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

Title:

Apply hydrologic modeling tools to delineate watersheds and extract a channel network of major rivers and streams for a selected area

Short Description (Max 500 words):

Hydrological modeling tools will be applied on a digital elevation model DEM for a selected area to:

A. Extract channel network directly from the QGIS program.

B. Delineate the watersheds

C. Calculate some statistics

Keywords (Up to 5):

DEM, fill sinks, flow direction, flow accumulation, watershed

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: Hydrological modelling

Objectives (Max 100 words):

Description of the learning objectives

- Knowledge of how to fill sinks and pets in a digital elevation model.
- Knowledge of how water is distributed and accumulated on a DEM.
- Know how to use raster calculator to extract stream network.

Materials (Max 100 words):

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

- Computer with internet connection
- Software: QGIS
- DEM for any area

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

Description of activities for face-to-face teaching in the classroom

Starting from the downloaded and clipped DEM we will extract a channel network, delineate the watersheds and calculate some statistics.

1. **Fill sinks, creates the Flow Directions grid and the Watersheds Basins grid**

Open the Processing Toolbox (ctrl-alt-T).
Type "fill" in the search box. All installed functions that contain this string in their name will be displayed (see figure 1).

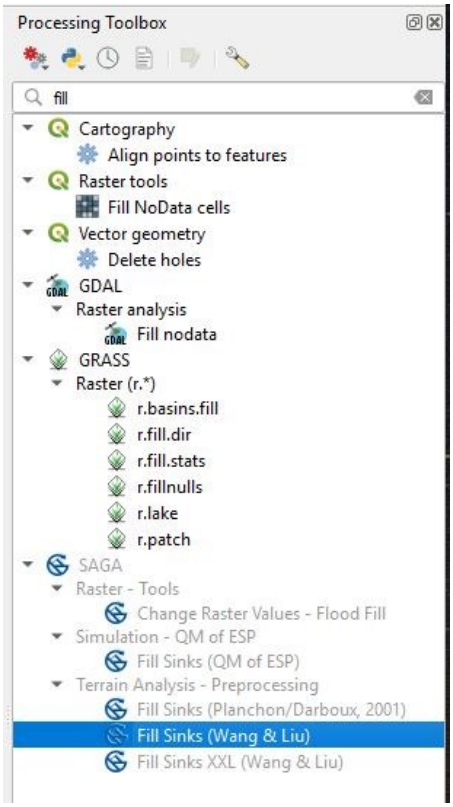

Figure 1. searching for tools in the Processing Toolbox.

In this activity, we will use the "Fill sinks (wang & liu)" tool from SAGA. This is one of the various methods to perform fill sinks.

Click on the "Fill sinks (wang & liu)" tool under the SAGA tool group in the Processing Toolbox window.

The tool creates the filled DEM, that is, the DEM without sinks. It also creates the Flow Directions grid and the Watersheds Basins grid. In this way, the entire set of operations is done directly with a single tool call (see figure 2).

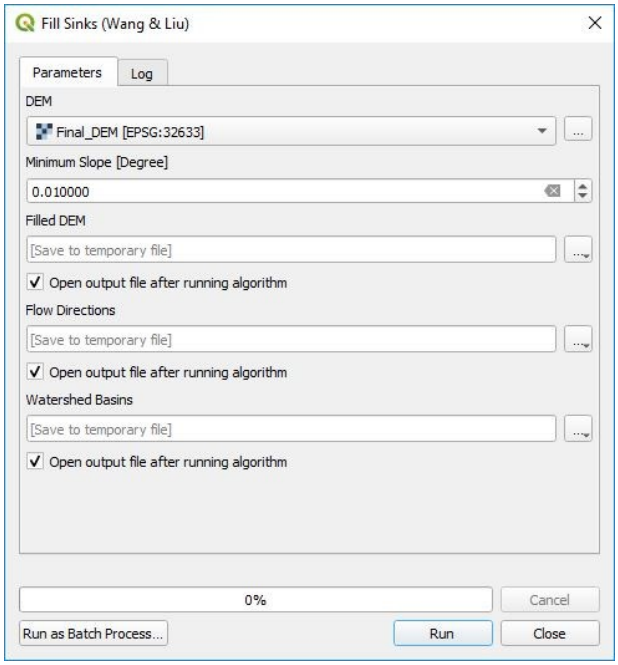

Figure 2. Fill Sinks dialog box.

You can leave the generated grids as temporary files. The generated grids are (see figure 3):

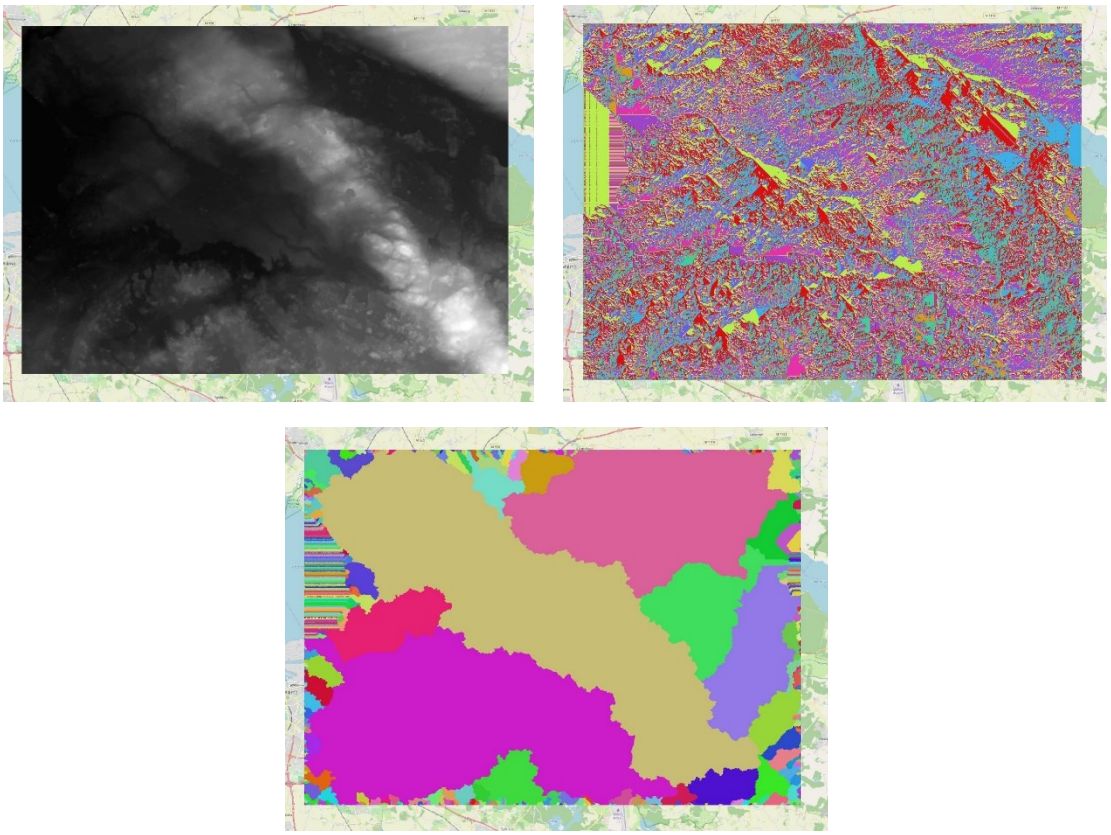

Figure 3. Results of the Fill Sinks tool: *Filled DEM* (top left), *Flow Directions* (top right), *Watershed Basins* (bottom). Watershed colours may differ from those shown here depending on the symbolism you choose.

2. Compute stream network

In the sequence we will compute the Strahler order of the stream network elements.
In the Processing Toolbox window, search for "Strahler order". Click on the Strahler order tool, under SAGA / Terrain analysis - channels toolbox.
- Under Elevation, select the Filled DEM layer.
- Under Strahler Order, you can specify a new file name or leave it as a temporary file. See figure 4

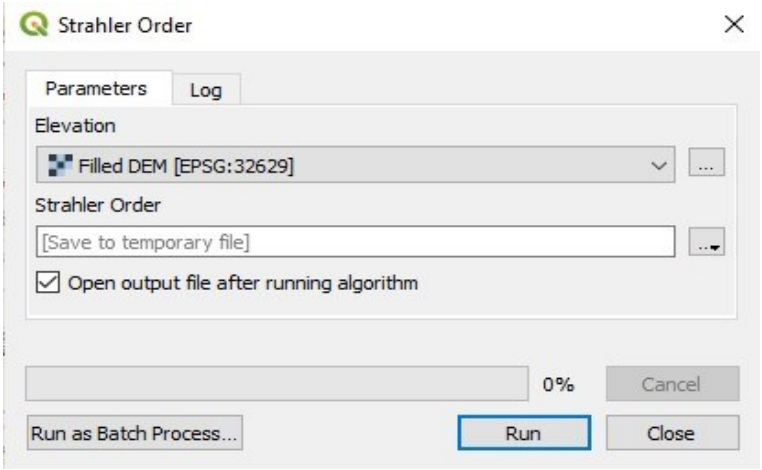

Figure 4. Strahler Order dialog box.

The result is as in figure 5

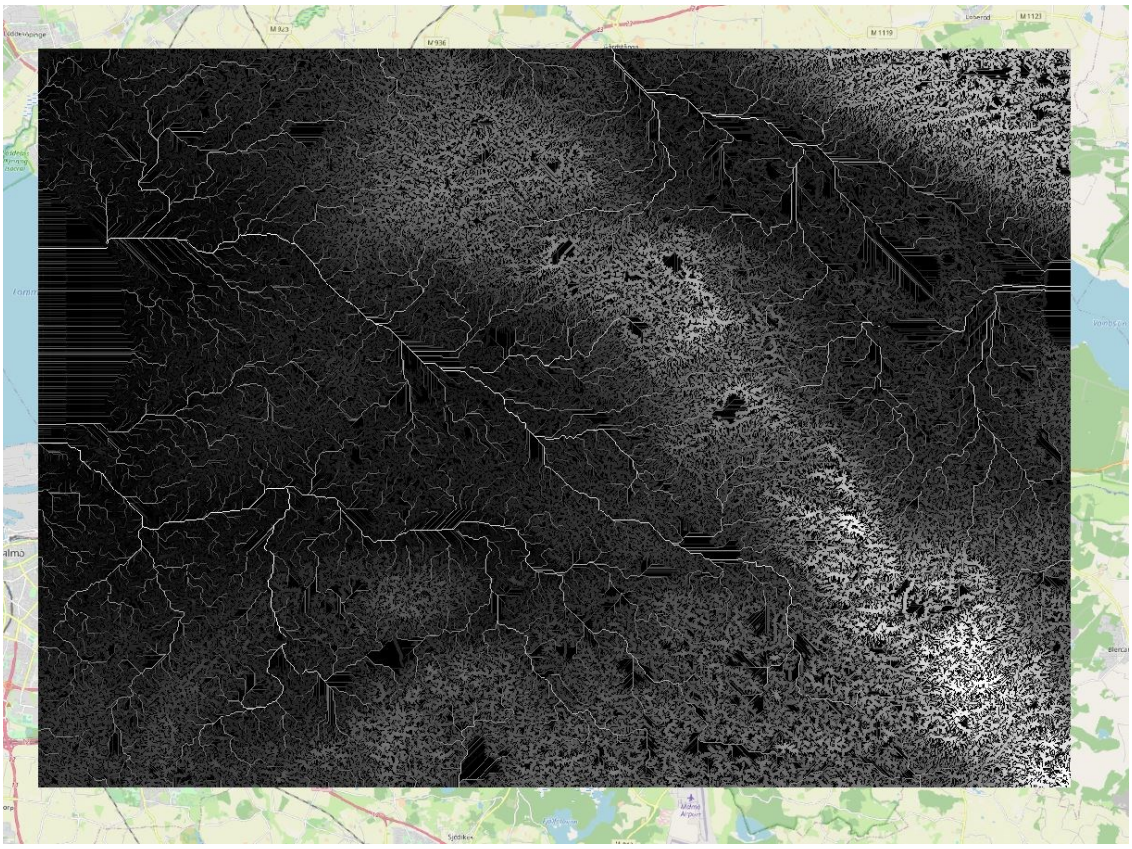

Figure 5. Strahler Order grid (1-black to 9-white).

To get a better visualization, we can change the symbology of the order grid: In the properties of this layer (right click on the layer name in the table of contents), select Symbology to change the symbology of the layer (see figure below).

- Under Render Type, choose singleband Pseudo Colour;

- Select the desired colour ramp; in this activity, we will use the Blue hue ramp;

- Click the Classify button

A colour should be output for each value of the Strahler order; the classification should be output. If not, change the number of classes using the plus and minus buttons until one class is output for each value. Then click the button OK to close the dialog box and get the desired symbology.

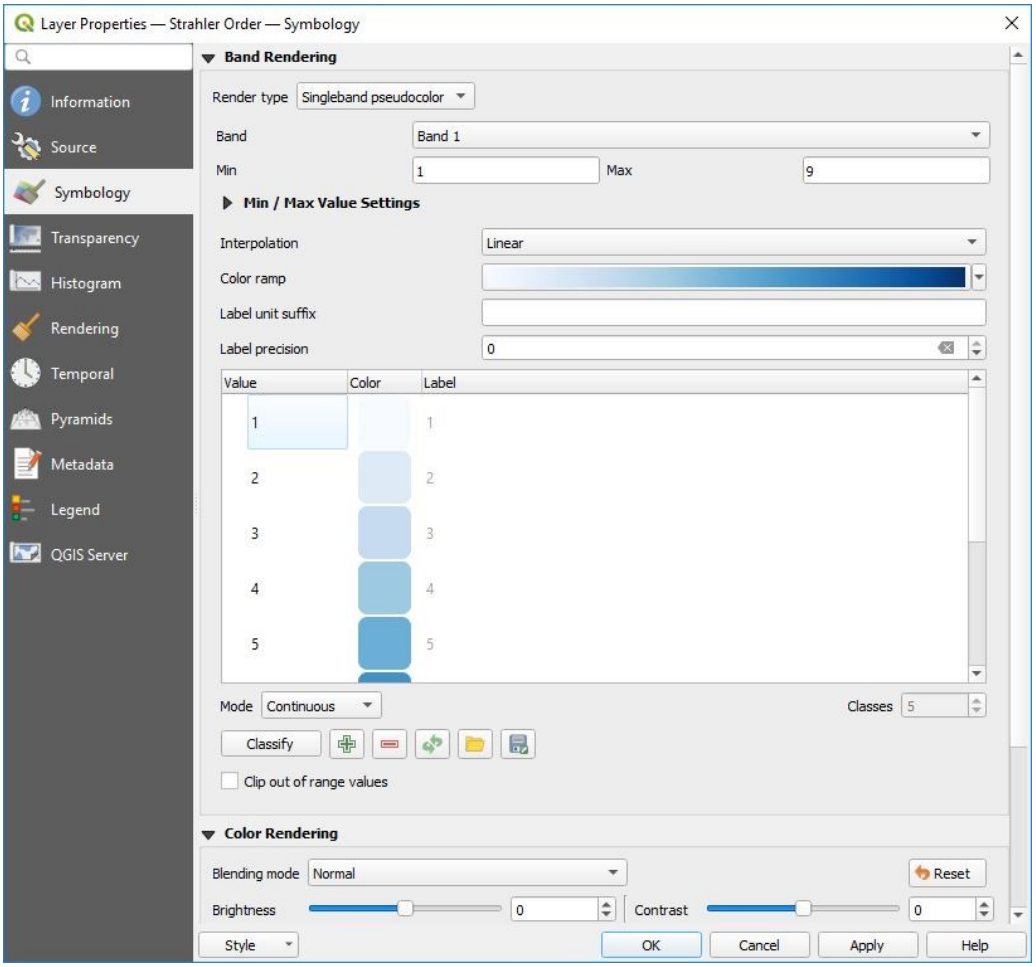

Figure 6. Changing the symbology of Strahler Order grid.

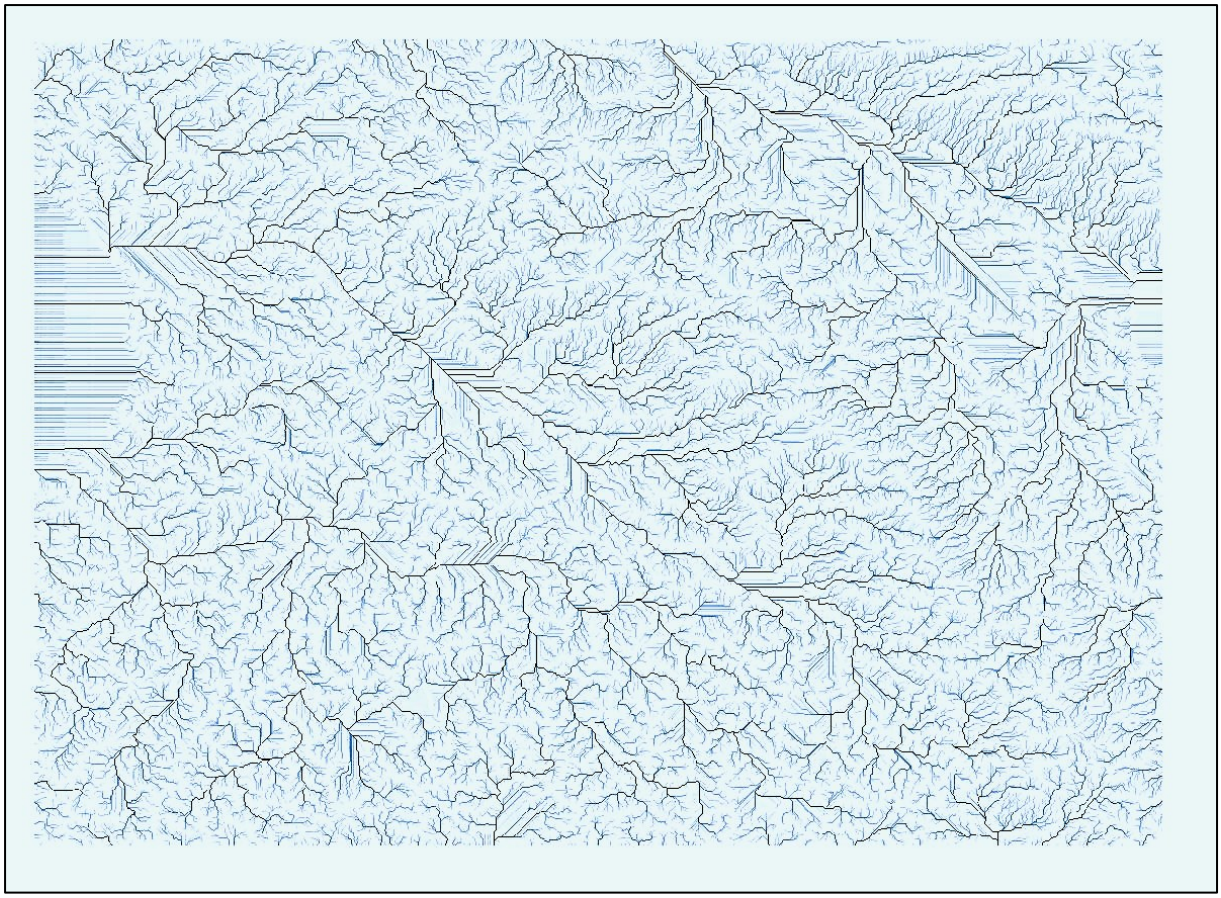

Figure 7. Strahler Order grid with new symbology.

3. Raster calculator to filter the main rivers in the area.

In this activity we assume that streams are the grid cells with higher Strahler order values. The threshold is defined by the analyst considering the number of levels, the type of streams or other factors. In the activity, we will consider only the streams where the Strahler order is greater than 5:

- Go to the menu Raster→Raster calculator.

The Raster Calculator window appears (shown below):
- Under Raster Bands, select the layer with the Strahler order grid (in our activity, it is called "Strahler Order@1" - the first and only band of this layer - Under Output Layer, specify a new file and its location.
- Choose the output format as "GeoTIFF".
- Keep the output CRS as "EPSG:32629 (...)"
- Leave the checkbox "Add result to project" selected
- Write below the text field Raster Calculator Expression "Strahler Order@1" >5

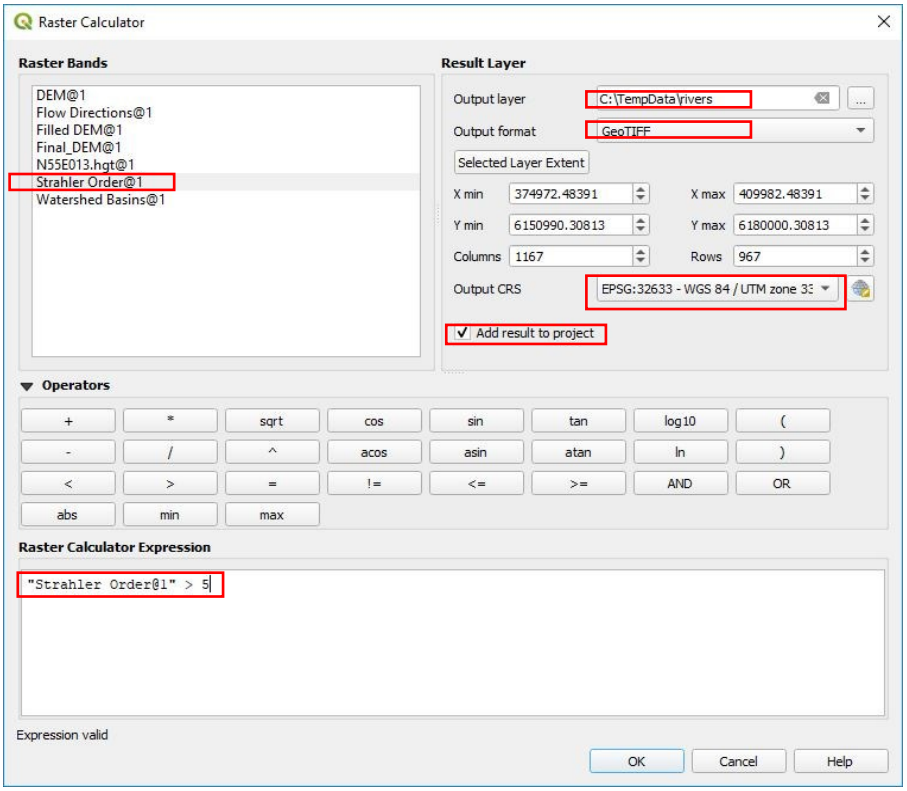

Figure 8. Using the Raster Calculator tool to obtain the binary grid with the streams.

The application of the raster calculator expression results on a new layer on the table of contents displaying only the streams which verify the boolean expression.

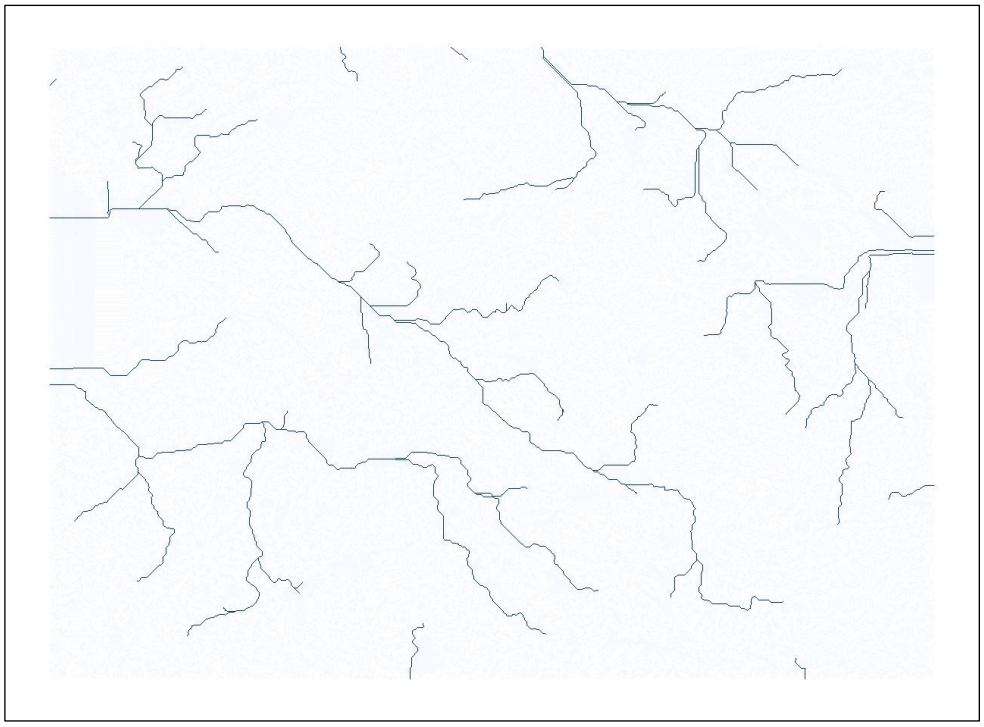

Figure 9. The final map with the rivers (Strahler order >5).

Description of activities for distance learning in home-schooling

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References (if any):

Assessment (if any):