CARTESIAN - Remote Sensing based Management Information System for Ski Resort Planning

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ABSTRACT: In the frame of an EU-Project an inter- and transdisziplinary team developed an interactive Management Information System (MIS). The aim is to provide a sophisticated tool for ski region management to planners, politicians and decision makers, environmentalists or tourist specialists, based on remotely sensed and auxiliary data for model based interpretation schemes.

1 DON'T CUT OFF THE BRANCH YOU ARE SITTING ON

Imagine the evolution of men for the last 250'000 years represented by one hour of a clock, 30 seconds ago we started with our calendar after Christ, since two seconds we proudly use the car and since one second we are confronted with a new phenomena called mass tourism.
Mass tourism bases on the four boom factors (Krippendorf et al 1986): (a) more and more time for leisure, (b) increasing amount of money for leisure, sport etc., (c) daily routine and stress asks for more easing and (d) mobility is still cheap and available for everyone.
So, millions of guests visit every year the alpine arc between Nice and Vienna for summer and winter recreation.
The results of this "last second" are more than 40'000 ski pists covering an area of more then 1000 km2 or more then 10'000 transport facilities with a still heavily increasing transport capacity (CIPRA 1993). We are confronted with a development which is rather new and with a dynamic we are not yet familiar to deal with.
It is not up to us to judge what is good and what is bad, but we would like to emphasize the necessity of monitoring and planning in alpine regions to prevent further damages. There is a severe risk, that tourism destroys its own base: an interesting and beautiful alpine landscape.

2 CARTESIAN, AN INTERDISCIPLINARY EU-PROJECT

Well aware of these problems a group of scientists developed an interactive Management Information System (MIS) to provide planners, politicians, nature conservationists or tourism specialists with a planning tool to make the decisions in planning processes more effective. Of special interest is the use of remotely sensed data, i.e. space born and air born imagery to provide an objective database related to environmental monitoring and maintenance of ski regions.
The management information system (MIS) is based on a GIS based expert system, which merges information derived from satellite imagery, aerial photographs, inventories, statistics, maps and of course knowledge of experts enabling model based analyses. By means of the MIS the user can interactively treat his planning scenarios, not to get <u>the</u> solution but to receive as much information as possible to take a comprehensible decision considering the assumptions.

3 CONSORTIUM AND CASE STUDIES

The international consortium exists of research institutes of Zürich, Amsterdam and Grenoble and "customers" representing the management of ski-regions, a bid-committee for Olympic games and touristic enterprises (CARTESIAN, 2000).

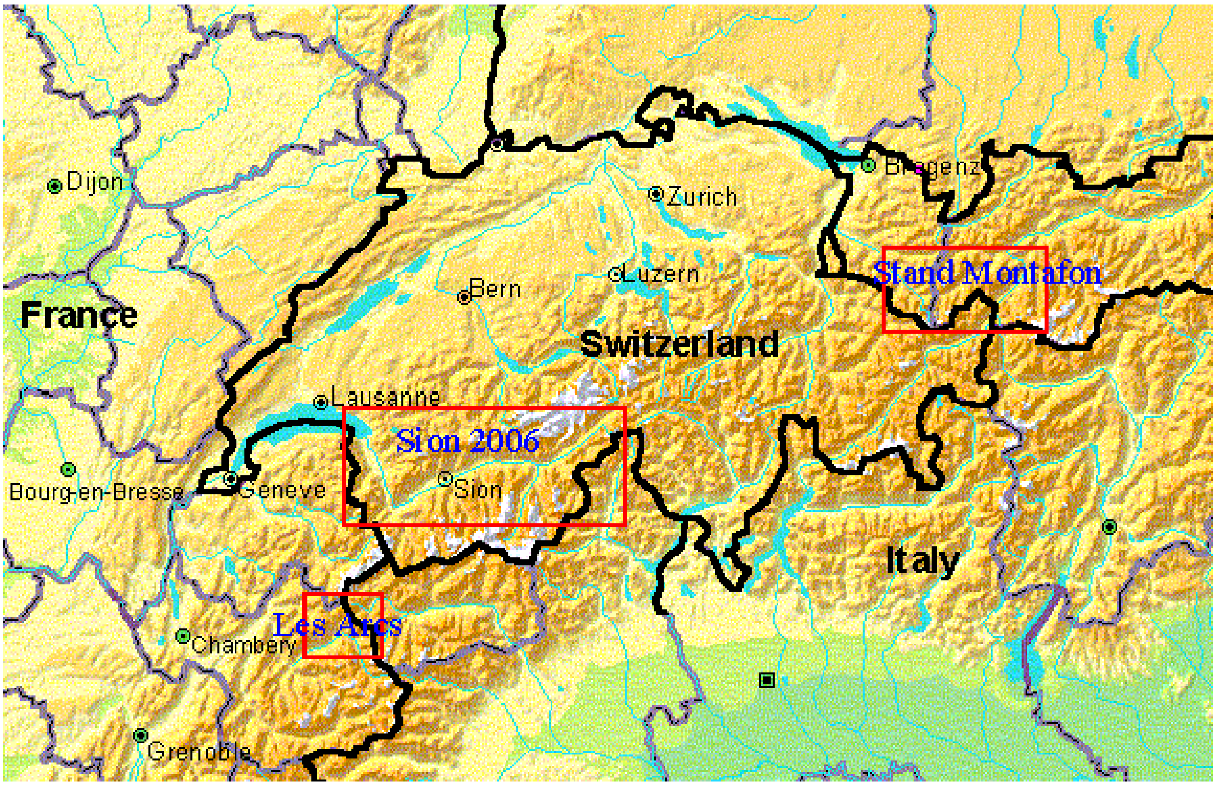

Fig. 1 The three case study areas in Austria (Sivretta Nova), Switzerland (Sion) and France (Les Arcs).

The three test sites are located in "Silvretta Nova" in the Austrian Montafon valley, the Sion area in Switzerland, where Olympic games could have taken place in 2006 and the ski station "Les Arcs" in the region of Albertville (see Fig. 1)

In each of the three test sites different case studies were exemplary elaborated:

a. Economical and ecological aspects of a new infrastructure in the ski-regions "Silvretta Nova". As an example: which information is used in the planning process of a new ski lift?
b. ecological and economical aspects of infrastructure needed for Olympic games, i.e. what is the best location for the freestyle slope in the Olympic perimeter in the valley?
c. What is the vision for a ski station as "Les Arcs" especially under changing climate or market conditions?

4 DATA AND MODEL

Due to the complexity of the task data from very different sources has been collected and models have been developed in order to show the interaction and the influence of different parameters.

4.1. Data

From various remote sensing sensors (Landsat, IRS, aerial photography) a variety of maps has been derived and integrated into the GIS database. In addition several inventories ranging from physical measurements, to land use and landscape properties have been compiled.
Whenever available corresponding data from historical surveys have been used in order to demonstrate changes in time.
Fig. 2 illustrates the diversity of information layers available in the MIS. The scorecard shows all relevant parameters for the envisaged analysis.

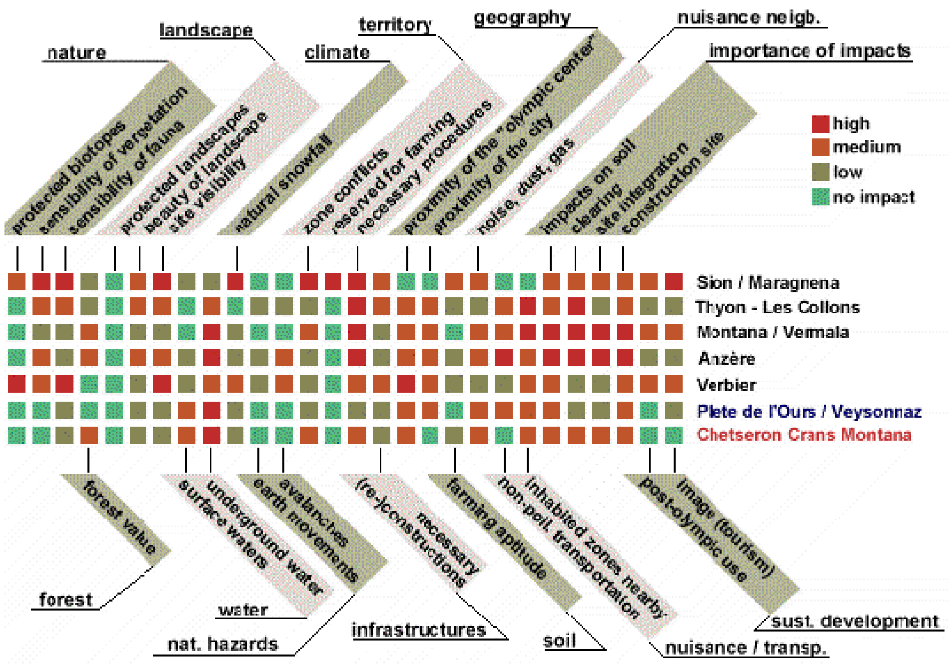

Fig. 2 Scorecard showing all the relevant parameters for a case study.

4.2 Models

The interdependence of economy, ecology and society and the above mentioned objective information layers are subject of this investigation. To treat the MIS information linear models for Multi Criteria Analysis (Nijkamp et al. 1990, Ridgley et al. 1998) are used. The advantage of these models is that the user can interactively manipulate different criteria without loosing control over the system. This means, the user can elaborate different scenarios by giving changing weights to economy, ecology or other parameters.

5 RESULTS

As a result of CARTESIAN a Management Information System is distributed by means of a CD. With the clearly designed interface the user gets (A) general information about the project and remote sensing background, (B) tools for ski area management, monitoring and planning, (C) tools for ski area promotion, (D) a list and the structure of the case studies and (E) information about eco-labeling in ski regions.

A General Information

The first chapter introduces the user to the project in general and remote sensing in giving a rough background on satellite data, sensors and products.

B Tools for ski area management, monitoring and planning

B1 high quality monitoring

Different operational satellite offer the possibility to monitor ski resorts with various resolution up to 1 m2 (Spaceimaging 2000) (Fig. 1). The satellite passes every 2-3 days and data can be acquired on request. This very high spatial and temporal resolution enables managers to supervise ski regions. Of course, as the sensor works in the visible range of the spectrum there should be no dense cloud cover to get usable data.

B2 Snow cover maps

Snow cover information is essential for managing and planning of ski regions. They are derived from satellite data over large areas. By means of time series of snow cover maps snow cover duration maps (Fig. 4) can be produced which are of high interest for planning purposes. Based on this information climate change scenarios and their impact on snow cover can be calculated. This is particularly useful for planning new ski infrastructure.

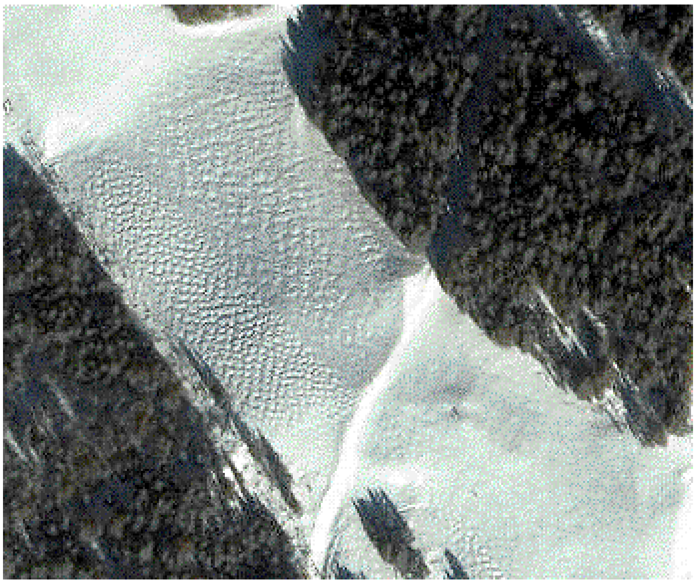

Fig. 3 IKONOS data from Les Arcs. With one meter resolution even small differences and bumps on the ski pists become visible.

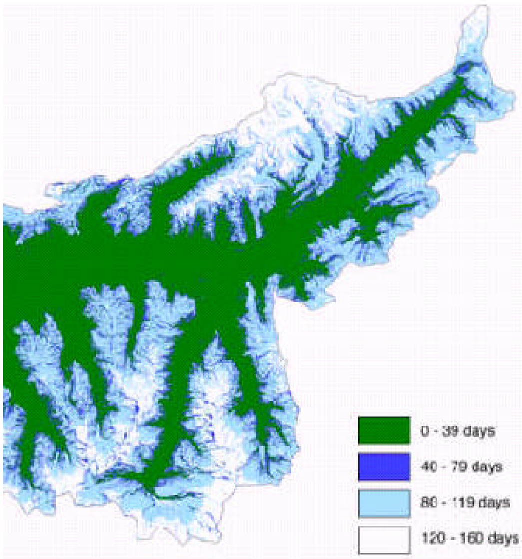

Fig. 4 Snow cover duration map of the Rhone Valley including the Sion test site.

B3 Land use change detection

Remote sensing data is perfectly suited to identify different land use classes and soil cover types. By comparing old an new satellite images or aerial photographs it is possible to detect trends in land use change. This methodology can be used to assess environmental impacts at local and regional scales.

B4 Ski area planning and design tool

The monitoring products mentioned above can, along with other relevant information as nature and landscape inventories, hazard maps etc. be integrated into a ski planning tool (Fig. 5), which facilitates the planning of new infrastructure as ski lifts or slopes.

C Tools for ski area promotion

C1 3-D-Visualisation

Ski areas can be visualized making use of 3-D computer animations. Fast and realistic 3-D representations of skiing areas enable the possibility to easily show future developments such as new ski lifts, pistes, clear fellings, buildings etc. Moreover prerecorded 3-D flights through the ski regions are possible and an attractive way to promote a ski region.

C2 Interactive Internet applications

The 3-D image or any other picture can be used to create a visual information system. Information to specific topics i.e. lodging, restaurants, infrastructure etc. can be obtained by simply clicking on the appropriate part of the image. This application is very important within a new communication tool using the internet.

C3 Internet panorama

Through new internet technology, it is possible to interactively look around in the ski area. This 360 degree panorama can be derived from 3-D animations or real photographs taken in the field (Fig. 6).

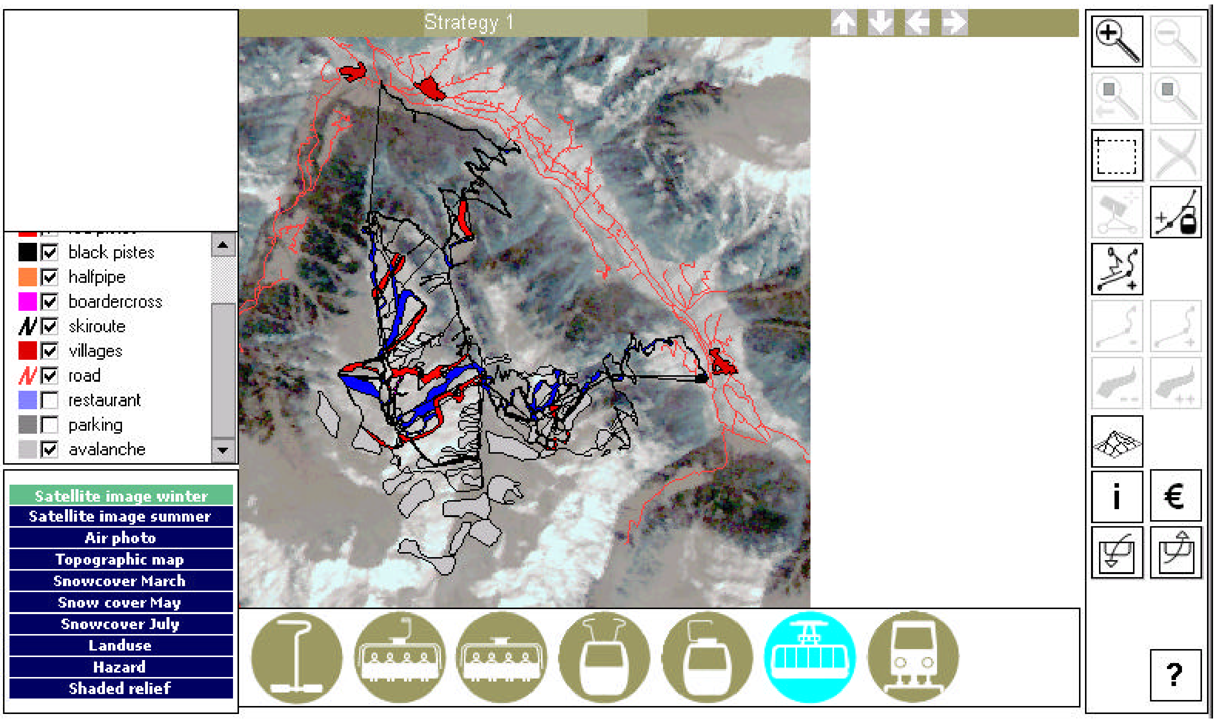

Fig. 5 Interface of the Ski area Planning tool for the Silvretta Nova test site.

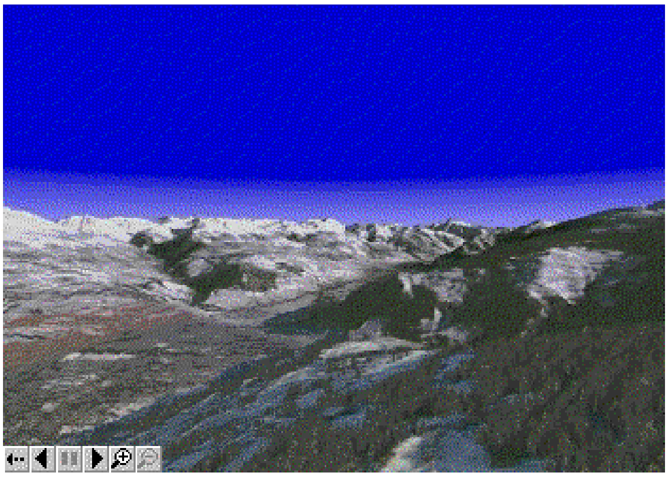

Fig. 6. Panorama tool. The user can roam and zoom in this virtual landscape. The image is composed out of satellite data and the digital elevation model.

D Structure of the case studies

In all three case studies the user finds the same structure: With 7 FFA (Framework for Analysis) the user can interactively approach to solve his problems.

A summary of the 7 steps gives an impression of the functionality within the MIS.

STEP 1: 'Issues and Problems' (what is going on?)
Within the first step, the user comes in contact with a Document Information System (DIS). This is an information system which shows the latest developments on issues and (potential) problems. The user gets an overview of the case study area: the geographical and socio-economic features, the processes which could influence the decision making process. In general, this step is meant to familiarize the user with the main subject and related issues.

STEP 2: 'Objectives and Criteria' (what must be accomplished? how is this established?)
The user creates a decision hierarchy by specifying the main objective and sub-objectives and selecting from a list of criteria (supplied by the knowledge-modules in the MIS); these criteria will measure the performance of his/her options regarding the (sub)objective(s); user-defined criteria can be specified.
The weights that are attributed to the criteria were derived from expert knowledge, but can be changed by the user. These weights symbolize the relative importance of the criteria compared to the other criteria (Fig. 7).

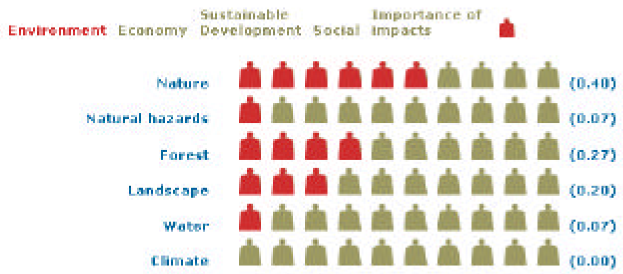

Fig. 7 One scenario dealing with the environmental parameters. The dark stones indicate the weighting factors.

STEP 3: 'Scenario' (what are the exogenous factors?)
A scenario is composed of exogenous factors that influence the outcome of a policy decision (climatic changes, change in tourism demand, change in international laws, change in infra-structure of the surrounding area etc.)

STEP 4: 'Alternatives, strategies and visions' (how can the problem be solved?)
In this step potential alternatives, strategies and visions are described in order to get an insight in their advantages and/or disadvantages.

STEP 5: 'Analysis' (analysis relevant combinations of scenarios and alternatives)
Out of all possible combinations of scenarios and alternatives an analysis is made against the criteria defined in Step 2.
Within step 5, a Multi Criteria Analysis model is used to analyse different alternatives. These patterns will be scored against the criteria in step 6.

STEP 6: 'Evaluation' (which alternative/case/vision prevails?)
The user is presented a scorecard in which estimated scores (qualitative) can be specified (on the sub-objectives level as well as on the criteria level). This helps in establishing the discriminating capacity of the criteria used, in the cases evaluated.
In step 6, the different scores for the alternative strategies will be compared. A ranking of the alternatives is meant to find the 'best' alternative.
If, by slightly changing the importance of a criteria, the best alternative changes the user knows this criteria is very important for the final result. If, by changing the importance of a criteria, the best alternative does not change the user knows that this criteria does not have an important impact on the outcome.

The difference between step 2 and 6 is that in step 2 you actually change the importance of the criteria while in step 6 you only evaluate if and how the criteria influences the outcome.

STEP 7: 'Presentation' (what does it look like?)
The 'best' alternative, strategy or vision is presented in more detail. The situation before and after solving the problem is presented using both 2D and 3D visualization.

D Eco labeling
Severe impacts on environment and society are very often recognized in ski regions due to extensive activities and infrastructures. With the introduction of eco-lables ski regions try to certify the quality of their "product" i.e. a sustainable tourism which is in balance with economy, ecology and society.

6 AN EXAMPLE OF WORKING INTERACTIVELY WITH THE MIS: SION 2006

For the Olympic games in the ski area Sion, Switzerland, the organizer were looking for the best location for a free style slope. Using the interactive MIS the planning process looks the following:

Step 1 gives different information about the geographical situation, natural, political background or socio-economic aspects relevant for the Olympic games as well as specific facts and figures concerning the technical requirements for free style skiing. In step 2 the user interactively prepairs the data for the analysis by giving weights to the different parameters in the area of economy, environment, sustainable development or social aspects. (see Fig. 2)

In step 3 and 4 different scenarios can be selected and 7 alternative sites under discussion for the free style slope are presented with general and more specific background information.

The scorecard in step 5 shows all relevant parameters for the Multi Criteria Analysis (see Fig. 2) and in step 6 the different alternatives are evaluated according to the weights defined in step 2 (Fig. 8).

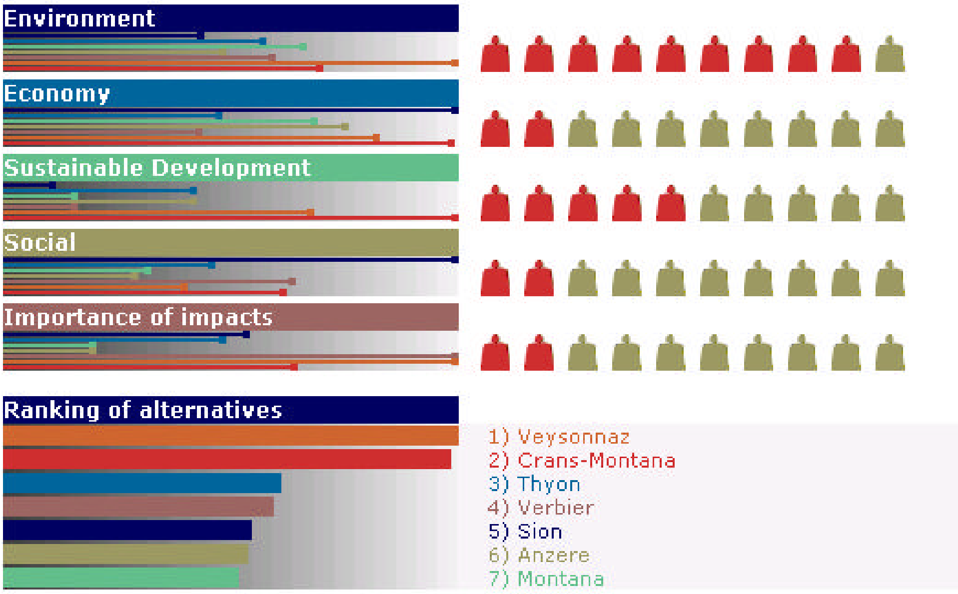

Fig. 8 According to the weights of step 2 Veysonnaz is the best location for the free style slope.

Finally in step 7 the results are visualized with all kind of auxiliary information. Fig. 9 shows for example the surface which has to be cleared to realize the free style slope in Veysonnaz (see the arrows).

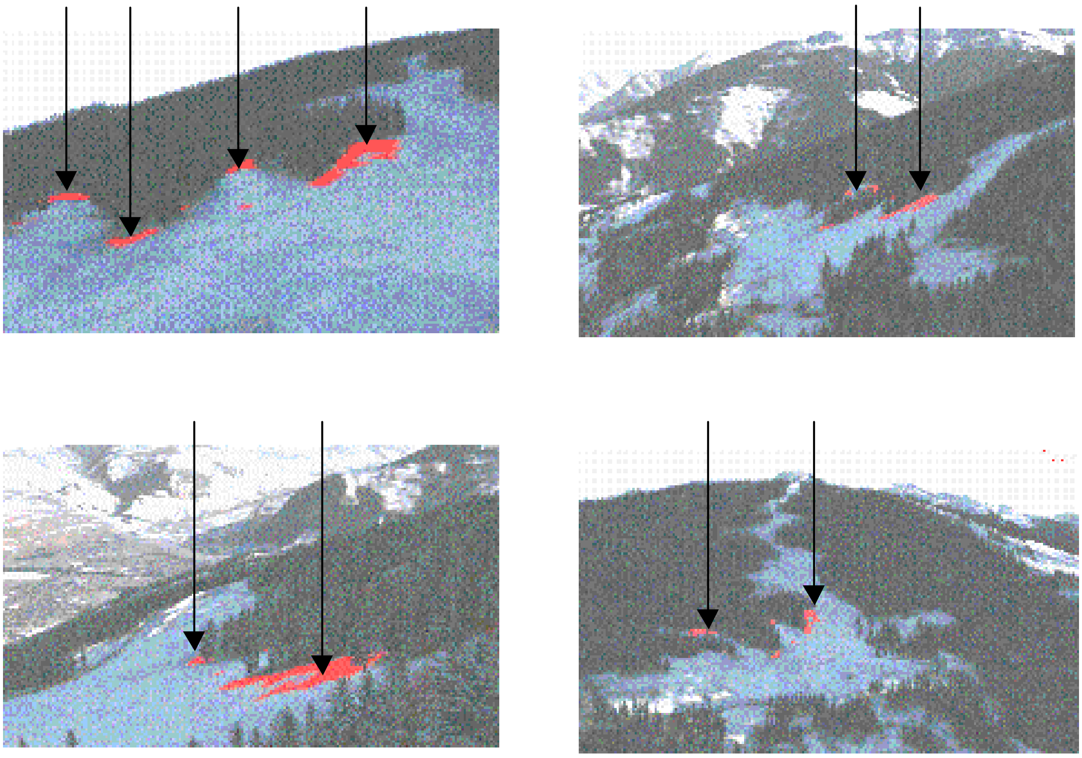

Fig. 9 Virtual pictures of the test site Veysonnaz. The arrows point to the grey shaded areas, which have to be cut for the free style slope. The pictures are the result of the overlay of aerial photographs over the digital elevation model in the foreground and of satellite data in the background.

Conclusions

Sustainable development in ski regions is based on the balance between social, ecological and economical aspects. This complex task can only be treated by an inter- and transdisciplinary process. The involvement of different specialists becomes necessary as well as the discussion with the end user in a participatory approach.
With the CARTESIAN project we hope to contribute to sustainable ski region planning and we are looking forward using the CARTESIAN MIS successfully for the organization of large events as Olympic games or World Championships.

Acknowledgements

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