

Customizable Map Content and 3D Visualization in the Online Platform GeoVITe

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Abstract. The GeoVITe project led to the development of a Web Platform for geodata visualization and download. As other projects came along, we took advantage of the existent knowledge and built on it new functionalities to reflect new research questions, dealing with new challenges in the Web-based Cartography, such as adjustable map content, online 3D visualization for custom extents from the whole data, visualization of rapidly changing data and time navigation.

Keywords: online 3D visualization, customizable map content, customizable 2D visualization

1. Introduction

The project "Geodata Visualization and Interactive Training Environment" (GeoVITe) aims to offer an easy-to-use online access to the most important geodatasets provided by the Federal Office of Topography swisstopo to the ETH Domain. The platform is available for the download of geodata since 2010 and as a GIS Platform for Interdisciplinary Environmental Research since 2011. In this latter form it is being used by researchers of the Swiss Experiment/OSPER (Open Support Platform for Environmental Research) project ("CCES - OSPER," 2013) working in the environmental domain and therefore many of our requirements for new tools and functionalities, such as 3D on-demand, customizable map content and visualization, are coming from their side.

Nowadays, any free or commercial GIS software may be used for the visualization and the layer management of the available geodata and, moreover, there exist also desktop modalities to create dynamical 3D maps. The challenge is to have these possibilities online, in the browser, without the need to install specific software on the client-computer. In this paper we will describe our approach to customizable map content and 2D and 3D visualizations for the GeoVITe online platform. We will also describe the technical

background and our experiences in developing these functionalities for the platform, so that they can be used and applied to Web-based cartographic products in general, beyond the specifics of the GeoVITE framework.

First we give an overview of the general functionalities offered by our platform, than go into detail for the new developed tools and their models. We conclude by describing our experience in maintaining and updating our system and with a short outlook, that is, by presenting related projects that build on the GeoVITE platform.

2. GeoVITE Basic

The GeoVITE project started in the pursuit of a better solution for the distribution of geodata to the ETH researchers. Thereby we offer a visual, easy-to-use and online accessible option to the traditional file system distribution. Thus, beside the download option, we facilitate the choice of the right data (map product and location), the cutting or the assembling of map sheets for the right extent needed, and finally offering specific services such as reprojection and generation of contour lines from digital elevation models.

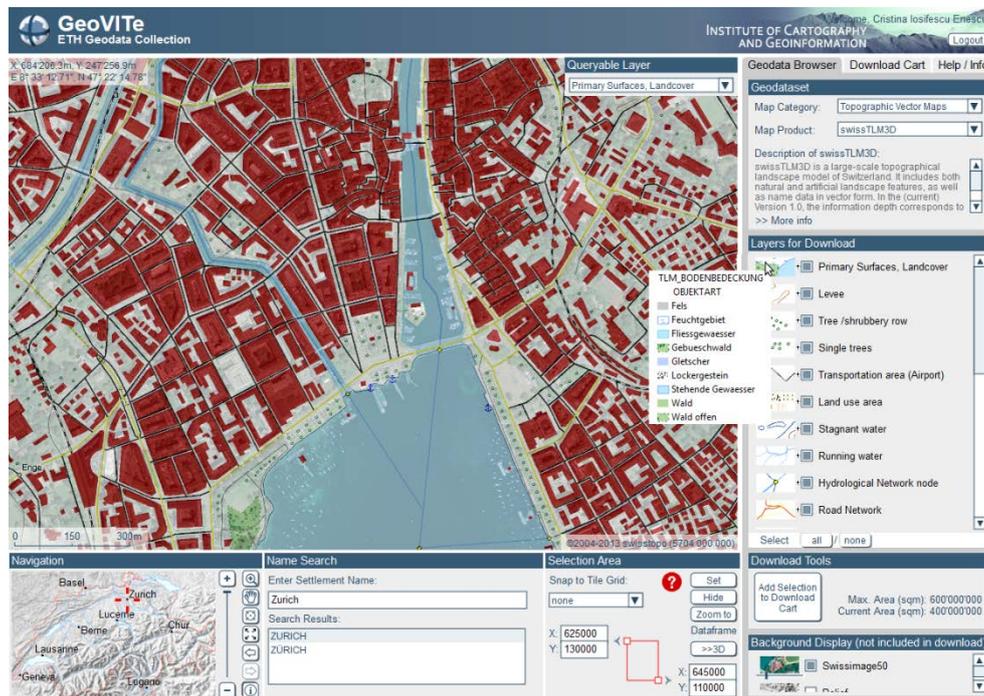


Figure 1. The GeoVITE User Interface; geodata © 2011 Bundesamt für Landestopografie swisstopo (Art. 30 GeoIV): 5704 000 000

We use a three-tier-architecture for our system, that is, a clear separation between data, services and user interface. Geodata is stored in databases, which are accessed by a GIS Server. The user has access only to the graphical user interface (*Figure 1*), which replies to the user interactions by sending requests and listening to responses from the GIS server. The server, in its turn, by means of services, looks for the right data in the database, does necessary processing to it and sends the response back to the user interface. These processes are transparent for the users: they only see that the interface reacts to their commands such as navigating through the different products available, zooming or panning the map, selecting the right area for download, the right projection and eventually downloading the data. In the following, we will have a closer look at these features. For a more detailed description of the entire system, please refer to (Iosifescu, Iosifescu, Jenny, & Hurni (2011)).

2.1. Visualization

For GeoVITe users is the WYSIWYG (What You See Is What You Get) concept very important, because this is the way they can choose the right product for their needs.

Therefore we use the WMS (Web Map Service) GetMap standard, which provides, on request, a georeferenced map image from the original data in the database. For this we created in advance map or image services on the GIS server for each geodata product. When the user navigates, i.e. changes the product, switches visibility on or off, changes the location, zooms in or out, we send WMS requests to the server and display each time the updated map.

By means of geocoding services, the search for settlements' names is provided, which facilitate the navigation to the desired place. Moreover, if the user knows already the coordinates of the region to download, he may enter these in the special fields and automatically navigate to this place. The selection of the extent occurs visually with a resizable rectangle on the map, which we call "dataframe". The overview map informs about the current position and the size of the extent compared to the whole country.

2.2. Geodata selection

We grouped the available geodata products by themes and the user may choose from two nested selection lists in the graphical user interface the desired product. We provide some background information about each product and we refer to the Web Site of the product provider.

A map product may contain more layers and, for each layer, a legend icon is displayed in the "Layers for Download" window. The actual download refers

to the checked layers in this list. Moreover, the user has now the possibility to query the features from a layer on their attributes.

2.3. Download

After choosing the right layers and extent, the users add these to the download cart. There, it is possible to change the format of the data to be downloaded (e.g. GeoTIFF, ASCII Grid (asc), ESRI Shape File, Autodesk Drawing Interchange Format DXF) and the projection (e.g. CH1903/LV03, WGS84, UTM 32N (ED50), UTM 32N (WGS84)); these will be added as parameters to the triggered geoprocessing service, when the user presses on the generate file button.

The geoprocessing service takes between a few seconds and a couple of minutes to execute. This depends on the product type (raster/vector, resolution), extent, respectively on the complexity of the geoprocessing involved (e.g. cutting takes less than generating contour lines). When ready, a link with the download file is provided to the user. This file contains the original product from the database or contains processed geodata that reflects the user's wishes and may be downloaded on the desktop computer and be accessed immediately. We limit the maximal area of the dataframe for downloading for very large products due to higher time needed by the geoprocessing service and bigger size of the download files.

3. Novel functionalities

We noticed that many users employ the GeoVITe platform mainly for visualization of geodata, and not only for download, as we assumed. Moreover, requests from related projects made us consider developing enhanced and more customizable visualization tools. As already mentioned, many of these requests came from the Swiss Experiment/ OSPER (Open Support Platform for Environmental Research) project, which aims at providing a platform for large scale sensor network deployment and information retrieval and exploitation.

We begin this section by highlighting the new implemented functionality that allows users to choose all the geodata they need and combine these layers into a user custom map online on the platform. Afterwards we will present our approach to 3D visualization on demand, followed by the encountered challenges regarding the 2D depiction of sensors, customizable visualization and time navigation.

3.1. Customizable Map Content

The default order of the datasets on our platform is not the most suitable for everyone. When users are more interested in visualization than in download, then a possibility to control which map products or layers from map products, in which order and how transparent these appear on the map is very welcome. Therefore we let people navigate in our structure and, when they find a layer they want to have in their map, they can add it to this. When at least one layer was added, then a new product category appears, named “User Map”. Here, the user is able to control the opacity of each layer and the visualization order (*Figure 2*).



Figure 2. A user custom map may contain for example a vector layer such as buildings, a thematic map such as the geological atlas, a digital elevation model and the airborne orthorectified imagery; geodata © 2011 Bundesamt für Landestopografie swisstopo (Art. 30 GeoIV): 5704 000 000

We implemented this option by taking advantage of the modality we use to feed and configure new map products into GeoVITe. We respect namely a clear structure with parameters for each layer such as legend icon, WMS and geoprocessing services that may be called for this layer, and even additional options which are activated if a parameter is present or not, such as the display of a raster legend or the possibility to change the visualization (for the latter see *section 3.3*).

3.2. 3D on Demand

Another novel functionality on GeoVITe is to visualize the geodata on demand in 3D. In order to cover different user interests, we implemented in our platform two ways of 3D visualization. The terrain data is in both cases automatically chosen from the available digital elevation/surface models, as a function of the scale of the map extent/map product.

The first option is the visualization of the current map extent in 3D, scale-dependent, directly in the browser, using the WebGL technology. The WebGL is a 3D graphics API for Web applications, which extends the HTML Canvas element. The WebGL interactive block image has been developed by Dr. Hans-Rudolf Bär (Bär, 2012) and adapted to our framework by Dr. Ionut Iosifescu.

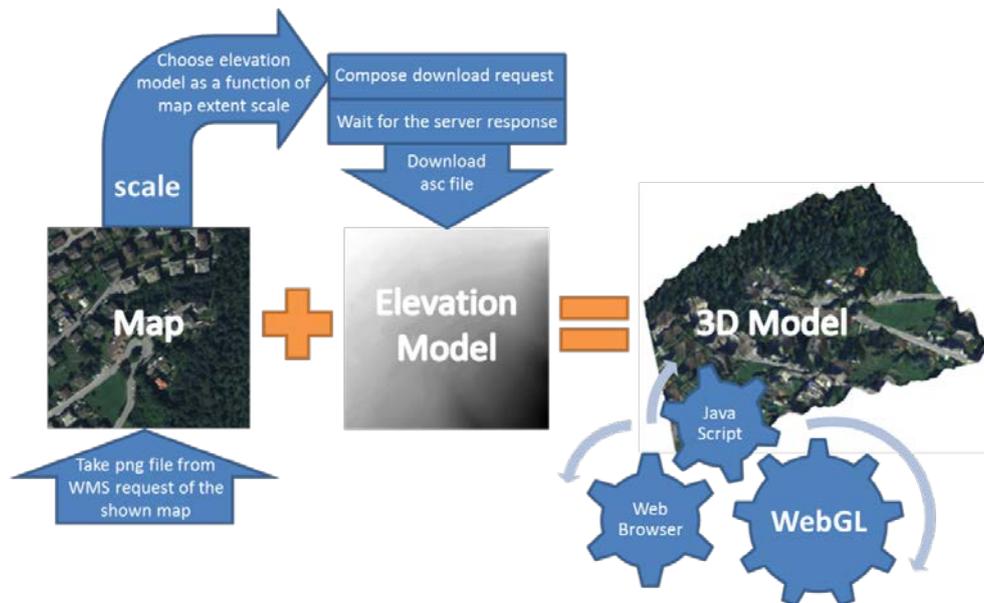


Figure 3. Schema of the 3D visualization in browser using WebGL

This is accessible in the map tab of the graphical user interface through a “3D” button. When the user presses this button, we first get the png file returned by the WMS request which represents the current 2D map (with its visible layers). Then we check the extent of the current map and depending on it we choose the right digital elevation model product. We then compose a geoprocessing service request for cutting the right extent from the original data. When the service has finished executing, it stores the asc file on the server. Then we start the WebGL engine and feed into our framework the two files: the map and the elevation model. The described procedure is also schematically shown in the *Figure 3*. Finally, the user sees a window opening in the map tab, where the 3D model can be checked, rotated, zoomed in and out.

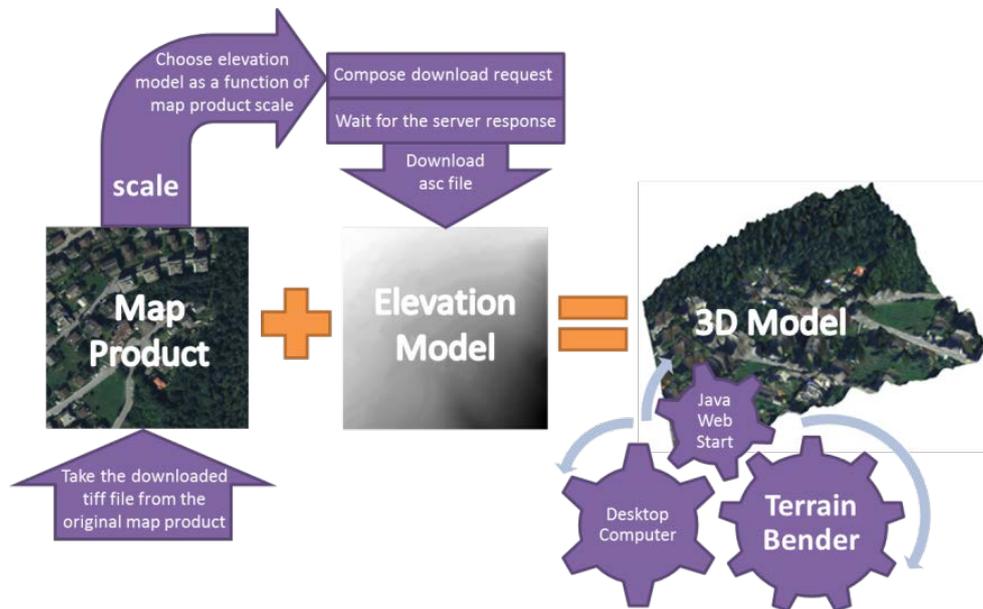


Figure 4. Schema of the 3D visualization with JavaWebStart software Terrain Bender

Intended for users who prefer to download the original data on their computers, we implemented a second 3D visualization option: to download the geodata in 3D. This feature employs a special visualization tool, based on the Terrain Bender software, which is provided in a Java Web Start package. The user will get two different links for raster products: one to download the original raster file and one to download in 3D. In the latter case, both the 2D image file and the terrain data will be downloaded on the desktop computer, along with the Terrain Bender, which we adapted for our platform. Currently, this functionality works with Java on Windows systems. The Terrain Bender (“Terrain Bender,” 2011) was originally developed at our institute by Dr. Helen Jenny and Dr. Bernhard Jenny. The workflow for the “download in 3D” is shown in *Figure 4*, and it is similar to the workflow used for implementing the 3D view in the browser.



Figure 5. Depiction of Matterhorn in 3D (Geological Atlas of Switzerland 1:25000 and the elevation model DTM from swisstopo) with WebGL technology in the Web browser; geodata © 2011 Bundesamt für Landestopografie swisstopo (Art. 30 GeoIV): 5704 000 000

Novel is the fact that both described 3D visualization options are available for the whole Switzerland and on demand for every possible extent (e.g. *Figure 5*). They are not prepared in advance, but generated on-the-fly, as shown in the depicted workflows (*Figures 3 and 4*).

3.3. Customizable Visualization

Data visualization in 2D presented some challenges as well, namely in the degree of visualization customization and the integration of different data into the system. It was required to have no restriction in the type of datasets that may be visualized in the GeoVITe/SwissExperiment platform, as long as they have a spatial component. We made it possible to integrate WMS services from foreign servers and data suppliers and also SVG data generated on-the-fly.

We integrated, for example, sensor data from dynamically updating databases and sensor middlewares such as Global Sensor Network (GSN). For this case, we implemented a tool (*Figure 6*), by means of the Styled Layer Descriptor (SLD), that allows users to customize the visualization according to their wishes (Iosifescu Enescu, 2011). Moreover, for rapidly changing data, such as the wind direction, we built an automatic refresh function, which reads the new data (e.g. angle) from the database and changes the visualization accordingly.

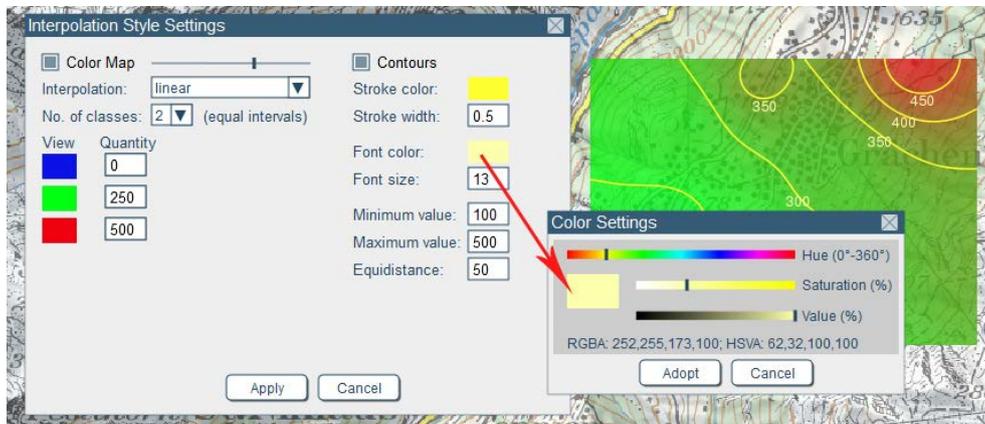


Figure 6. Customizable visualization with SLD (“GIS Platform - Frequently Asked Questions” 2013)

Another example of customization is the visualization of gridded sensor data. Researchers from the OSPER project are interested in visualizing their archive of gridded sensor data. We therefore implemented a time navigation bar (*Figure 7*), which allows the visualization of the available data from the same region at different time points. The steps in time, as well as the general time frame are provided by the data producer. The user may go step by step in the flow of time, enter a date, or jump to an approximate time by clicking on the time bar.

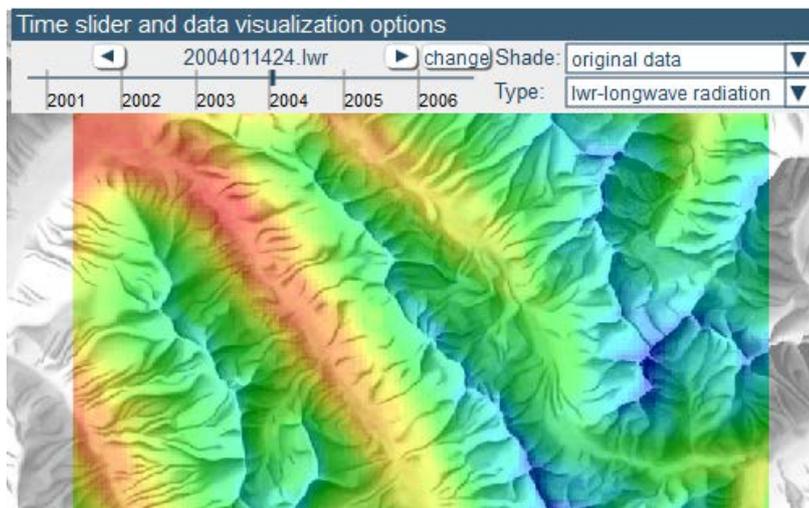


Figure 7. Time navigation

The radar gridded sensor data, which was made available in a georeferenced ASCII grid format, have not been visualized by the means of a service-driven cartography, but rather native in the browser.

A rendering technique, developed in cooperation with Dr. Jiri Kozel (Masaryk University, Brno, Czech Republic) during a stay at our institute, renders on-the-fly each raw data file into a SVG fragment and assigning for each raw value a certain color from a customizable color scale. We used this technique to automatically render the raw data from the server to the user-friendly visualization of data as SVG on our platform, refreshing each time the user goes a step forward or backward in time. We therefore had to integrate the new type of data into our framework, which previously only worked with service-based WMS requests.

4. Conclusion and Outlook

In the following we briefly describe our experience in providing, developing, updating and maintaining a useful online service for an expert community. Finally, as an outlook, we mention other on-going research projects based on the GeoVITe platform.

The GIS Platform is being used by researchers from different areas. They produce various types of data, which they need to visualize and to customize. This is a challenge for us and we are each time searching for new developments in the Web technology and try to integrate the most feasible ones into our platform in order to meet the requirements. This is how we came to functionalities such as the 3D visualization, loading of SVG data, time navigation, etc., which we previously described.

Being settled in a research community, one of the most difficult parts is the update of the available basis geodata, because of the lack of funds for a larger database. Other problems are related to the technology we use for the server side, because new commercial server software sometimes does not grant the compatibility with older versions. Therefore it is a challenge to decide which software to use for the system in order to last for a medium period of time (4 to 5 years) and we tend to migrate to opens source software, where the backward-compatibility is treated fairer. For example, for the GIS platform of the SwissExperiment project we have migrated from ESRI services to a completely open solution based on QGIS mapserver and custom geoprocessing services based on the GDAL library¹.

In addition, the GeoVITe platform is a good starting point for other projects and, besides SwissExperiment/OSPER we want to mention two more at our institute: GeoIDEA.ro and GeoHistory. The GeoIDEA.ro (GEodata Openness Initiative for Development and Economic Advancement in Romania) project aims to improve the scientific basis for open geodata model adop-

¹ <http://gdal.org/>, accessed 25 March 2013

tion in Romania. Its main objective is to implement a geoportal allowing the access to geodata in a usable format and under an open license (“GE-OIDEA.RO - About us,” 2013). The GeoHistory project aims at offering an easy way to get online access to historical maps, mainly of the Canton of Zurich (17th-20th cent.). Its main objective is to facilitate the comparison with modern raster and vector data, therefore making possible to observe and study the changes which took place in this area over time (“GeoHistory - About us,” 2013).

We conclude with the remark that, by granting certain flexibility and taking user suggestions into account, we do facilitate the communication between different research areas and allow researchers to focus on their own areas of expertise.

5. Acknowledgements

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² http://www.innovedum.ethz.ch/index_EN/, accessed 25 March 2013

³ <http://www.cces.ethz.ch/>, accessed 25 March 2013

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