2ND ATLAS OF SWITZERLAND: INTERACTIVE CONCEPTS, FUNCTIONALITY AND TECHNIQUES

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ABSTRACT

Multimedia-atlases still have a great potential regarding functionality and techniques. Releasing the new *Atlas of Switzerland* (AoS 2) in the first half of next year, we now take the opportunity to present the enhancements of this interactive multimedia atlas. We explain the basic conditions and concepts, as well as we briefly show an overview of the software implementation. The AoS 2 is subdivided into two parts: 2D and 3D. The functionality of the two parts will be discussed in depth, with particularly emphasis on new and expanded features. We also present a number of examples from a pre-release version of the new *Atlas of Switzerland – interactive*.

1. INTRODUCTION

First implementations have proved the basic concepts of multimedia atlases, but their full potential will not be tapped for a long time yet. Data analysis tools, multimedia features or adaptive zooming techniques are still in their early stages. Upcoming editions must show further enhancements with regards to both content and functionality, while not losing sight of the target audience and the requirements of high standard atlases.

This sets the stage for the 2nd edition of the *Atlas of Switzerland* that will presumably be released in the first half of the next year. The first version of the *Atlas of Switzerland – interactive* was released in 2000. This thematic national atlas on CD-ROM consists of more than 250 statistical maps and includes a 3D topography module.

The second edition, which currently is in a stable testing stage, highly extends the themes and introduces new map interaction tools. We present here a summary of its concepts, features and design.

2. CONCEPTS

The target audience of the atlas is broad – from laymen to students and experts, from different regions, with heterogeneous operating systems, and with different needs.

Therefore, the basic conditions are:

- A comprehensible and intuitive GUI that requires a minimum of help; it offers basic functionality on a first level, as well as advanced cartographic and GIS techniques.
- An overall graphics design that is platform independent.
- A multilingual environment; the most important languages of Switzerland as well as English are supported.
- Runs on common operating systems: Windows (98 and newer), Mac OS (Classic and X).
- The diffusion of DVD is still discontenting; the AoS 2 will be released on two CD-ROMs.

The thematic content will be updated and heavily expanded:

- The existing topics (statistical maps) will be updated and slightly enhanced.
- Comprehensive topics from the fields of nature and environment will be added.
- Interdisciplinary co-operation with experts of various disciplines has been mandatory throughout the project.

The unrealised “dual” concept (multimedia and printed version) has been dropped. The new release is a milestone toward multimedia. Every topic will be illustrated with text (more than 600 pages), partly supplemented by pictures and (a few) movies.

The atlas functionality will be refined and heavily expanded.

- The “intelligent map” concept (Hurni, Baer and Sieber 1999) will be refined: base map layers in two map scales, generally more base map layers, simultaneous queries of base map entries and up to four thematic variables, new symbolisation methods, etc.
- The atlas contributes a step towards integration of thematic maps in 3D.
- Using the full potential of the DEM data, many analytical visualisation methods and overlays will be offered.

The drafted functionality and growth of topics make great demands on the implementation strategy. The keyword to manage these demands is modularity. That means among others lean interfaces, modular feature implementation, reduced interdependency between GUI and AoS 2 core, and standardised data description (XML).

3. IMPLEMENTATION ASPECTS

Like most projects of this extent, the software implementation for the AoS 2 is a compromise between existing, general-purpose solutions and specialised proprietary development; following concepts resulted in the actual implementation of AoS 2 (see Fig. 1):

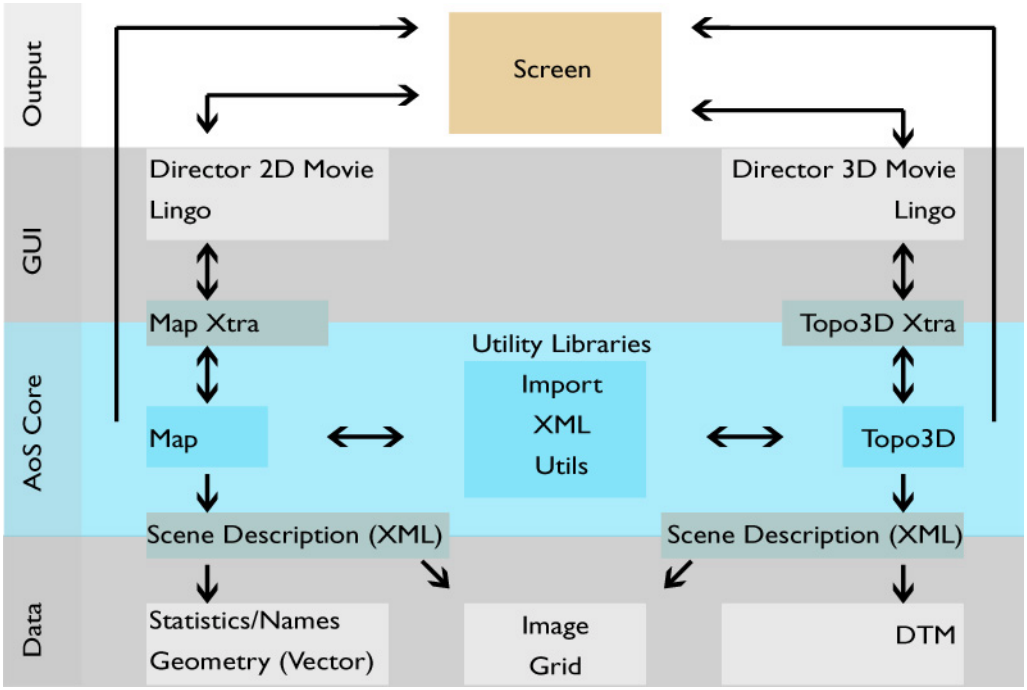


Figure 1. AoS 2 implementation: A modular, layered configuration.

- The solution must run on Macintosh computers as well as on Windows machines. Therefore all code must be portable.
- The implementation follows the overall concept, dividing the functionality into a 2D and a 3D part.
- Solutions for building a functional and attractive user interface on Macintosh/Windows platforms are available, there is no point in implementing this from scratch. As in the first edition, the user interface for the AoS 2 is implemented in Macromedia Director, which provides an open architecture and allows for free design.
- There is no sophisticated atlas authoring software available at this time. Thus, we had to implement the core atlas functionality by ourselves. The concept therefore had to be modular to assure extensibility and reusability. That's why the AoS 2 core consists of several interacting libraries. These libraries are separated from the GUI to provide an opportunity to attach any other user interface. The libraries are coded in C++, thus they are potentially fast and they can be developed concurrently on Mac/Windows.
- Data standards can drastically simplify and improve the data workflow as they allow using various and fully developed authoring tools. Unfortunately other implementation constraints (e.g., encryption) often call for proprietary formats.
- The interfaces between the GUI and the AoS 2 libraries, like those between the libraries and the data description, are kept as lean as possible with strictly defined interdependencies.

4. 2D MAP PART

The 2D map part of the AoS 2 represents the classic form of the Swiss national atlas. It contains maps from over 600 topics and implements the main atlas functionality: thematic navigation, spatial navigation, visualization and analysis functions (Baer and Sieber 1997). Figure 2 shows the user interface.

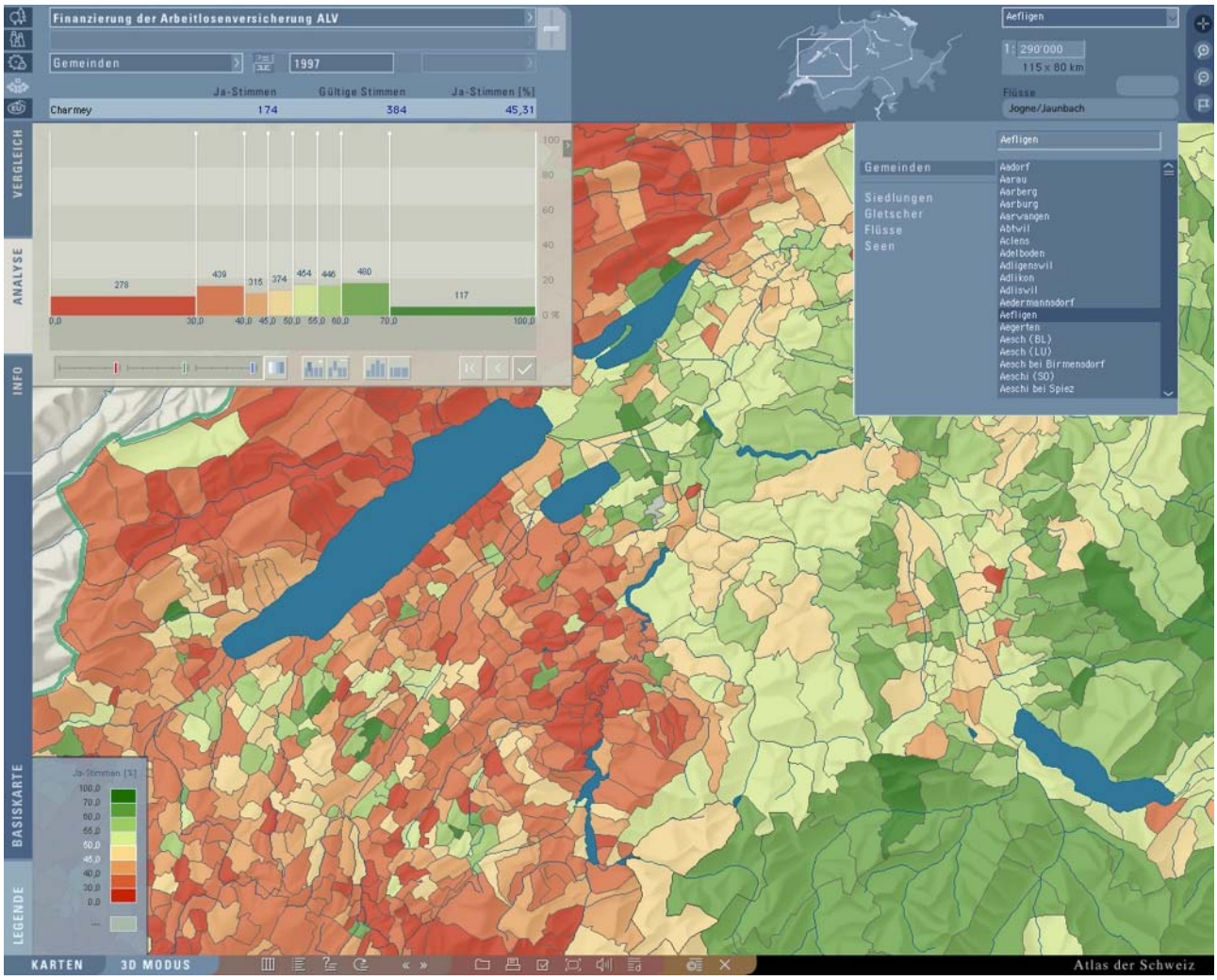


Figure 2. The user interface of the AoS 2 with legend (lower left), analysis tool (upper left) and geographic index (upper right).

4.1 Base Map

The stage for all thematic map presentations in the AoS 2 is the base map, a set of map layers that form the topographic foundation for the thematic views. This base map is built from up to twelve layers that the user can combine arbitrarily. Compared to the first edition, the covered perimeter is enlarged and we introduce some new layers: a satellite map, glaciers and forests.

As described in Cecconi and Calanda (2002), a typical convenience of interactive computer maps is the possibility to zoom adaptively, i.e., maps preferably display more details with increasing scale and generalize at lower scales, otherwise the display might get unfavourable. Automated map generalization is a very complex topic and algorithms thereto are being researched. At this time, this requires the base map layers to be prepared manually in different scales in advance to assure high map quality. Further, the combination of all these layers must be consistent at any scale, e.g., the rivers must fit the subjacent relief. That way over 30 individual base maps in twelve groups were prepared for the AoS 2. The base map can be queried independently from the thematic query; most of the items are referenced in a name database that contains over 8000 entries.

4.2 Navigation

Spatial navigation is of particular importance in every interactive atlas. It must be intuitive, fast, accurate and yet versatile. We kept the small navigation outline map from the first edition. It allows for choosing the map area close to two kilometres. For more precise adjustments the new navigation tools allow to pan and zoom more accurately inside the main map display. Position pins make it possible for the user to store favourite positions on the map and to recall them on demand.

For convenient look-up of cities, towns, lakes and other base map items, a classified index of base and thematic items allows to retrieve objects on the map. This index derives from the same name database as the base map query.

4.3 Theme

"Nature & Environment" was chosen for the theme of the second edition of the AoS 2, following the tradition of Swiss national atlases and according to the social geographical approach proposed for the interactive edition of the AoS 2.

A huge variety of over 600 topics originates from this theme, from classic topics like geology or climate to rather special subjects like future vegetation or avalanche descents. All these data derive from different sources and are available in various formats. This manifests in the following examples of different map types used in the AoS 2 (Fig. 3).

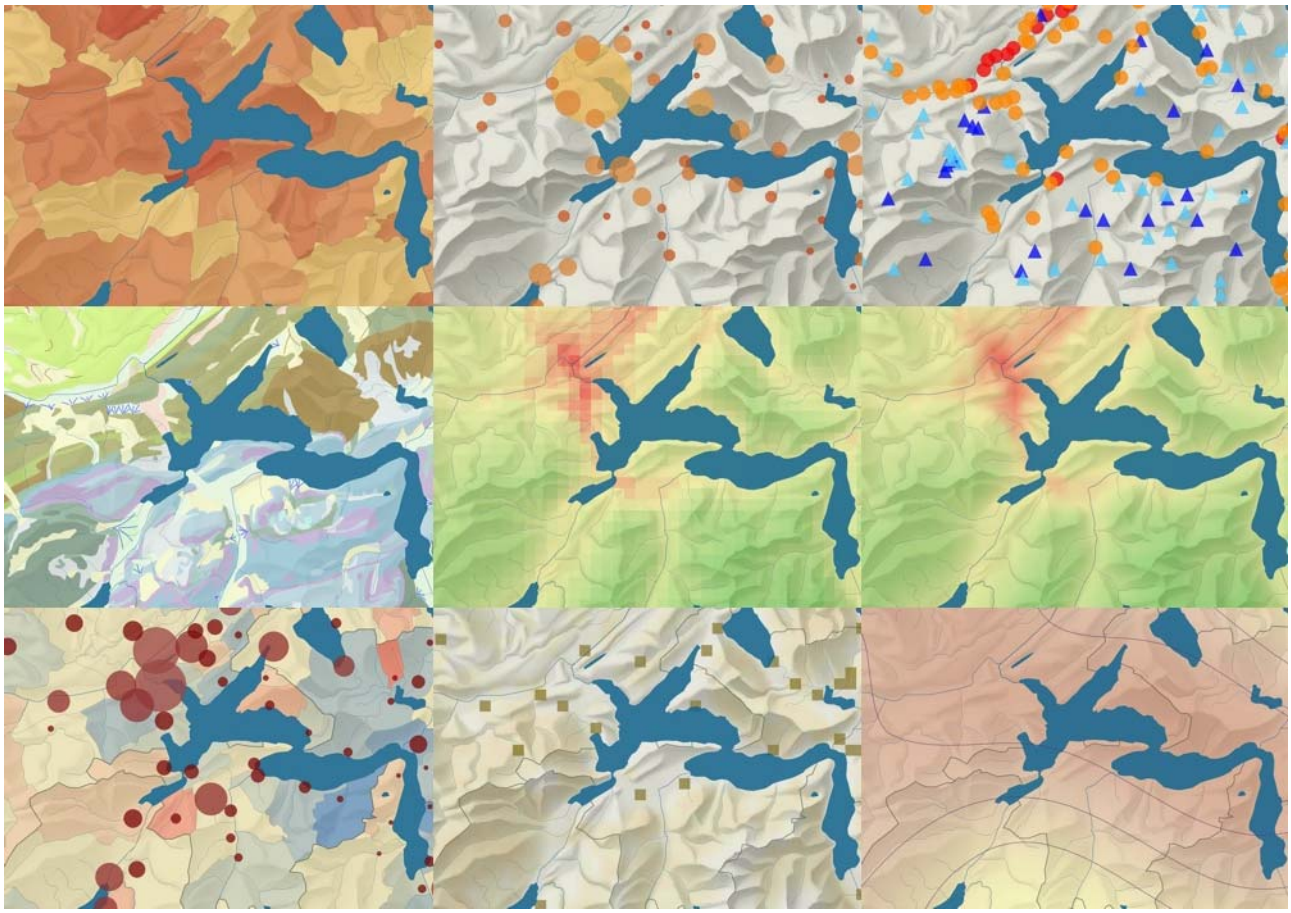


Figure 3. Map types of AoS 2, from top left to bottom right:
a) simple vector map; b) point symbols; c) mixed point symbols;
d) complex vector with line overlay; e) raster data, non-interpolated;
f) raster data, interpolated; g) vector map with point symbols overlay;
h) raster data with point symbol overlay; i) interpolated raster with line overlay.

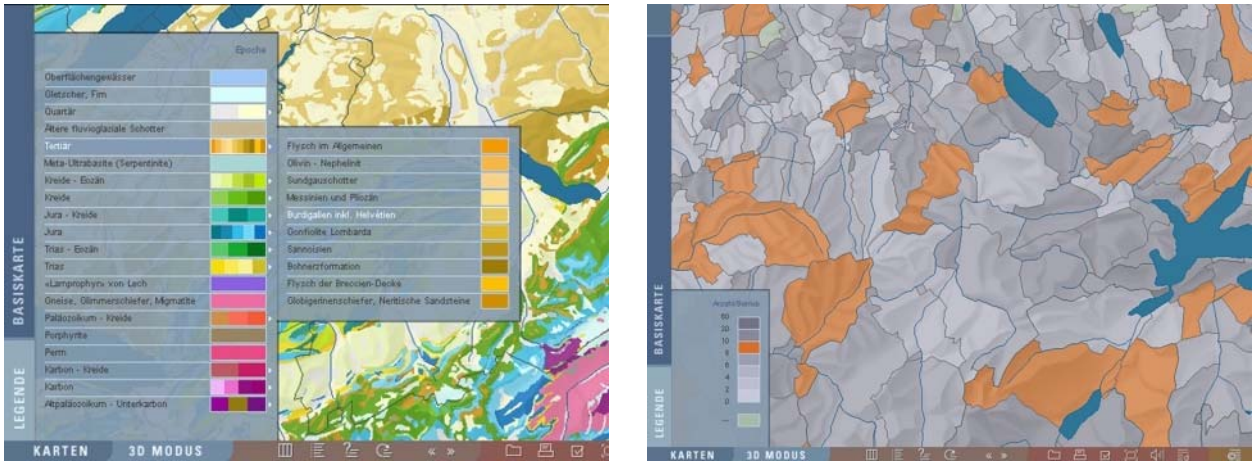
As many of the new data do not refer to administrative units or any other entity easy to define, a major prerequisite to the AoS 2 was the ability to process raster data (Ruegsegger, Schmid and Sieber 2002). Raster data is a common method of storing environmental data, e.g., sample data was collected and interpolated or the data originates from remote sensing imagery. Of all "Nature and Environment" maps, about 60% will be of raster origin. In the AoS 2 concept, raster data can be used interactively, side-by-side with vector data sharing user interface, features and functionalities. With the visualisation parameters, the respective look and feel of raster maps can be adjusted (see Figs. 3f, 3g).

4.4 Interactive Tools

One claim for multimedia atlases is to implement user interaction possibilities and thus advance from mere map displaying towards GIS functionality. This must be done very carefully to not overstrain the average user while at the same time provide a powerful tool to the advanced user.

Here is a short summary of the interactive tools available in the AoS 2:

- *Queries*: All objects of thematic map layers can be queried. They each can provide up to four independent pieces of information on request.
- *Legend*: The legend must adapt itself to the variety of different map types. While mainly designed to display information, the map legend contains a great potential for interactivity, which should not be left unused. From the many possible uses, e.g., altering colours or changing classifications, we chose to mark and point out values or value classes in the map (Fig. 4b). All legend items are also linked to the map query; the entry that contains the queried object's value is highlighted respectively. As a consequence of the increasing map complexity, legends now can be organised hierarchically (Fig. 4a).
- *Comparison*: With the comparison tool it is possible to build a value list in order to visualise and compare values at different locations.
- *Analysis*: The analysis tool enables the user to alter classification and visualisation parameters and thereby implement his/her subjective view on the map. This is the crucial ability for an analytical atlas (Hurni, Baer, and Sieber 1998). Since doing data classification well can be a challenging task, the tool provides some additional helpful information, e.g., statistical values and if possible, a data histogram.
- *Multi-Map*: The combination and comparison of two data sets is a manifest demand for interactive atlases. While simple in theory, implementations prove to be tricky. Side-by-side display, alternating map display or map overlay are just some possibilities, each with its advantages and caveats. For the AoS 2 we implemented the map overlay technique. After adding a second thematic layer to the view, the user can choose which of the two layers he currently wants to interact with. To avoid poor thematic and cartographic combinations, every map that allows overlay therefore provides a list of related topics. The user interface is not affected by this concept; it just displays information of the currently active layer.



a) b)

Figure 4. a) Hierarchical legend. b) Highlighting of a legend class.

4.5 Metadata

Even the most beautiful map is useless if the presented content is not understandable to the user. Thus it is very important to provide additional information with every map to give the observer an understanding of both the basics and subtleties of the map. Here lies the power of multimedia atlases, as they can make use of text information, images, sounds and movies and combinations thereof. Altogether over 600 pages of additional map information were gathered.

5. 3D PART

Atlas users increasingly require cartographic solutions connecting topography (including analytical methods) and thematic information. The range of interactive features has been highly expanded.

The main guidelines for the 3D visualisation tool of the atlas (Topo3D) are:

- High rendering quality
- Interactive querying
- Easy-to-use spatial navigation
- Modular visualisation methods

While improving and enhancing concepts of version 1 of the AoS mainly will achieve the first three goals, the new concept of modular visualisation methods will be introduced here. The Atlas offers two different types of perspective views; block diagram, and panoramic views.

5.1 High rendering quality

High rendering quality can be achieved by high-resolution data and appropriate rendering algorithms. AoS 2 now uses the improved 25 m digital terrain model of Switzerland (DHM25 Level 2, http://www.swisstopo.ch). The border areas outside Switzerland are completed with MONA DEM (http://www.geosys.fr; original grid cell size is 3 arc-second). Multi-resolution representation accelerates the rendering process and improves thematic overlay representation.

5.2 Interactive querying

All 3D data are geo-coded. Interactive querying includes height above sea level and Swiss coordinates, distance from the camera (panoramic view only), names of base map entries, and optionally (depends on the activated modules) thematic information, aspect, slope, and distance from initial point for each pixel on the surface. Available among the base map entries are geographic regions, administrative entities (communes and cantons), urban areas, mountains, lakes, passes, and glaciers.

5.3 Easy-to-use spatial navigation

"Navigation is ... the overall process of motion and wayfinding" (Huber and Sieber 2001). Given that, our high-quality rendering engine is not fast enough for continuous navigation (apart from preview image, see below), motion is, in the majority of cases, discrete and means just "jump". Easy wayfinding demands constrained and intelligible navigation modes (e.g., stable horizon, identifiable relation between initial point and end point) that may be redundant.

The simplest (and most limited) way to navigate is to select a predefined viewpoint from a list. Numerous predefined viewpoints of impressive scenes will be offered. A 2D reference map in two resolutions allows interactively selecting the area of a block diagram or camera position, line of sight, and field of view of a panoramic view. Since the resolutions of the reference maps are limited (2km; about 500m), more accurate numeric input of the parameters is possible.

The preview image mentioned above serves at the same time as an easy-to-use continuous navigation tool. Concerning navigation, two frames of references can be distinguished: exocentric (external view, world-in-hand metaphor), and egocentric (self-view, eyeball-in-hand metaphor) (Ware and Osborne 1990). Exocentric navigation is appropriate for block diagrams, egocentric navigation for panoramic views. A simple mouse handles two continuous degrees of freedom. In the AoS 2, block diagrams can be rotated around two axes whereas the rotation about the x-axis (in world coordinates) is constrained so that block diagrams will never be turned upside down. Panoramic views offer left/right yawing (turn left/right) and up/down panning.

Theoretically, the final image could be used as a navigation tool in the way as the preview image. As continuous high-quality rendering is far to slow, moving (dragging) the 2D image may serve as a replacement as long as the newly rendered image fits to the moved image. For block diagrams (exocentric navigation) only panning in both directions accomplishes the criteria. For panoramic views (egocentric navigation) we can use the same navigation modes as in the preview image: yaw (left/right) and pan (up/down).

Both block diagram and panoramic view support zooming. In the former case, zooming means to shorten respective to lengthen the distance between camera position and block diagram, in the latter case to alter the field of view. A nifty way to zoom in is to select the desired area on the rendered image by mouse.

Finally the *Atlas of Switzerland* provides several sophisticated navigation modes where the user has to select one or two points on the rendered image. Selecting the target on the image defines a new line of sight. Selecting the camera position (and keeping the line of sight) is an often-required feature. In practice the implementation is rather difficult as we must guarantee a certain distance (horizontally and vertically) to the ground, or else the scene will be reduced to few unidentifiable surface faces. Selecting camera position and line of sight on the image is an intuitive way to reposition the camera. As mentioned above the scene can be queried. We take advantage of this feature and introduce the *climber* mode; whereby selecting any point in the area of a mountain moves the camera on the top of this mountain.

A fast continuous rendering engine in order to extend navigation features is currently under evaluation and will not be discussed here.

5.4 Modular visualisation methods

The atlas supports a wide range of visualisation methods (see Fig. 5). Each method will be handled by another module. The user can combine several modules. In order to control the visual effect of each module, the colouring intensity of each module has to be specified. Depending on the module type, additional settings will be offered. We can distinct two groups of methods: Analytical overlay methods exclusively based on the DEM data itself, and overlay methods of external data assign various data to the 3D model (textures).

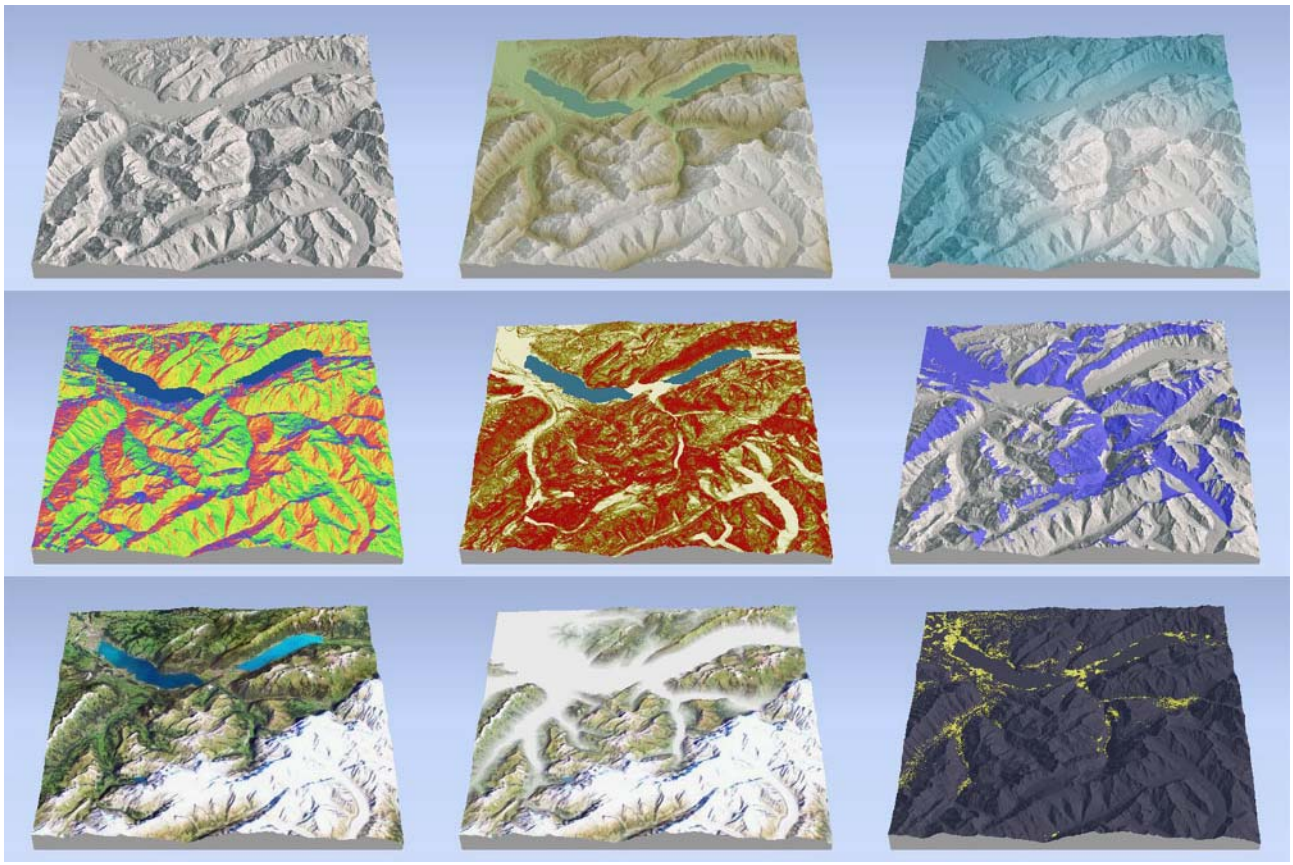


Figure 5. 3D visualisation methods, from top left to bottom right:
a) lighting; b) hypsography (and lighting); c) distance (and lighting);
d) aspect; e) slope; f) visibility (and lighting);
g) satellite map; h) fog and satellite map; i) population per hectare (and lighting).

Among the former group, elevation (hypsography, Fig. 5b), slope (5e), and aspect (5d) are inherent variables, which serve as a basis for further overlay. The gathered overlays can be coloured by the user without restrictions. Additional methods of this group are haze, distance (5c), visibility (5f), fog (5h), and lighting (5a). Haze depends on the distance from the camera position. Distance, and visibility additionally require an initial point, which can be interactively selected on the 3D model. Fog depends on lower and upper bounds with smooth transitions. Finally lighting requires a direction, and a few other light specific and material parameters.

Overlay of external data includes base map data like lakes, or satellite map (Fig. 5g). Numerous themes qualified for 3D visualisation from the subsystems atmosphere, lithosphere, hydrosphere, biosphere and anthroposphere will be available (Fig. 5i). As all methods are modularly implemented, a free choice of any desired combination of modules is possible. The blend of each module is manually adjustable. Some methods demand rather intricate and time-consuming calculations. Therefore a small preview image will be rendered first.

AoS 2 is able to generate terrain profiles (Fig. 6). The intersection path of the profile will be interactively selected on the rendered model. Profile and intersection path are linked; while querying the profile height and base map entries will be shown, and the position on the intersection path will be marked.

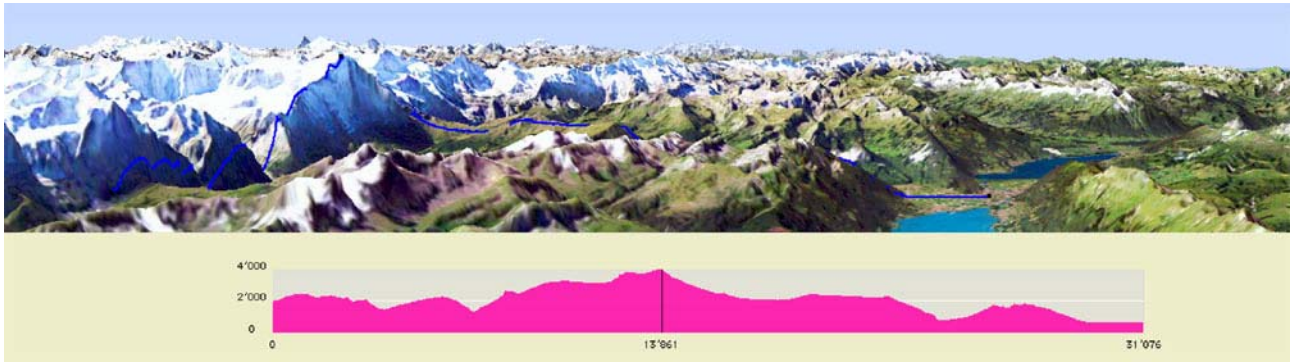


Figure 6. Terrain profile from a panoramic view: intersection path (blue line) and profile.

6. CONCLUSIONS AND OUTLOOK

The second edition of the Atlas of Switzerland puts into practice many requested features for interactive multimedia atlases in a mature commercial product. With its rich, thematically linked content it is on the way to supersede the classical printed edition. The specially tailored libraries are very versatile and extensible and therefore allow for sophisticated interactive map authoring and future functionality improvements.

Plans for future development involve many aspects. Improving the map display quality (anti-aliasing), adding more GIS functionality and consolidating 2D and 3D parts (Huber and Sieber, 2001) are just some of the cartographic concerns. As for development, an augmented use of standard formats (SVG for vector graphics) will facilitate map authoring. More multimedia elements like images, sounds or movie clips will be supplied by the data owners as they get used to the concept of multimedia atlases.

7. REFERENCES

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