)
- O Autres : _____

10. Quelles informations aimeriez-vous voir dans le nouveau système ? (précisez SVP)

	Très important	Moins important	Pas important
Cartes sur l'ensoleillement	O	O	O
Cartes sur les types de sol	O	O	O
Cartes sur l'alimentation en eau	O	O	O
Cartes sur le vent	O	O	O
Cartes sur les niveaux thermiques	O	O	O
Profils pédologiques	O	O	O
Autres :	O	O	O
Autres :	O	O	O

11. Quelles données de vignoble aimeriez-vous pouvoir consulter sur ce site ? (précisez SVP)

	Très intéressant	Moy. intéressant	Pas intéressant
Cépage	O	O	O
Mode conduite	O	O	O
Surface des parcelles	O	O	O
Porte-greffe	O	O	O
Entretien du sol	O	O	O
Produits de traitement	O	O	O
Autres :	O	O	O
Autres :	O	O	O

12. Quelles donnés êtes-vous prêts à saisir ? (précisez l'usage SVP)

O : pour un usage privé

☐ : pour un usage public

	Oui	Plutôt non	Absolument pas
Cépage	O ☐	O ☐	O ☐
Mode conduite	O ☐	O ☐	O ☐
Surface des parcelles	O ☐	O ☐	O ☐
Porte greffe	O ☐	O ☐	O ☐
Entretien du sol	O ☐	O ☐	O ☐
Récolte	O	O	O
Produits de traitement	O ☐	O ☐	O ☐
Autres :	O ☐	O ☐	O ☐
Autres :	O ☐	O ☐	O ☐

13. Quelles autres choses aimeriez-vous voir dans le système ?

- O Liens (communes, autres sites intéressant pour la viticulture)
- O Forum (pour échanger avec d'autres vignerons sur des sujets professionnels)
- O Autres :_____

14. Commentaires

Nom : _____

Merci de votre collaboration !

English translation :

Question :

1: Do you have access to the Internet? - Yes/No (if no please continue with question number 10)

2: What type of connection do you have to the Internet? - Modem/Broadband/I don't know/Other

3: What operating system do you use? – Windows 95 or 98/Windows NT, 2000 or XP/Macintosh OS X/Macintosh OS 9.x/Linux or Unix/I don't know/Other

4: Which web-browser do you use? – Internet Explorer/Netscape/Mozilla/Opera/I don't know/Other

5: How old is your computer? – New/1-2 years/3-4 years/5 years and more/I don't know

6: Do you use your computer to store viticulture-data? – Yes/No

7: Have you already consulted a map on the internet? – Yes/No

8: Have you already used your computer to draw? – Yes/No

9: Have you already used one of the following services on the Internet? – Swissgeo.org/ White pages, Yellow pages/ GéoPlaNet/Other

10: Which maps do you want to see in the new system? - Sun-radiation/type of soil/water supply/winds/thermal levels/soil profiles/other

11: Which viticulture-data (related to the parcel) would you like to see in the new system? – Sort of grape/management method/the parcels surface/root stock/soil treatment/exterminators/other

12: Which viticulture-data are you ready to share? (Alternatives for each choice): public usage, private usage) – Sort of grape/management method/the parcels surface/root stock/soil treatment/exterminators/harvest/other

13: Which other things would you like to see in the new system? – Links to other communities, other interesting sites for vine-cultivation/Forum (to discuss professional subjects with other wine-growers)/Other

14: Comments?

Thank you!

B: Results of the inquiry

Number of inquiries sent out: 35

Number of inquiries sent back: 28

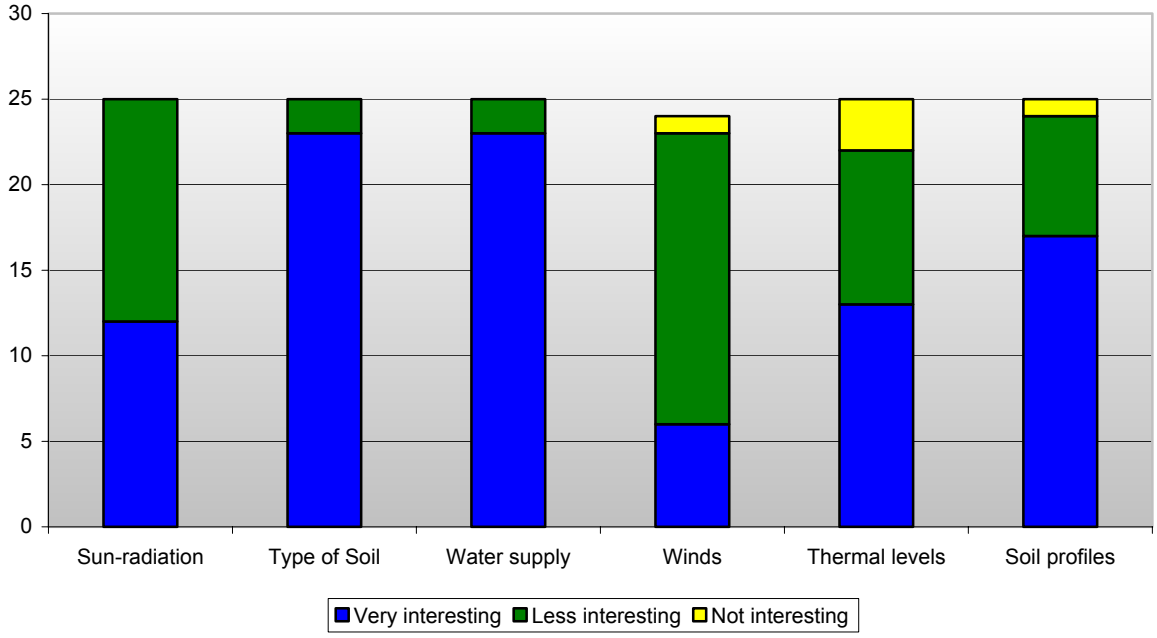
Number of invalid inquiries: 1 (the winegrower was no longer active)

Number of valid inquiries: 27

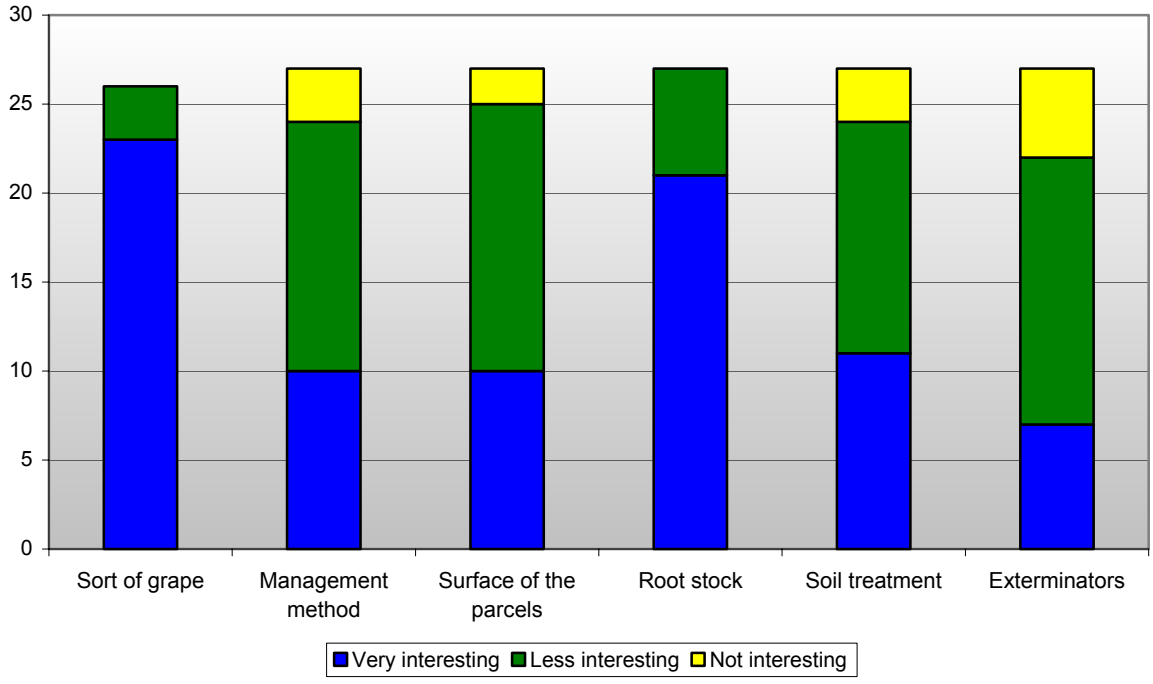
Question	**Result**	**# of answers**
1: Access to the Internet:	Yes: 25 (93%) No (7%)	27
2: Type of access	Modem: 16 (64%) Broadband: 6 (24%) ISDN (=other): 1 (4%) Don't know/no answer: 2 (8%)	25
3: Operating system:	Windows 95/98: 8 (31%) Windows NT/2000/XP: 16 (61%)* Mac OS X: 0 (0%) Mac Os 9.x:1 (4%) AS 400 (IBM) (= other): 1 (4%)* *: One wine-grower was using two different OS	(26*)
4: Web-browser	Internet Explorer: 24 (89%)* Netscape: 3 (11%)* Mozilla/Opera/Other: 0 (0%) *: Two wine-growers were using both Internet Explorer and Netscape	(27*)
5: Age of the computer	New: 3 (12%) 1-2 years: 13 (52%) 2-4 years: 6 (24%) 5 years and more: 3 (12%)	25
6: Use of to computer to store viticulture-data	Yes: 19 (76%) No: 6 (24%)	25
7: Have consulted a map on the Internet	Yes: 17 (68%) No: 7 (32%)	25
8: Have used the computer to draw	Yes: 5 (20%) No: 20 (80%)	25

9: Have used these services:	Swissgeo: 8 (32%) White pages/yellow pages: 12 (48%) GéoPlaNet: 11 (44%) Other*: 3 (12%) *: mappy.fr , bluewin.ch (addresses), telesearch	25

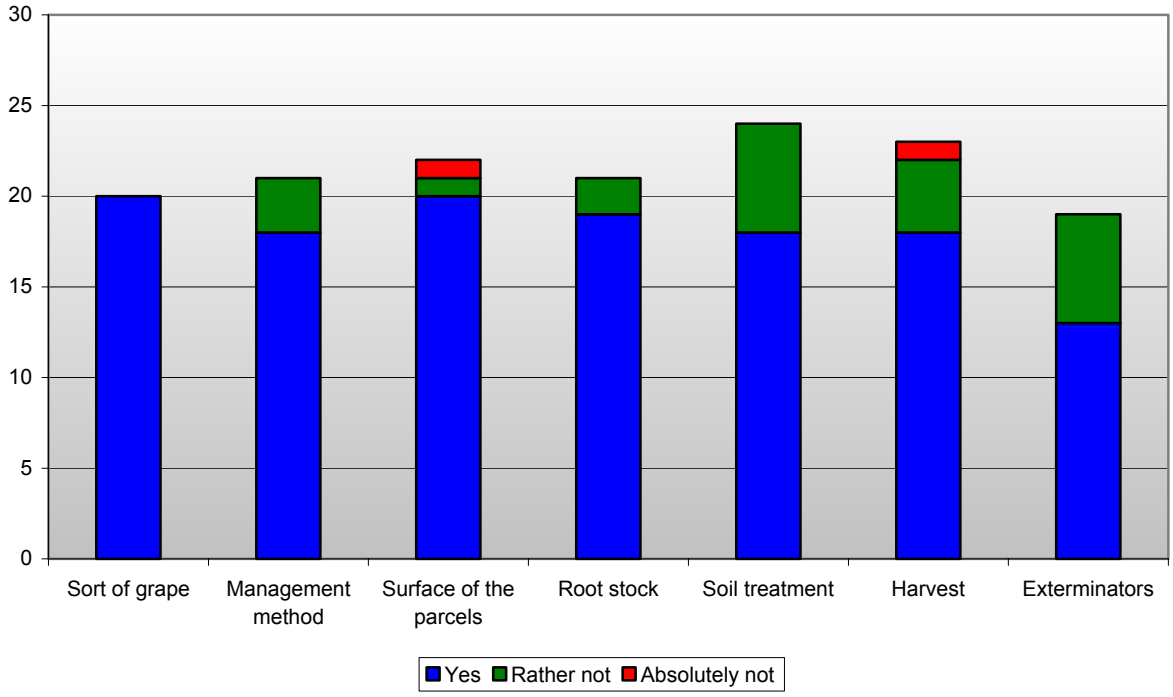
10: Maps winegrowers would like to see in the system



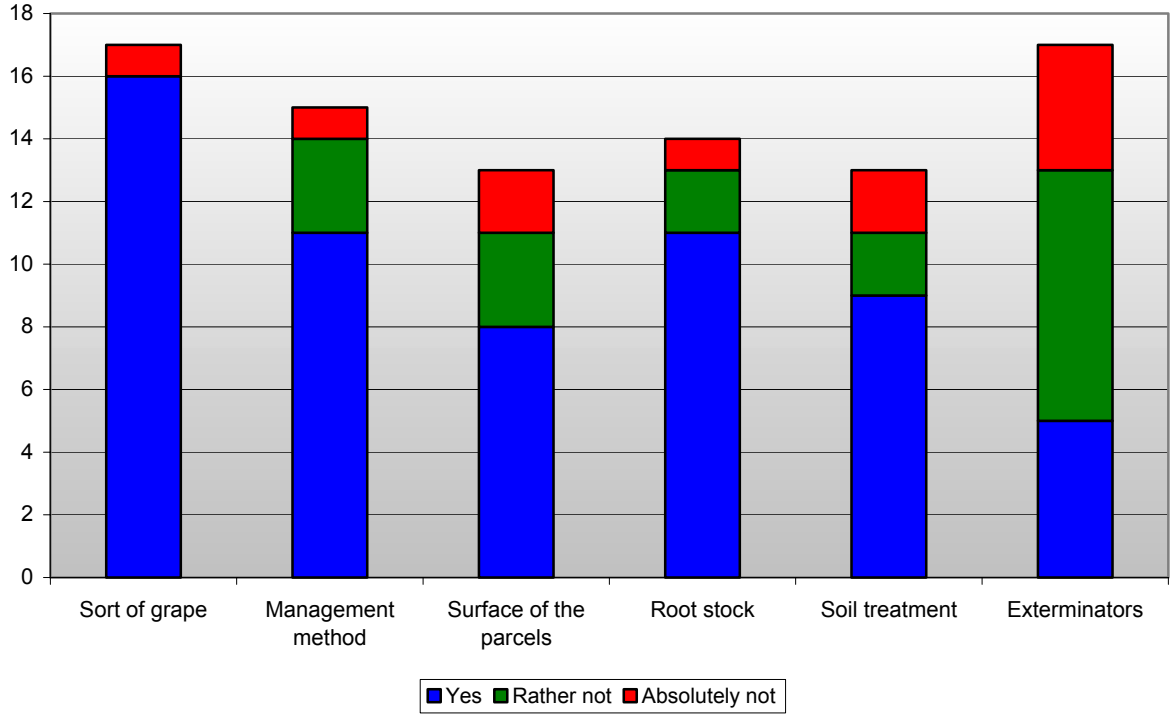
11: Data winegrowers would like to consult in the system



12: Data winegrowers are ready to share (for a private usage)



12: Data winegrowers are ready to share (for a public usage)



13: Other things that winegrowers would like to have in the system	Links: 16 (60%) Forum: 10 (37%) A system with a link to the federal wine-control (=Other) 1 (4%)	27

14: Comments (see chapter 4.1.1)

C: Evaluation

Exercises given to the winegrowers:

Exercice :	Cet exercice était :			
	Très difficile	Difficile	Facile	Très facile
1. Naviguez sur le village de St.Saphorin !	O	O	O	O
2. Sur quel niveau thermique se trouve St.Saphorin ?	O	O	O	O
3. …et sur quel type de sol ?	O	O	O	O
4. Mesurez la distance entre St.Saphorin (village) et la place de camping à la Pichette (à l'est de St.Saphorin) !	O	O	O	O
5. Cherchez une parcelle sur la carte et affichez les données de cette parcelle !	O	O	O	O
6. Créez une carte d'impression !	O	O	O	O
7. Créez un compte d'accès ! (Vous pouvez utiliser des noms imaginaires si vous voulez)	O	O	O	O
8. Créez une parcelle de vigne (Vous pouvez créer une parcelle imaginaire si vous voulez)	O	O	O	O
9. Ajoutez des données relatives à cette parcelle (lieu dit, cépage, etc.) !	O	O	O	O
10. Ajoutez des récoltes !	O	O	O	O
11. Cherchez votre parcelle sur la carte et affichez les données que vous avez enregistrées.	O	O	O	O

English translation:

The evaluators had the choice between very easy, easy, difficult and very difficult (it was allowed to check between the alternatives)

1. Navigate to the village of St.Saphorin!
2. On which thermal level is St.Saphorin located?
3. … and on which type of soil?
4. Measure the distance between St.Saphorin and the camping at La Pichette (east of St.Saphorin)!
5. Find a parcel on the map (at the time of evaluation the developer had added some sample-parcels) and get the meta-data of this parcel!
6. Create a map for printing!
7. Create an account (you can use imaginary names if you prefer)!
8. Create a parcel (you can create an imaginary parcel)!
9. Add meta-data to this parcel (place, sort of grape, etc.)!
10. Add some harvests!
11. Find the parcel you have created on the map and get the meta-data that you just have added!

Questions asked after the evaluation (English translation):

Interface and functionality:

What do you think of the navigation-tools?

Do you think that it is complicated to display different themes on the map?

What do you think of the printing-map-function?

What do you think of the query-function (to get the meta-data)?

What do you think of the function to draw your parcels on the map?

What do you think of the start-page?

Are there any functions that the system lacks?

Data:

Are there any other themes that you would like to display on the map?

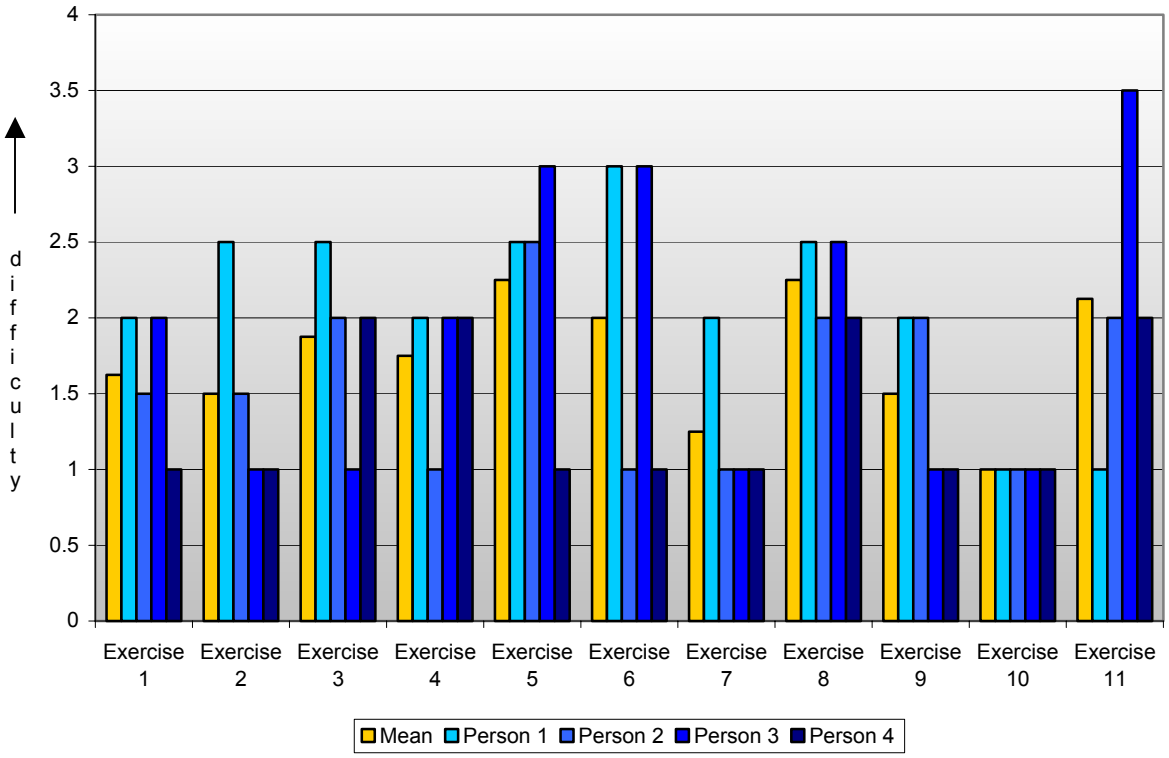
Are there any other information-fields that you would like to have in order to enter other information?

Are there information-fields that you consider unnecessary?

What do you think of the terminology?

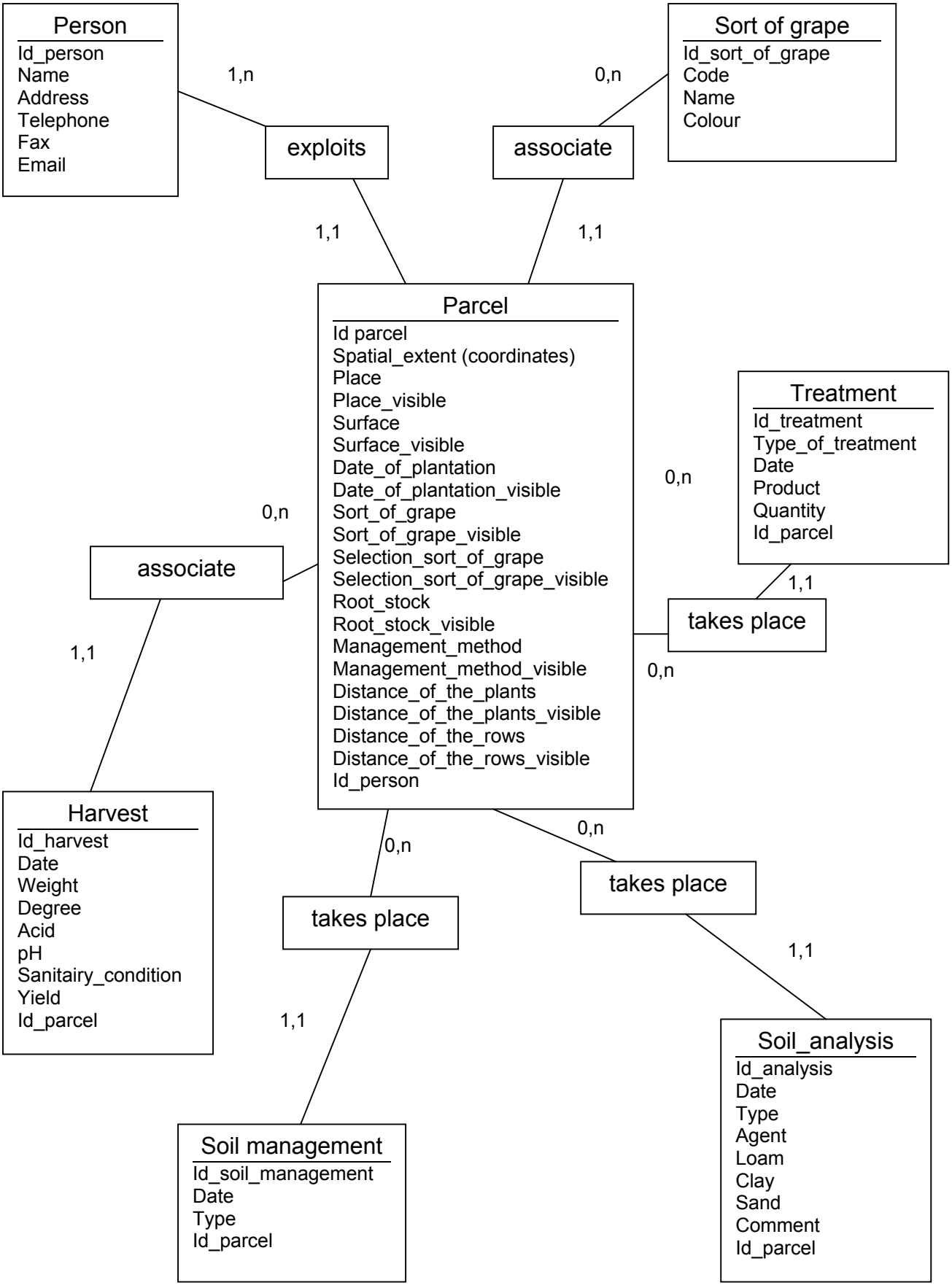
D: Result of the evaluation

Exercises:



The answers to the questions asked after the evaluations are described in chapter 7.3

E: Database scheme



F: Theme categories

Category parcel
Parcel
Cadastre
Maps* (CNS 25, CNS 50, CNS 100, CNS 200)
Orthophoto

Category pedology
Parcel
Water supply (4)
Depth (7)
Type of soil (8)
Bedrock (8)
Maps* (CNS 25, CNS 50, CNS 100, CNS 200)
Orthophoto in grey**

Category landscape
Parcel
Heights (8)
Slopes (5)
Directions (8)
Maps* (CNS 25, CNS 50, CNS 100, CNS 200)
Orthophoto in grey **

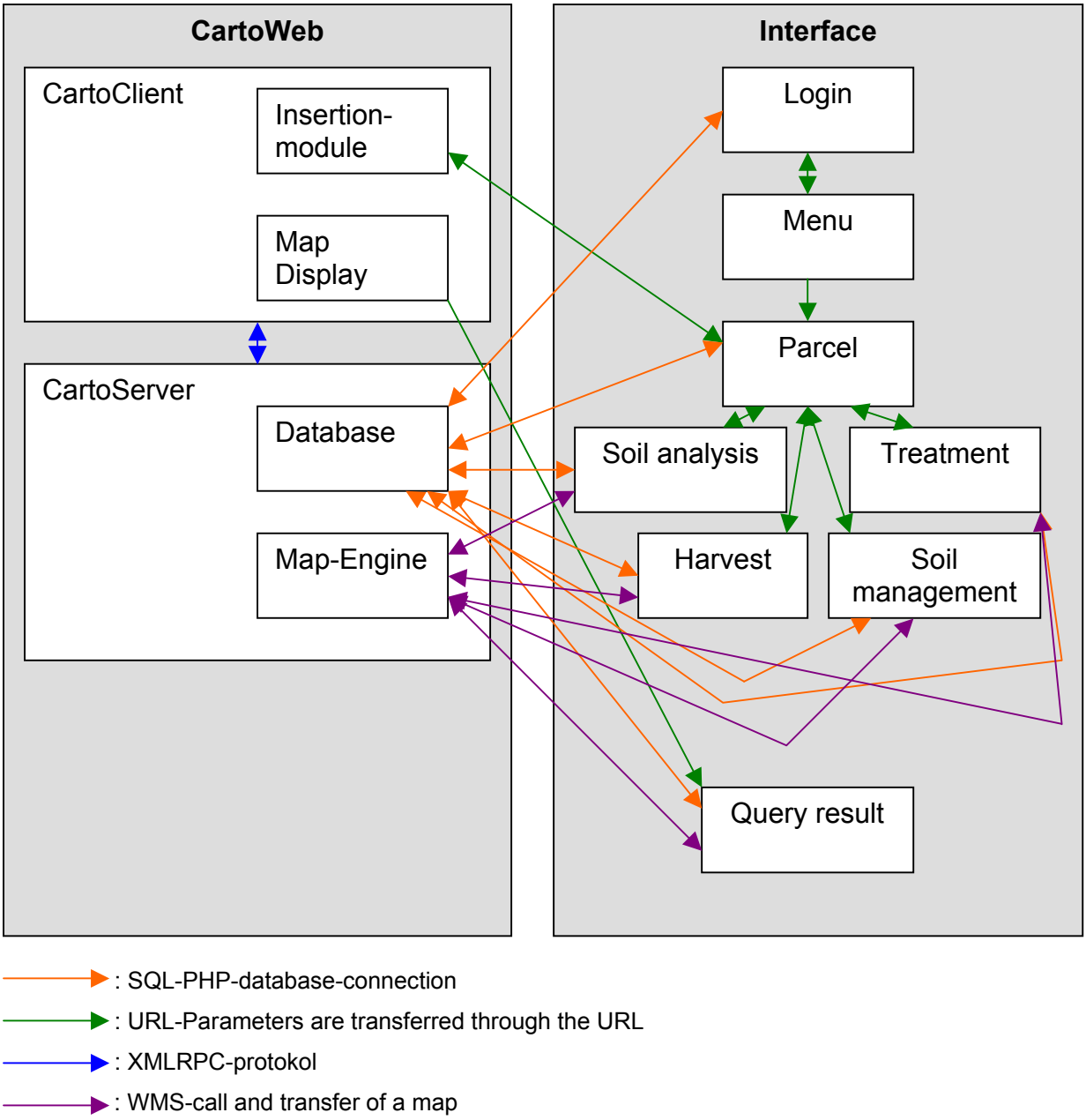
Category microclimate
Parcel
Sun radiation in august (5)
Sun radiation over the year (5)
Thermal levels (6)
Winds (5)
Maps* (CNS 25, CNS 50, CNS 100, CNS 200)
Orthophoto in grey**

*Maps:
CNS: Swiss National Map
25: Scale 1:25’000
50: Scale 1:50’000
100: Scale 1:100’000
200: Scale 1:200’000

**The orthophoto was discolored in order to permit to display the color of the overlay-themes correctly

(5): number of classifications

G: Important modules of the system and its connections



The figure shows the way the interface is integrated in the whole system and how information between the CartoWeb-system and the interface is transferred.