OpenSchoolMaps: 2 What is Geodata solution

OpenSchoolMaps.ch — Free learning materials for free geodata and maps

A worksheet

Geodata and spatial reference

In the last chapter you learned that the data presented in a GIS is spatial data. These spatial data are often called geodata.

❗ *Task 1*
As an introduction to this chapter, consider what the terms geodata and spatial might mean. Think also of other words with the prefix geo (e.g. geography, geology etc.). Do not look up the words on the Internet or in a lexicon. Write your thoughts on your worksheet.

Learning objectives of the theory

After this chapter, you will be able to:

- Explain the terms "geodata" and "spatial reference" in their own words.
- Distinguish raster data from vector data.
- Explain the benefits of coordinate systems.

Theory

Geodata

The prefix geo comes from Greek and means earth. Geodata must therefore be data that is related to the earth.

Spatial reference

A spatial reference can be interpreted in such a way that an object can be assigned to a place on earth. There are two different types of spatial reference. If the spatial reference is indicated by measured two- or three-dimensional coordinates, for example in the official cadastral survey, then one speaks of a direct spatial reference. In the area of official statistics, however, the coordinates for positioning information in space do not have to be so precise. There, the information is often linked to generalized administrative boundaries such as cantonal borders. In such a case, the term indirect spatial reference is used.

Imagine you have a mobile phone or a camera with a built-in GPS, which you can use to determine

the position where you are standing. If you now take a photo, the coordinates at which you took the photo can be saved in the digital image. So the photo has a spatial reference.

Georeferencing

Objects without a spatial reference can often be assigned a direct or indirect spatial reference. This process is called "georeferencing". With postal addresses the spatial reference can be calculated through "geocoding". Of course, the spatial reference always refers to an earth image, i.e. a coordinate system. These coordinate systems were introduced in order to be able to indicate the geographical position of a place on earth in numbers. You probably know the different coordinate systems from geography lessons. If you would like to refresh your knowledge in this area, you can do so with the help of the "Maps" guide program. This guide is available on the EducETH server under the link http://www.educ.ethz.ch/unterrichtsmaterialien/geographie-umweltlehre/karten-leitprogramm.html .

Type of data storage

Geodata can be stored either in the form of raster or vector data. What does this mean more precisely?

Raster data

When you look at digital photos on your computer, you look at raster data.

❗ *Task 2*
To get to know the most important properties of a raster image,open the image Testfoto.jpg, which is located in the folder with the data for this guide program, in a graphics program. Then answer the following questions. Do not go any further until you have answered the questions.

- *What happens to the picture if you keep zooming in?*
- *How are the objects displayed in the image saved?*

Raster data can be imagined as if, for example, a regular grid was laid from above over the landscape to be displayed, dividing the section into many equally sized cells, also known as pixels. In each pixel the color value is stored, which best represents the underlying colors. The number of pixels per unit is also called point density or resolution. An often used unit for dot density is the term dpi (dots per inch). 1 inch corresponds to 25.4 mm. Thus, for example, a resolution of 72 dpi means that 2.83 dots per mm are stored. For comparison, 11.81 points per mm are saved at a resolution of 300 dpi.

Information can be saved for each pixel. This can be a gray or color value as for example with photos or pixel maps (as you will get to know them in the exercise) or numerical information as for example a measured value. Take a look at the map with the snow depths on the homepage of the Institute for Snow and Avalanche Research (SLF) as an example for grids from measured values: https://www.slf.ch/de.html

Vector data

The vector data includes, for example, the shapefiles you used in the first exercise. With vector data, the geometry of the objects is saved as points, lines or areas, where one line is defined as the

connection of two points and one area as a closed line. Further information about the object, so-called attribute data, is stored in a table in addition to the geometry.

Comparison of vector and raster data

 *Task 3*
Now imagine that you want to represent a building in a GIS. Once the building is saved in the form of raster data and once in the form of vector data. What does the house edge look like with the raster data and like with the vector data, if you zoom now completely near to a house edge? Record this on your worksheet.
Think about which format (raster or vector) needs more space.

Metadata

Metadata, i.e. data about the data, is also always stored with the geodata. Information about the spatial extent, the creator, the quality etc. of the data can be noted in it. For example, if you work with data from an external source, you can check where the data comes from and whether it really contains what you need.

Web Map Services

More and more providers have data stored on a server and offer other users excerpts from this data as maps via special interfaces, so-called Web Map Services (WMS), via the Internet. This allows users to integrate these maps into their GIS projects. However, it is important that there is always a connection to the server on which the data is stored. For example, if you no longer have an Internet connection, the map is no longer accessible in the GIS project.

The CRS (coordinate reference system) should already be set correctly in our given project. If you still want to know how to change the CRS, you can read the following optional chapter.

Map Projections

In GIS, projections are usually specified with an EPSG code.

QGIS has some useful tools to search for specific projections. QGIS can project the CRS for a project in real time.

To change the CRS of a project, you can click on the EPSG code in the status bar and select a new CRS.

Projection of a layer

To specify a specific CRS for a specific layer, right-click on the layer and move the mouse pointer over the *Set CRS* menu and select *Set Layer CRS...*. Then you can select the desired CRS.

Re-projecting the data

To re-project the data in your table, just right-click the layer name, click *Export* and select *Save Feature As...*. In the upper part of the window you can change the CRS.

If you are not sure which EPSG code to use, you can look it up at http://spatialreference.org/ .

QGIS Exercise

In the theory part you learned a lot about vector and raster data. In this exercise we want to create a new GIS project and load vector and raster data into it.

Learning objectives

After this exercise you will be able to do the following:

- Choosing the right coordinate reference system for a new project.
- Load vector data and WMS services into the project.

Project settings

To open an empty project, either close and open QGIS again or click the "New Project" button. Now you want to load geodata into the empty project.

However, before loading data, the coordinate system of the project should be defined. To do this, press the *Current CRS* button in the lower right corner of QGIS. With the filter you can then search for the desired coordinate system.

The following coordinate system are used for Switzerland: The EPSG:2056 (CH1903+/LV95) and sometimes still CH1903 /LV03 (EPSG: 21781).

Select the default system using the search function and confirm the setting by clicking on button "Apply" .

Then go under *Project* → *Properties* to the tab with the name General, set the project title "Switzerland" and define a background color.

Under "Save paths" you can choose whether the paths should be saved relative or absolute to the data. The advantage of the relative paths is that you can copy the folder with the QGIS project and the data to another location without having to adjust the whole paths to the data. So choose the "Relative" option for your new project.

Then close the Project Settings window by clicking the "OK" button. In order for the new background color to appear, a navigation function such as Move map must be executed in the map window.

Save project

Use the *Save Project* button to save your new project to the folder where you saved the data for this exercise.

Import data

The map is now ready to read data. The menu "Database" in the menu bar is used for this purpose. For the different types of data that can be read, it also has different buttons.

Import vector data

The first step is to import the vector data from the first exercise. Click on the tab GeoPackage, if you don't see the tab introduction_in_qgis_data.gpkg, right-click on GeoPackage and navigate to the tasks folder for part 1. If you see the database, open the tab and use right-click and choose "Add to map" to add canton borders and lakes to the map.

Select the cantonal borders as background for the map overview. If you don't know exactly how to proceed, check again in the first exercise.

What information is stored in the two layers at all? Let's take a closer look at this. Click with the right mouse button on the layer lakes and choose *Open attribute table*. The table will open with the thematic information about the lakes. Which information was saved as attribute?

 *Task 4*
Take a close look at the table and write down what data each column contains.

 *Task 5*
Do the same for the cantonal borders.

Read raster data

The raster data are to be read in in the form of a WMS layer. Do you remember what a WMS layer is? If not, check again in the theory part.

The Federal Government offers an overview of the available WMS services on its homepage (http://www.geo.admin.ch under Services → Geoservices → Presentation services → Web Map Services).

Under the title "Available WMS Services", "GetCapabilities" stores the requests in the form of links. For example, if you click on the link http://wms.geo.admin.ch/?REQUEST=GetCapabilities&SERVICE=WMS&lang=en , a request to the server http://wms.geo.admin.ch/ will be started and you will receive a list of available WMS services in response.

Under *Title* you will find the title of the WMS service and under *Abstract* a short description of exactly what is stored in the data. In addition, information about the extension and the possible coordinate systems is also available.

From these data we would like to integrate the overview map into our project. Select the tool *Add WMS/WMTS Layer* in the toolbox *Manage Layers*. If you click on the arrow in the top bar of the *Layers* tab, you will see that some servers are already included by default. To include the server with the public data of the *Bund Geodaten-Infrastruktur* (BGDI) as well, a new WMS connection must be created. To do this, click on the *New* button. In the *Create a New WMS/WMTS Connection* window, enter the name of the connection (e.g. WMS-BGDI) and the URL to the desired server (in our case http://wms.geo.admin.ch/). Username and password are not needed in this case.

If you now click on the arrow of the first bar again, the newly created connection should also appear. Select it and click *Connect*.

Now all WMS services that are publicly offered on the BGDI server are displayed. Click on the *overview map hydrogeology* and select "overview map" as layer name and change the coordinate reference system from WGS 84 to the Swiss reference system CH1903 / LV03. The easiest way is to select the filter and enter CH1903 as text. The desired system will appear in the selection. Then you can add the WMS layer and close the window.

The layer order must be adjusted so that the overview map in the map window does not cover the cantonal borders and lakes. Think of a suitable order and apply it.

Comparison of raster and vector data

At the end of this exercise you should take a closer look at the differences between vector and raster data.

 Task 6
To do this, fade out the layer with the cantonal borders and zoom to any lake. Zoom in on the shore area and observe what happens with the sea borders in the vector and raster data and what the differences are. If not both borders are visible, you can show or hide the lakes to see the raster data below the lake layer. Write down your observations in your own words.

Save your project. In the next exercise you will continue working with the same project. But first you have to pass the chapter test.

Chapter test 2

Here we go again. You have reached a chapter test again. Put all documents away again, except a sheet of paper and a pen. Here are the questions for chapter 2:

Question 1

You want to represent a wall in your GIS that looks like two lines meeting at an angle of 135 degrees when seen from the air.

What's the picture if you're choosing

1. the raster format
2. the vector format

as the storage format? What is stored in the individual formats of the wall?

Answer the questions in your own words. In addition to the description, create a sketch of the wall in raster and vector format.

Question 2

Chapter 2 often referred to geodata.

What does the term geodata mean? What is the difference between geodata and other data?

Answer the questions in a way that they can be understood by a GIS layperson. So don’t use technical terms.

Question 3

In the exercise section you have loaded a WMS layer into your project in addition to vector data.

What is the difference between the vector data layer and the WMS layer regarding:

- Format
- Storage location
- Availability

Write at least one sentence for each point.