

Assessment of standards-compliant Web Mapping Tools for Atlas Creation

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Introduction

Maps of national atlases are valuable resources to be served via the World Wide Web. This paper examines which GIS tools can help map editors and software engineers creating maps for web-based atlases. To assess the tools, we replicated exemplary maps of the Atlas of Switzerland 3. Focus has been put on web mapping tools being compliant to open geospatial standards. Benefits for this are manifold. As atlas data originates from heterogeneous sources, the use of standardized data formats will save time when integrating new materials into the atlas. Even externals might be able to contribute their own maps. This fits well to the concept of Web 2.0. Moreover, atlas systems will not be dead ends anymore. Partners and students will be able to reuse the maps in their own applications.

Background

The Atlas of Switzerland 3 is a digital collection of high-quality 2D and 3D maps. It comprises about 2,000 thematic maps of Switzerland and Europe. Multiple visualization modi are offered for displaying the maps. In addition, simple analyses can be performed. The atlas has been developed in-house as a closed system with proprietary data formats. Graphical user interface and cartographic tools are tailor-made [1]. The downside of this approach constituted in its production time of more than five years.

From 2012 on, an online version of the Atlas of Switzerland is planned. As a visualization engine, a virtual globe will be introduced. For users, a three-dimensional view on the world will be more attractive and navigation will be more intuitive. Cooperations with different institutions - such as the Swiss Federal Office of Topography and the Hydrological Atlas of Switzerland - will be continued [2]. Open standards will be used wherever possible to facilitate data exchange and to concentrate on cartographic relevant features.

Web Mapping Standards

The Open Geospatial Consortium (OGC) and the Open Source Geospatial Foundation (OSGeo) have elaborated a set of standards for publishing maps in the Internet [3] [4] [5]:

- A schema how to store and access geographic data is provided by the *OGC Simple Features Specification*. Many spatial databases implement this standard. Compared to a file-based storage, databases possess several advantages. In terms of atlas creation, a potential gain is the ability to perform analytical GIS-functions.
- Map layouts can be defined according to the *OGC Styled Layer Descriptor* (SLD). SLD itself relies on two sub-specifications: the *OGC Symbology Encoding* (SE) and *OGC Filter Encoding* (FE). SE helps for example to express dashes, color and width of linear features. FE restricts these kinds of rules to a certain subset of the data.
- The *OGC Web Map Service* (WMS) is an interface to access maps via the Internet. WMS-compliant servers render map images based on underlying attributes, geometries and styles. Different types of input and output formats can be chosen.

- Instead of rendering an image each time on-the-fly, map tiles can be cached. This technique accelerates delivering maps to the client and also saves processing power. A prerequisite for this is the mostly static nature of atlas data. As standards the *OGC Web Map Tile Service* (WMTS) and *KML-Superoverlay* as well as the *OSGeo WMS Tiling Client Recommendation* (WMS-C) and *Tile Map Service* (TMS) can be referred to.

Methods

Altogether, 25 web mapping tools conforming to international standards were assessed. Most of them belong to the open-source sector. After having ascertained some background information, we tested each tool in a basic setup. Here, we focused mainly on usability and functionality. We compared key features in a table, noted individual advantages and evident shortfalls. The best candidate of each category is presented below. With the chosen tools, we established a chain to replicate exemplary maps of Atlas of Switzerland 3. At this, we wrote Python scripts which converted our proprietary data into standardized formats. Attribute data and map geometries were stored in a spatial database. Map layouts were transferred into SLD documents. Configurations of web map server and map tiling server were also conducted programmatically. Finally, we embedded the tiled maps in a virtual globe.

Results

From three tested spatial databases, **PostGIS** [6] emerged as the most suitable candidate for the next version of the Atlas of Switzerland. PostGIS is an extension to the open-source database system PostgreSQL. It has been developed by Refractions Research, a Canadian company specialized in geospatial technologies. An advantage of PostGIS is the interoperability with other GIS software. The basis therefor lies in using OGC compliant spatial data types and functions. Data in PostGIS can be handled in a transparent way. This is important regarding maintenance and consistency. Since recently, also raster data support is included. We see room for improvement in terms of user-friendliness, for example in administration. When formulating SQL statements, auto-completion would be helpful.

AtlasStyler [7] and **Styler** [8] are two SLD creators with individual advantages. AtlasStyler is a Java application which originates from a diploma thesis written by Stefan Krüger. Since then, the tool has been developed actively by the author and his team. From all examined SLD creators, AtlasStyler offers the most features. For example, it supports styling raster data and enables advanced labeling. Concerning user-friendliness, Styler is the better candidate in our study. Styler, also known as GeoExt Styler, is part of the OpenGeo Suite. In a web-based interface, multiple filter rules can be combined. Both, AtlasStyler and Styler, allow integrating external symbols. Desirable features for both would be the dependence of visual variables (e.g. orientation) on entire database columns, the inheritance of styles and support of SLD version 1.1.0.

GeoServer [9] is a web map server implemented in Java. GeoSolutions, an Italian geospatial ICT company, and OpenGeo, a division of an American non-profit organization, are its core developers. GeoServer supports WMS versions 1.1.1 and 1.3.0 with SLD extensions 1.0.0 and partly 1.1.0. A graphical user interface facilitates the configuration of general and map-specific settings. Further, a RESTful API is offered. This HTTP interface can be used for example to register databases, layers or styles programmatically. Maps can be previewed straightaway in OpenLayers (see Figure 1) or in Google Earth. One point which could be improved is the error handling. Long, technical error messages appear in the log file and sometimes on web pages.

MapProxy [10] is a map tiling server developed by Omniscale, a small German enterprise. It supports the four main tiling standards WMTS, WMS-C, TMS and KML-Superoverlay. Additionally, MapProxy offers a WMS. It is possible to seed map tiles in advance or to cache tiles on demand. Parameters for both operations can be set in configuration files. When changing these files, they will be reloaded automatically. Our analysis showed that MapProxy has more features than other map tiling servers: It stores identical images just once (e.g. ocean tiles), it allows adding watermarks and results can be previewed in OpenLayers. Furthermore, different sources can be combined and limited to polygon areas. Maps can be resampled and reprojected. From our point of view, an extension of the graphical user interface to administrate the tiling process would be beneficial.

From the analyzed virtual globes, **osgEarth** [11] convinced us most. osgEarth is developed by Pelican Mapping, a small American company. It is programmed in C++ and based on the 3D graphics toolkit OpenSceneGraph. In osgEarth, not only the earth is modeled as geoid, but also the terrain is rendered. This is especially appealing in mountainous countries like Switzerland. In contrast to other virtual globes, it is possible to integrate your own digital elevation model. You can overlay custom imagery, cached locally or imported on-the-fly. In the latter case, services like WMS and TMS can be consumed. For a smooth performance however, local caching should be considered. Despite the complexity, osgEarth has been implemented in clean code in our opinion. As drawback, we found that it is quite hard to compile. Also, the documentation is in many parts not up-to-date.

With the help of the described tools, representative maps of the Atlas of Switzerland 3 have been replicated. Approximately 85% of the current map stock can be transferred in this way. Many properties of the original maps could be preserved. Bézier curves, adaptive zooming and charts were not possible to maintain. Although having tiled the maps in advance, the rendering process took still a long time. However once a map was loaded, navigation and appearance outperform the 3D view in Atlas of Switzerland 3. As illustration, we arranged two nearly identical scenes including some feature data (see Figure 2).

Conclusion & Future work

In this paper, we showed that GIS tools can support the creation of atlases. Especially for publishing maps in the Internet, a series of implementations are available. Interoperability between them is ensured by open geospatial standards. The most suitable tools have been selected to replicate maps of the Atlas of Switzerland 3. Visually pleasing results could be achieved in this way. Next, it is planned to automate the map production workflow as much as possible. Some tools have to be extended or customized for this purpose. For example, atlas-specific functionality has to be added to the virtual globe. Also, the performance needs to be improved. Tiled feature services (e.g. ArcStache [12]) will be examined here to minimize data transmission for vector maps. Lastly, the security aspect of web mapping has to be assessed. Opening up an application to the web carries the risk of data theft and manipulation. Atlases do not own usually the underlying data, so certain protection mechanisms have to be installed. Despite these future challenges, we are confident that the presented web mapping tools provide a stable basis for the next version of the Atlas of Switzerland.

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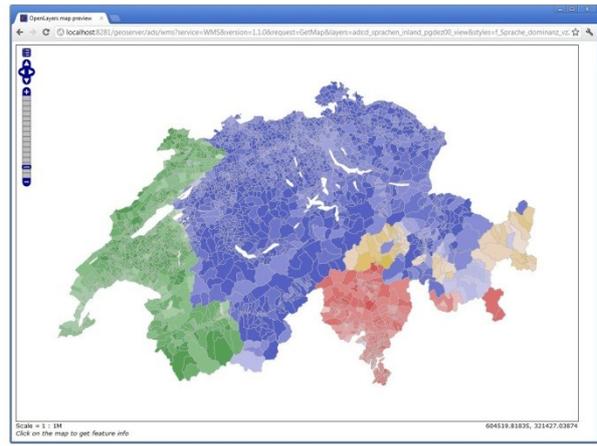
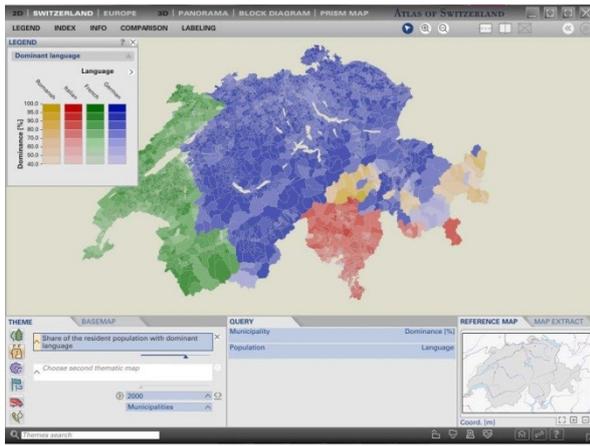


Figure 1: Dominant languages in Atlas Switzerland 3 (left) and web mapping replication with GeoServer and OpenLayers (right)

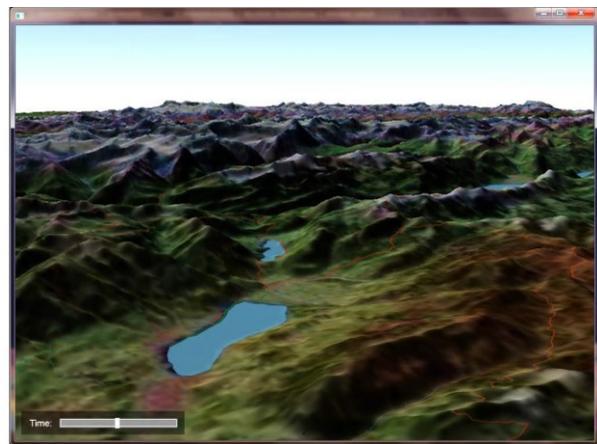
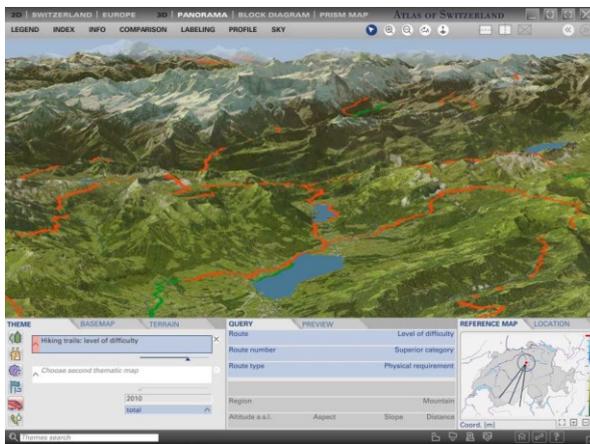


Figure 2: Hiking trails, rivers and lakes in Atlas of Switzerland 3 (left) and web mapping replication with osgEarth (right)

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