Degree project

UNIVERSITY OF SKÖVDE

PHOTOSHOP AND QGIS WORKFLOW

Photoshop workflow

Charts for Lake Mälaren were downloaded from SLU's Geodata extraction tool (2023) where the extent was set to the entire lake. Then "Sjöfartsverket: Sjökort latets (S-57) Nautical Chart" was ordered. Since files in S-57 format cannot be used in QGIS, the files were converted to .shp format with the function "ogr2ogr" (GDAL, 2023). The function was run in FWTools Shell version 2.4.7 with the syntax "ogr2ogr -skipfailures output input" where "output" was set to the path of an empty folder on the computer's hard drive and "input" to the path of the S-57 file. The procedure was repeated for all S-57 files that came with the order from the Geodata extraction tool (2023).

Since the Swedish Maritime Administration's charts only cover depths down to 30 metres, the chart was supplemented with depth data from Genesis Maps (2023). 85 screenshots were taken with the highest level of detail of the lake where the stations "Skarven" and "Görveln S" are located and saved in .jpeg format. The files were then imported into Adobe Photoshop (2022) through "Files" > "Scripts" > "Load files into stack". As 85 images were to be spread out and merged, the background canvas was made larger by "Image" > "Canvas size" > "Width = 200cm", "Height = 200cm, "Relative" > "OK". The files were moved with "ctrl + left click" and overlapped so all the files created a complete continuous chart without gaps. The files were then merged by "Edit" > "Auto-blend layers" > "Panorama" > "OK". Superfluous canvas was removed by selecting the extent and then "Image" > "Crop". The merged file was named "genesis_merged" and then saved in .png format to retain the detail.

QGIS workflow

Import and prepare data

Lantmäteriet's terrain map and the converted S-57 files (the nautical chart) were imported as vector layers into QGIS version 3.26.3. The nautical chart was classified by depth value through "Layer properties" > "Symbology" > "Interval" > "Value: DRVAL2" > "Colour gradient: Blues" > "Mode: Even interval" > "Classes: 8" > OK. The chart was delivered in two different levels of detail. The files comprising the chart with the highest level of detail were merged by "Merge vector layers" > "Input layer: 'SE3CIE9S', 'SE3CIE9W', 'SE4DIE9S', 'SE4DIE9U', 'SE4DIE9W', 'SE4DIE9Y', 'SE4DIGHS', 'SE4DIGHU', 'SE4DIGHW', 'SE4DIGHY', 'SE5CIE9S', 'SE5DIE9W', 'SE5FIGHW', 'SE5GIFDY', 'SE6DIGHU', 'SE6EIFDU', 'SE6EIFDV', 'SE6EIFDW', 'SE6EIGHW', 'SE6FIFDY', 'SE6HIE9Y', 'SE6HIFDS', 'SE6HIFDT', 'SE6HIFDZ', 'SE6HIGHY'" > "Wrapped: Save to file: 'nautical'" > "OK".

The Swedish Maritime Administration charts are delivered in the reference coordinate system "EPSG:4326 - WGS 84". Since the survey's terrain map is projected with "EPSG:3006 - SWEREF99 TM", the merged chart was re-projected to the same reference coordinate system through "Vector" > "Data management tools" > "Re-project layer" > "Input layer: 'nautical'" > "Target coordinate system: EPSG:3006 - SWEREF99 TM" > "Re-projected: Save to file: 'nautical_sweref'" > "OK".

The layer "genesis_merged" was georeferenced using the chart as a template and 20 control points through "Layer" > "Georeferencer" > "File" > "Open raster" > "Enter map coordinates" > "From map window" > "OK" > "Transformation parameters" > "Transformation type: Helmert" > "Resampling method: Nearest Neighbour" > "Horizontal: 0" > "Vertical: 0" > "OK" > "Start the georeferencer". As the screenshots covered land structure, the raster was cropped according to the extent of the chart by "Raster" > "Extract" > "Cut raster by mask layer" > "Input layer: genesis_merged" > "Mask layer: 'nautical_sweref'" > "Cut: Save to file: 'genesis'" > "OK.

Digitalise georeferenced .png

Since the multi-band colours of the "genesis" layer have the same values, the symbology was set to greyscale to facilitate calculation in the raster calculator through "Layer properties" > "Symbology" > "Rendering type: Single band grey". The cell values for the cells that made up the depth curves of the 'genesis' layer (94-175) were obtained using the Value Tool (version 3.0.15). These values were then filtered from the original image using the "Raster Calculator" > "Raster band: 'genesis'" > "Output file target: Save to file: 'genesis_calculated'" > "Spatial extent: Use the selected layer's extent" > "Raster calculator expression: 'genesis' >94 AND 'genesis' <175" > "OK". The result was a black map with white depth lines with value 0 for all black cells and value 1 for all white cells. The raster file is saved with a size of Int32 which puts higher demands on the vectorisation hardware than the specs given in the material part of this report. Therefore the file is translated to Int16 through "Translate" > "Input layer: 'genesis_calculated'" > "Output type: Int16" > "Converted: Save to file: 'genesis_int16'" > "OK". Since all cells with cell value 0 should not be vectorised, these are set to NULL by "r.null" > "Name of raster map for which to edit null values: 'genesis_int16'" > "List of values to be set to NULL: 0" > "Null raster: Save to file: 'genesis_rnull'" > "OK". The depth lines are very tightly drawn where there is a large depth change in a short distance. These areas will result in a large polygon instead of the line polygons that digitisation aims to produce. Therefore the lines are thinned with "r.thin" > "Input raster layer to thin: 'genesis_rnull'" > "Thinned: Save to file: 'genesis_rthin'"" > "OK". The raster file was then vectorised by "r.to.vect" > "Input raster layer: genesis_rthin" > "Vectorized: Save to file: 'genesis_vectorized'" > "OK". The vectorised lines are assigned corresponding depth values through "genesis_vectorized" > "Attribute table" > "Show selected objects". Then one line at a time was selected with "Select object".

Despite the implementation of "r.thin", there were some bottom structures on the Genesis Maps images where the depth lines were too dense to be vectorised. Lines that could be distinguished and determined by depth were traced by hand and saved in the attribute table of the "genesis_vectorised" layer through "Toggle edit mode" > "Add line object". The digitised depth data from Genesis Maps was then supplemented with the Maritime Administration's chart by converting the chart polygons to lines using "Vector" > "Geometry tools" > "Polygons to lines" > "Input layer: nautical_sweref" > "Lines: Save to file: 'nautical_sweref_lines'" > "OK". In the attribute table of nautical_sweref_lines, a new column was then created, named with the same column name as the depth column in the "genesis_vectorised" layer, and assigned the values from the "DRVAL2" column by "Open field calculator" > "Create new field" > "Field name: 'depth'" > "Field type: 'Decimal number'" > "Expression: 'Fields and values: "DRVAL2"'" > "OK". Next, the layers were merged through "Vector" > "Data management tools" > "Merge vector layers" > "Input layers: 'genesis_vectorised', 'nautical_sweref_lines'" > "Merged: Save to file: 'vectorised_complete'" > "OK".

Interpolation of unknown depths

Since the extreme values from the analysis in R were produced with 0.1m accuracy, the level of detail from the Swedish Maritime Administration's nautical charts and the vectorised images from Genesis Maps was not sufficient as the accuracy of the vectorised result varied between different parts of the lake due to the density between the depth lines. To create depth data with the same accuracy as the analysis in R over the entire depth data, values were interpolated between known depth values in the vectorised result. This was done by converting the line layer "vectorised_complete" to a temporary point layer through "Vector geometry" > "Points along geometry" > "Input layer: 'vectorized_complete'" > "Distance: 1m" > "OK". Next, TIN interpolation was applied to the temporary layer ("Interpolated points") through "Interpolation" > "TIN interpolation" > "Vector layer: 'Interpolated points'" > "Interpolation attribute: 'depth'" > "+" > "Pixel size: 1" > "Interpolated: Save to file: 'complete_nautical_chart'" > "OK".

Three dimensional anlyze and vizualisation of habitat spread

In order to be able to run analysis tools on each basin separately, "complete_nautical_chart" was cut into two by "Raster" > "Extract" > "Cut raster by distribution" > "Input layer: complete_nautical_chart" > "Cut distribution: draw distribution on map" > "Cut: Save to file 'basin'" > "OK". The boundary between the two basins was drawn in the narrowest and shallowest part between the southern part of "Skarven" and the northern part of "Görveln" with the coordinates: N:6595932, E:658113. In order to visualise the distribution areas of the different layers in the water body, the symbology of the raster models was changed where all raster cells with a value below a threshold value (e.g. the roof of the habitat) were assigned the same colour (see figures 3 and 4). QGIS does not offer a predefined function that calculates the volume between two depths in a depth gradient. Even though other functions offered by QGIS could have been used in several steps to calculate the habitat volume, a different method was chosen for two reasons: 1. The chosen method was considered to require fewer steps and thus result in fewer possible miscalculations and 2. The chosen method was considered to facilitate the visualisation of the habitat thickness and could thus save time in a later part of the analysis. Since the pixel size during the digitisation was set to "1" and the unit of the grid was in "metres", the depth value of each pixel was equivalent to the volume value of each pixel since (depth(m)*1(m)*1(m) = depth(m^3)). This meant that if all cells with a value (<0) in the grid were summed and multiplied by -1, it resulted in the total volume of the basin. By reclassifying the grid and assigning each pixel depth its corresponding habitat thickness, the habitat volume could be summarised in the same way. QGIS offers a function for reclassifying rasters with a table, but since the result of the analysis in R showed habitat thickness between 0-28.5m and the rasters have an accuracy of 0.1m, this would mean >285 rows in the reclassification table and a human factor that could result in wrongly entered values. Due to this uncertainty, a reclassification method was chosen that automated the process in the QGIS Python console. By opening the raster file with GDAL(2022) and reading the raster file as an array with NumPy(2023), all the features NumPy offers for arrays are made available. A copy of the read array can then be overwritten with a custom function. The copy of the loaded array is then added to QGIS for further analysis (LINK TO GITHUB). The process was repeated for both raster layers. The new raster layers show the thickness of the habitat in different cells instead of the depth of the water body. Since the raster layers have NVD (no data values) that all have the value -9999, a mask layer is needed to separate the data to be analysed from values that should not be included in the analysis. The mask layer for each raster layer was created as a temporary raster layer using the "Raster Calculator" and the expression ("Layer" < (0.1)). The result was raster files where pixels with habitat were given the value 1 and the rest of the pixels the value 0. Both temporary raster layers were then vectorised by "Raster" > "Conversion" > "Vectorise (raster to vector)" > "Input layer: temporary_raster_layer" > "Vectorised: Save to file: 'mesh_layer_basin'" > "OK". The mask layers were then used in the function "Zone statistics" > "Input layer: mask layer_basin" > "Raster layer: basin" > "Statistics to calculate: Sum" > "Zone statistics: Save to file: 'habitat_volume_basin'" > "OK". In the attribute table of the new layer, each patch has been assigned its volume.

Analysing migrating route

The study could not find data on the migration behaviour of vendace and what a possible escape from a shrinking habitat would look like. The study therefore did not model deteriorating habitat conditions but conducted the analysis on the worst conditions measured. The distance from the pool with the least habitat volume to the pool with the greatest habitat volume was analysed with the criterion that the distance between each habitat patch should be measured at the distance that followed the highest possible depth of the route. The function "Shortest line between features" with the input "Source layer: mesh layer_basin1" > "Target layer: mesh layer_basin2" > Method: "Distance to Nearest Point on feature" > "Shortest lines: Save to file:`Shortest_route`" > "OK". Next, lines intersecting the land structure were moved by "Add vertex". New vertices were placed in the centre of the highest possible sea depth of the route. The distance was then calculated with "Field calculator" > "New column" > "Geometry: $lenght" > "OK".

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