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GOSTEAM Hands-on Activity Template *(Classroom-Formal)*

Title:

Work with digital elevation models (DEM) for a selected area - download, project, clip, and visualize in 2D and 3D views

Short Description (Max 500 words):

A. To download a digital elevation model (DEM) for a selected area directly from the QGIS program.

B. Apply tools such as Project and Clip to the DEM data

C. Visualize the DEM data in 2D and in 3D view

Keywords (Up to 5):

DEM, gridded data, projections, clip raster, visualization

Information about the Implementation

Age and language of the students: 9-12 12-15 15-18 18+

Language: English Age: ☐ ☐ ■ ☐

Number of Lessons – Duration (per lesson):

Number of Lessons: 3 Duration per Lesson: 45

Subjects:

For which subject(s) the activity is usable, is it an interdisciplinary activity?

Science ☐

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Physics ☐ Chemistry ☐ Biology ☐ Geosciences ■ Environmental ■ Other ☐

Technology ☐

Engineering ■

Arts ☐

Mathematics ☐

Information about the Scenario

Curriculum and country:

Link of the current activity to the curriculum:

Country: Sweden | Class: geography | Grade: 10-12

Topic: Data types, Cartography

Objectives (Max 100 words):

Description of the learning objectives

- Knowledge of how elevations are stored in a raster data model.
- Knowledge of how to manipulate raster data with reprojection and clipping.
- Know how to use raster data models to visualize continuous data as hillshade or in Pesudocolor.

Materials (Max 100 words):

Which resources and materials (software, hardware) are needed?

- Computer with internet connection
- Software: QGIS

Spatial concepts, skills and abilities:

Which spatial concepts and skills are covered by the activity?

Spatial concepts:

Primitives: Identity/Name ☐ Location ■ Space/Time ☐

Simple: Distance ■ Direction ☐ Connectivity ☐ Movement ☐

Boundary ■ Shape/Area ■ Adjacency ☐

Difficult: Overlay ■ Buffer ☐ Topology ☐ Coordinate ■

Map ■ Scale ☐ Shortest Path ☐ Navigation ☐

Surface ■ Slope/Gradient ☐ Aspect ☐ Contour ☐

Complex: Interpolation ☐ Map Projection ■ Spatial Dependency ☐

Other:

Spatial skills:

- ■ Map literacy
- ☐ Navigation/orientation
- ☐ Estimating distances and directions
- ☐ Recognizing and understanding patterns/Understand and identify models of spatial organization
- ■ Select an ideal location based on the given spatial features
- ■ Visualization
- ☐ Understand and identify spatial correlations/ dependencies
- ☐ Categorize spatial entities/ geographic features and identify hierarchies
- ☐ Compare spatial entities and draw analogies among them
- ☐ Identify/determine connections/relations
- ☐ Understanding scale in space and time
- ■ Delineation of spatial regions/ zones based on given features/ properties

Short Description

Navigation/orientation: Finding one's way in unfamiliar environments, interpreting and giving walking and driving directions.
Estimating distances and directions: Measure paths, weighted distances, angles.
Map literacy: Using, interpreting/understanding, learning from, and communicating acquired spatial knowledge from maps, comprehension of geographic features represented as points, lines, or polygons.
Recognizing and understanding patterns/Understand and identify models of spatial organization. Delineation of spatial regions/zones based on given features/properties: Regionalization processes, pattern recognition and clustering identification in the 2d and/or the 3d world.
Select an ideal location based on the given spatial features: Single or multi-criteria siting and optimal areas identification.
Visualization: Visualizing spatial entities from written/oral verbal descriptions, from their 2d or graphical representations or through mental transformations; such as axis rotation or perspective taking.

Understand and identify spatial correlations/ dependencies: The ability to realize, identify and explain patterns, clusters and relevant spatial dependencies.
Categorize spatial entities/geographic features and identify hierarchies: Identify the hierarchical form of data and gradients between spatial entities.
Compare spatial entities and draw analogies among them: Calculate and compare different geometric objects' shapes, area and, boundaries.
Identify/determine connections/relations: The ability to identify links and common characteristics among spatial entities and between humans and spatial entities.
Understanding scale in space and time: The understanding of changes/transitions through space and time for different spatio-temporal scales.

Geospatial concepts and spatial abilities documentation (see Section 3.2):
http://www.gosteam.eu/wp-content/uploads/2021/05/GOSTEAM_IO1_A1_final.pdf

Description of the activity in detail

Classroom activities

Introduction

This activity was created with version 3.16.10 (Hannover), but will also work with earlier versions of QGIS 3.x. However, if you are using a version after 3.16.10, some of the menus, commands or plugins mentioned in this activity may work differently, have a different name, are no longer available or have been replaced somehow.

Steps to download digital elevation model (DEM) for a selected area.

1. Prepare the QGIS plugins

Open your QGIS program.
Activate the QuickMapServices plugin. If you do not know if it is installed on your computer, go to the *Plugins* menu, select *Manage and Install Plugins*, then search for "QuickMapServices". Install it if necessary.

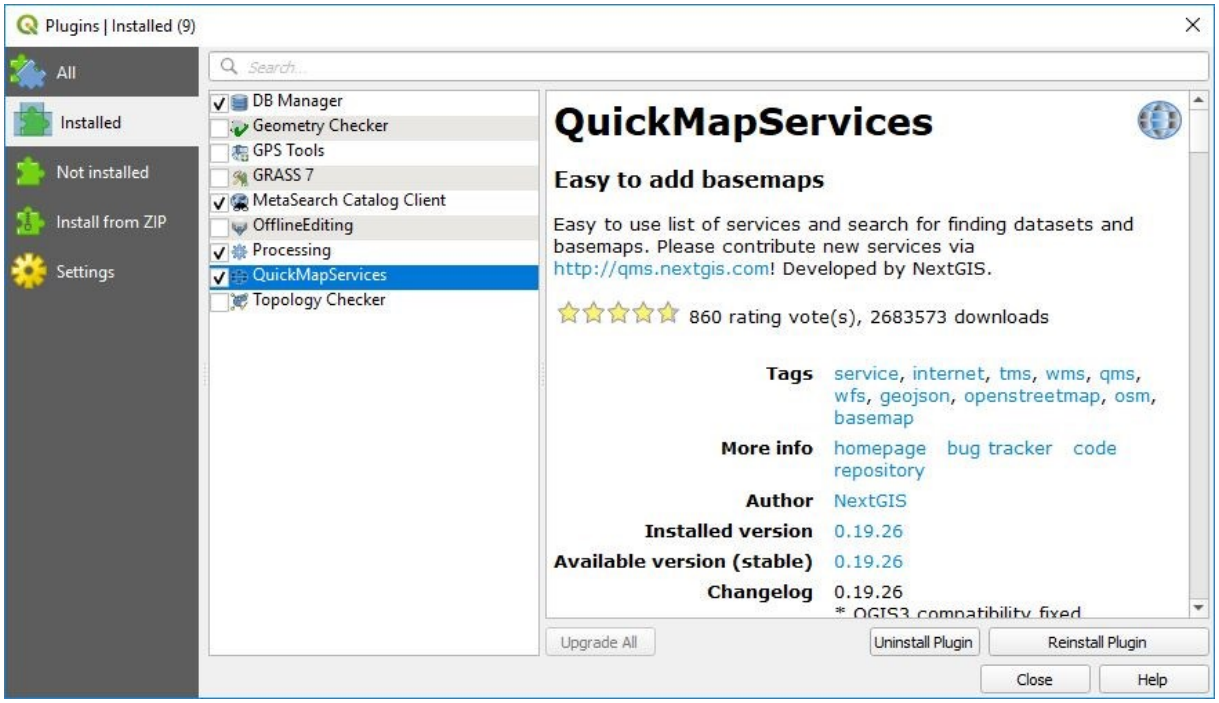


Figure 1. Installed plugins in QGIS

Go to menu Web → QuickMapServices → Settings, and on the *More Services* tab, click on the button "*Get contributed pack*". This will update the list of services that provide useful maps for your QGIS software.

Open the menu Web → QuickMapServices → OSM → OSM Standard. The *OpenStreetMap* world map should appear.

Let us zoom in to the area of interest. The idea is to choose an area of more or less 30 km by 20 km, with some rivers. Below, the example will use data from southern Sweden.

Therefore, change the coordinate system of the project to EPSG: 32633 (WGS 84 / UTM zone

33N): go to menu Project → Properties, select *CRS* and filter by "32633" to quickly find and select such a coordinate system. The project will then be updated to show this change.

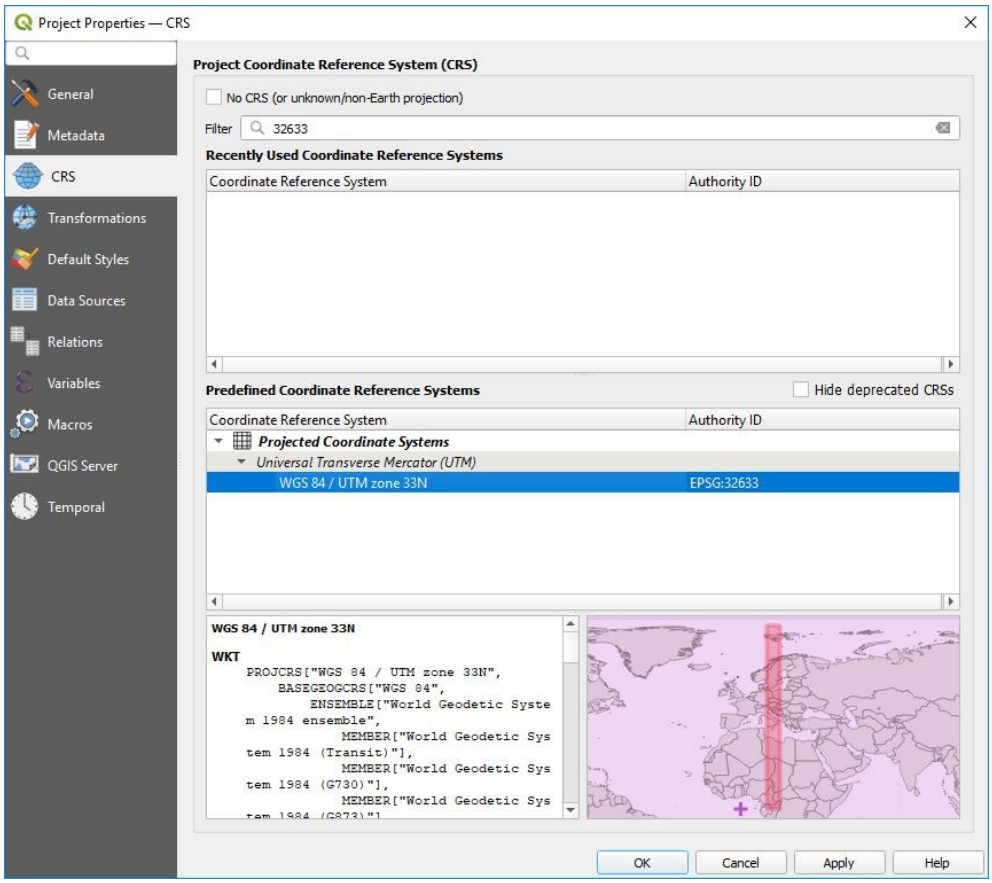


Figure 2. Coordinate reference systems (CRS) in QGIS

Note: If you want to continue the activity with a different area of the globe, find the appropriate zone or your preferred coordinate system.

2. Obtain a DEM for your area of study

Move and zoom the OSM map so that your screen shows the region of Malmö, Lund, and Malmoe Airport. The region is located in Skåne county in the south of Sweden (see figure where the names of the cities are highlighted):

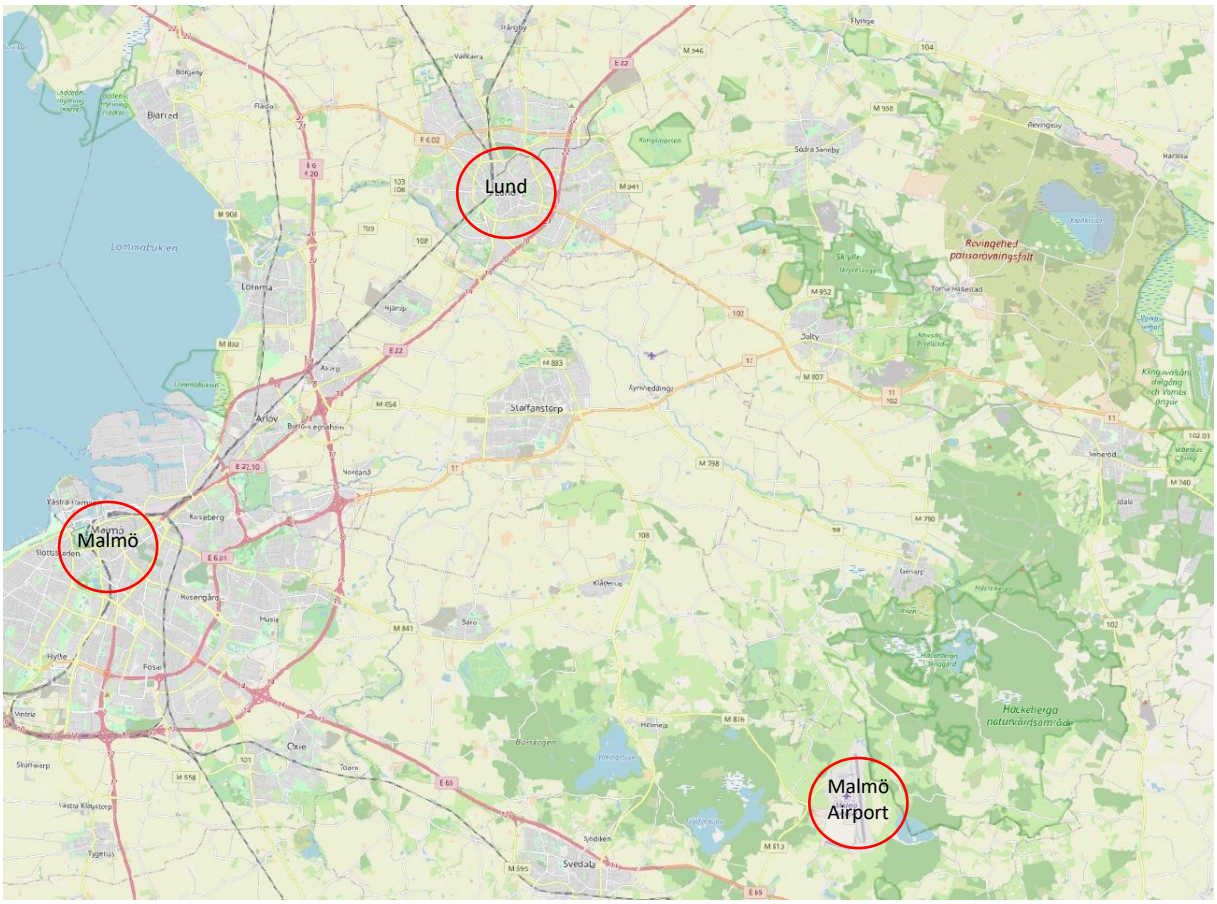


Figure 3. approximate area to download a DEM

We obtain the SRTM (Shuttle Radar Topography Mission) DEM from an area near the above image. It allows downloading the SRTM tiles with 30 m resolution from the server NASA for our study area.

Go to menu Plugins -> Manage and Install Plugins and find the SRTM Downloader plugin. If you have not already installed it, please do so. Once it is installed, click on the button with the tooltip SRTM Downloader or go to Plugins -> SRTM- Downloader -> RTM Downloader.

Write the following extent limits:

	North: 56	
West: 13		East: 14
	South: 55	

and select a folder for the tiles you want to download (see figure below). Then click the Download button.

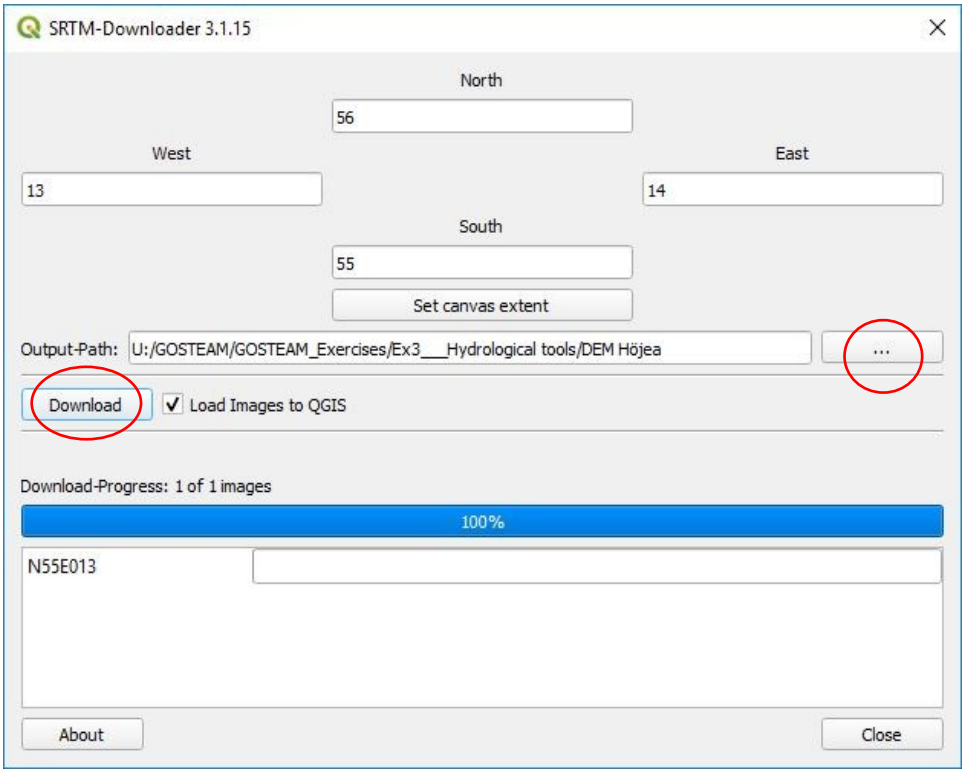


Figure 4. Coordinates to input in the SRTM-Downloader window

You will need your username and password to access the EarthData server at NASA. If you do not already have one, use the link to create a free account.
The SRTM tiles will then be displayed in the QGIS project.
You can now close the SRTM Downloader window.

3. Reprojection of DEM

The downloaded digital elevation model has the coordinate system EPSG:4326 (unprojected, degrees, WGS84 system) and must be reprojected to the EPSG: 32633 system used in the QGIS project.

Go to menu Raster -> Projections -> Warp (Reproject).

The Warp (Reproject) tool window appears.

- Select EPSG:32629 as the Target CRS.
- Select Nearest Neighbour as the resampling method to use.
- Write -9999 in Nodata value for output bands (a nonsense value that will not enter any further calculations).
- Write 30 in Output file resolution in target georeferenced units (this way we will get a raster with 30 meters in spatial resolution).

- Under Reprojected, select the location and name for the new file: below the output will be stored in a TIF file (DEM.tif).
- When complete, click the Run button.

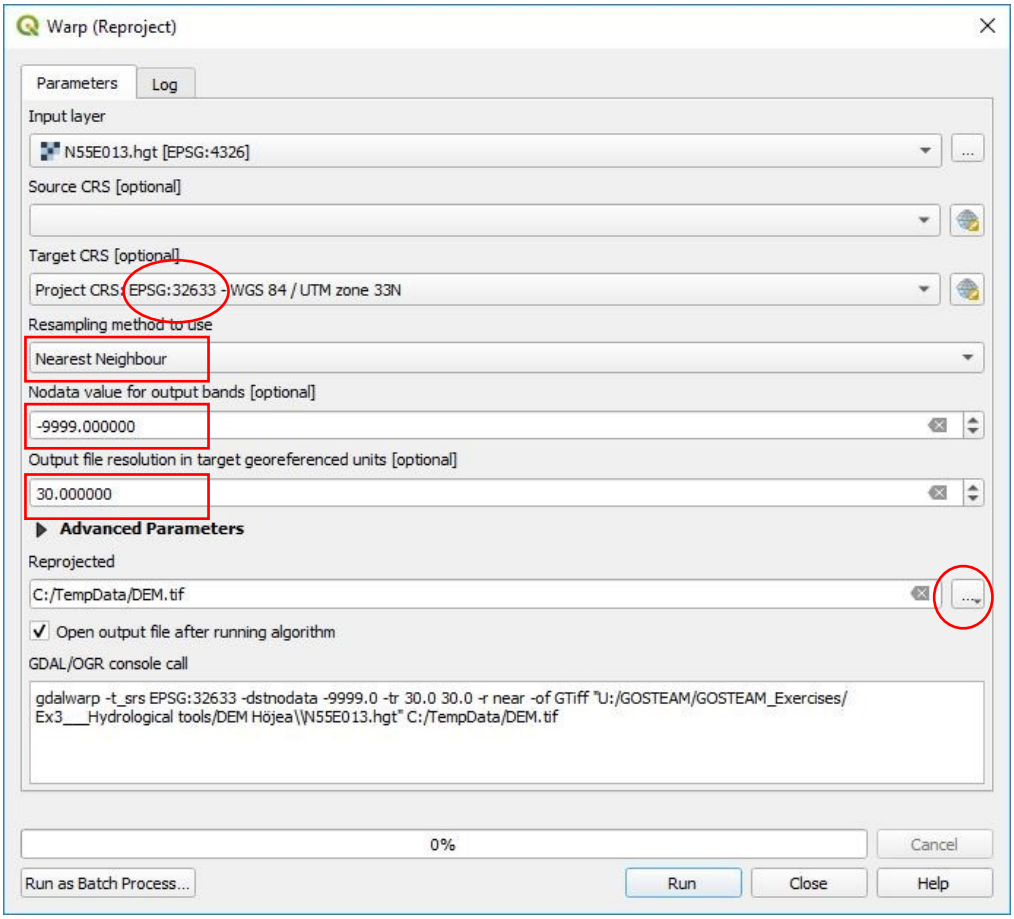


Figure 5. Reprojection window.

4. To Clip DEM to a smaller area

However, the area covered by the tiles is too large, including our study area and other nearby regions.
A such, we will need to clip it to a smaller area. The coordinates of this smaller area are (using the EPSG:32633 coordinate system):

	Top: 6181000	
Left: 375000		Right: 410000
	Bottom: 6156000	

Go to menu Raster→Extraction→Clip Raster by Extent… The

Clip Raster by Extent window appears.

- Under Input layer, select the elevation model.

- Under Clipping extent, write 375000,410000,6151000,6180000
- Under Clipped (extent) select location and write the name of the new clipped DEM
- Click the Run button

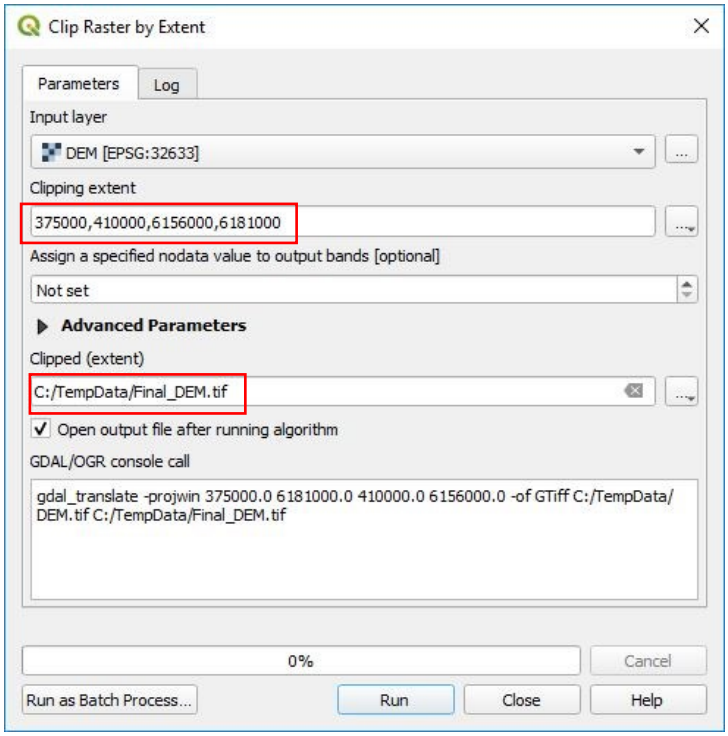


Figure 6. Clip Raster by Extent dialog box.

Unselect the layer DEM in the layers menu and keep the layer Final_DEM selected. Your screen should display a map like in the figure below:

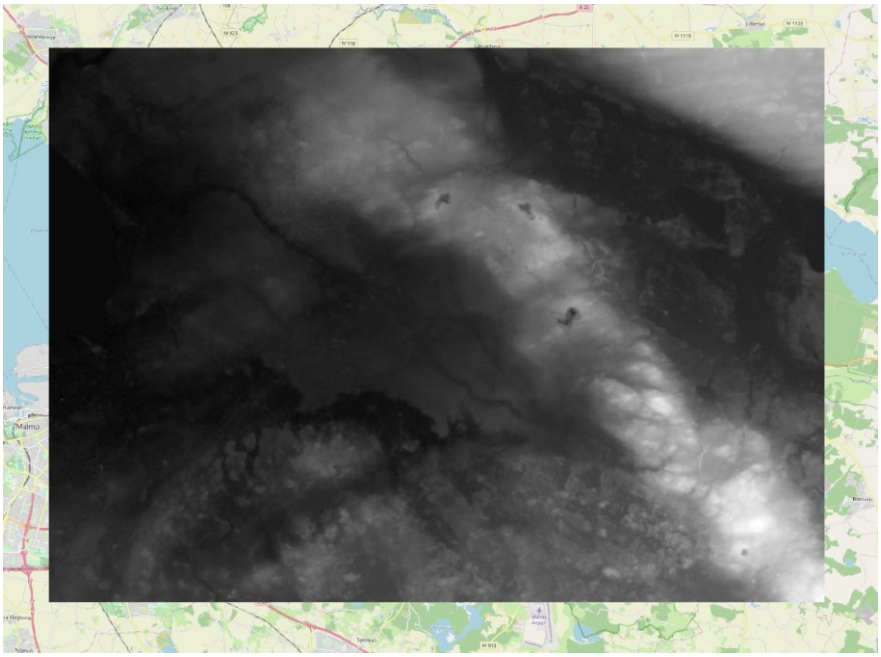


Figure 7. Final DEM overlapped with the OpenStreetMap basemap layer in QGIS.

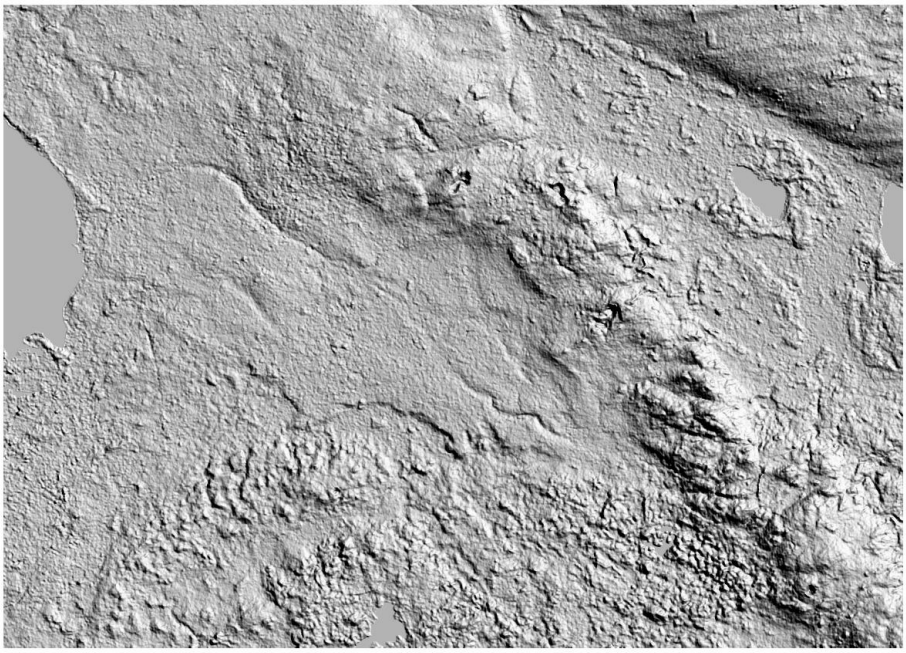
5. Visualisation of DEM and

This step is only to better visualise DEM and is not required to continue with this activity.

5.1 Hillshade

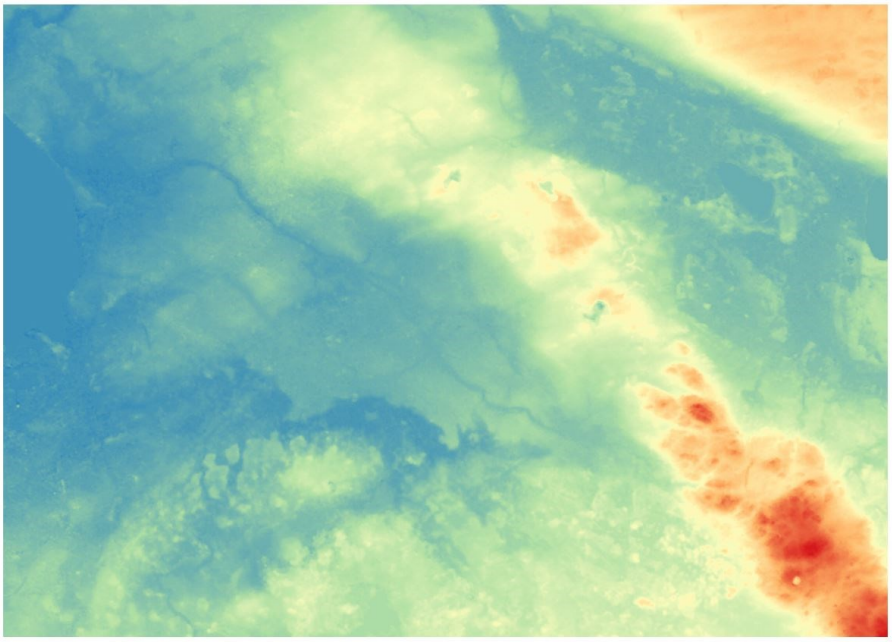
To create a Hillshade grey scale representation of the DEM for the study area;

Right click on the name of the Final_DEM layer -> select properties -> symbology -> on the Render type select Hillshade. You can change the hillsahde settings to create an nice visualisation.



5.2 Pesudocolor

Right click on the name of the Final_DEM layer -> select properties -> symbology -> on the Render type select sigleband Pesudocolor. You can change the colorramp, the number of classes, or other settings to create a nice coloured visualisation.



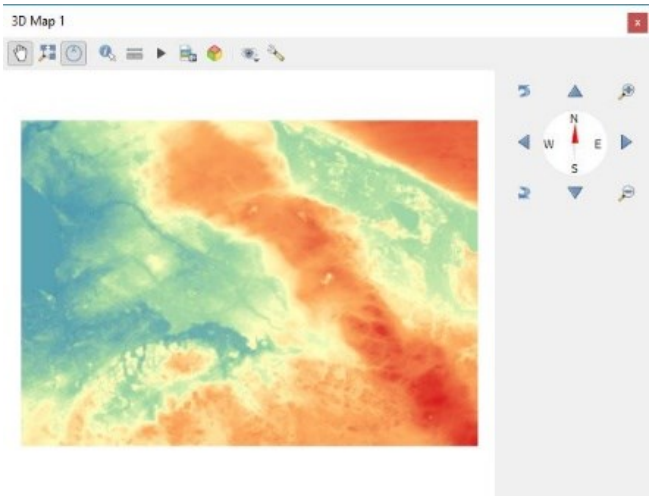
5.3 3D visualization

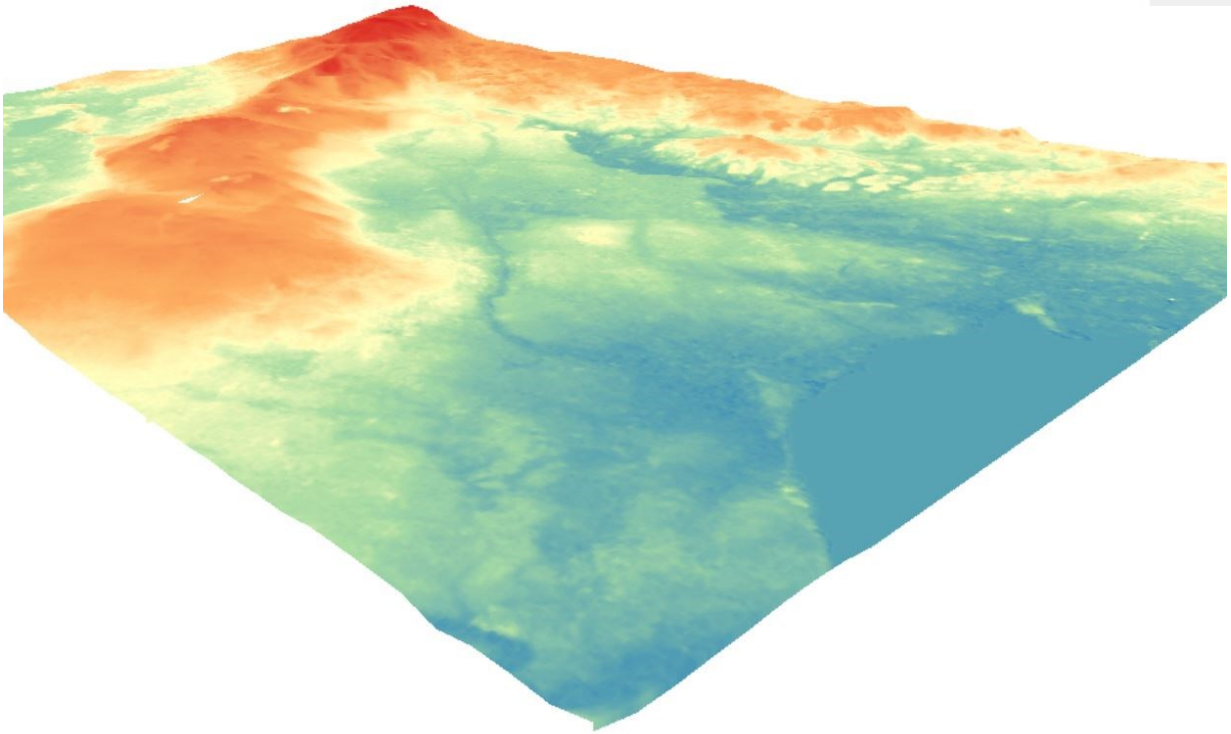
3D visualization of Digital Elevation Model (DEM) can now be done in QGIS 3.0. QGIS 3.0 has a 3D layer view that allows us to visualize GIS data in 3D.

On the view menu -> select New 3D map view. A popup window will open

click on the configuration tool, then select your DEM and change the vertical scale to 5 or 10.

Several other settings are available to help creating a nice 3D view.





Description of activities for distance learning in home-schooling

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References (if any):

Assessment (if any):