Extracting drainage network from SRTM1 DEM using GRASS GIS

French National Forests Office

2014 November 27

Adrien André

Email : adrien.andre@onf.fr
IRC : `aandre @ freenode`
Twitter : @adrienandrem

Introduction

The aim of this workshop is to present the drainage network extraction procedure from elevation data.

We will be using GRASS GIS modules through QGIS. Every OSGeo tools, incuding GRASS and QGIS, are provided by the OSGeo4W Windows installer or cross-platform OSGeo-Live products.
GRASS GIS modules are available in the QGIS *Processing toolbox* (*Processing* menu > *Toolbox* item, then unfold *GRASS commands*).

Source data is a 1 Arc-Second resolution Digital Elevation Model (DEM) acquired during the Shuttle Radar Topography Mission (SRTM) by the Space Shuttle equiped with a C and X band Radar. Sensed from space, beware that elevation is calculated from a radar signal reflected by the *first object met*[1], which in our case is mainly canopy. The DEM is actually a *Digital Surface Model* (DSM)[2], and no *Digital Terrain Model* (DTM). In our work, this means that an aerodrome runway, for example, might be seen as a valley by a hydrologic algorithm.

Watershed creation belongs to Horthonian analysis which features:

- Drainage directions computation: direction that pixel slope is facing;
- Accumulation computation: amount of overland flow that traverses the cell;
- Stream extraction.

[1] To simplify; more details in the SRTM FAQ
[2] See: `http://en.wikipedia.org/wiki/Digital_elevation_model#Terminology`

1 Data retrieval

The United States Geological Survey (USGS) provides an open access to the DEM dataset through its data portal.

For this example, we downloaded 4 tiles (of 1x1 degree) with the following steps:

- Create an account by registering;
- Zoom to the region of interest on the dynamic map;
- On the *Search Criteria* tab *Coordinates* panel, click *Use Map*;
- On the *Data Sets* tab *Data Set Search* box, type *SRTM 1* and select *SRTM 1 Arc-Second Global*;
- Selected data appears under *Digital Elevation* > *SRTM* > *SRTM 1 Arc-Second Global*;
- Click the *Results* button at the end of the tab box;
- On the *Results* tab, select and download as GeoTIFF files the following tiles:
  1. SRTM1N02W055V3 (`n02_w055_1arc_v3.tif`)
  2. SRTM1N02W056V3 (`n02_w056_1arc_v3.tif`)
  3. SRTM1N03W055V3 (`n03_w055_1arc_v3.tif`)
  4. SRTM1N03W056V3 (`n03_w056_1arc_v3.tif`)

2 Preliminaries

2.1 Tiles gathering

The watershed creation module needs to be provided a unique raster layer.

To gather the tiles, we used the GRASS GIS r.patch module:

1. Load the 4 tiles on QGIS;
2. Open the `r.patch` module;
3. Click the ... button to open the *Multiple selection* window, then on *Select all*;
4. On the right of the *Result* entry, click the ... button, then on *Save to file* and enter `elevation.tif`;
5. Be sure the *Open output after algorithm is finnished* checkbox is checked;
6. Launch the module with the *Run* button;
7. On the *Layers* tab select the 4 `n.._w0.._1arc_v3` raster layers, and remove them (Right clic > *Remove*).

2.2 Void filling

High relief affected the SRTM radar sensor leading to data voids. Yet several methods exist for void-filling[3].

Here is how we proceeded using the `r.fillnulls` module:

1. Open the module and provide the `elevation` layer as the *Input raster layer to fill*;
2. Notice the default RST interpolation method and type 30.0 as the *Spline tension parameter*;
3. Save the output to `elevation-filled.tif` (... button > *Save to file*)
4. Launch the module with the *Run* button;
5. Finally remove the `elevation` layer.

[3]See Void filling of original SRTM tiles

3 Watershed creation

1. Open the r.watershed module and provide the following parameters:
   - *Name of input elevation raster map*: `elevation-filled`
   - *Minimum size of exterior watershed basin*: 75 (a pixel number)
   - *Name for output stream segments raster map*: stream (saved to `stream.tif` file)
2. After each output map title, name box and ... button, notice the checkbox. Uncheck each output not mentioned before.
3. Launch the module with the *Run* button.

Notice In future works you might also be interested in saving intermediary map, such as *Drainage direction*, *Accumulation* and *Watershed basins*.

4 Output formating

The computed stream network is of raster type. For display purposes and potential network analysis, we will tranform the stream network into vector format.

1. Vectorization requires *thinning* easily achieved using `r.thin` with `stream` as *Input layer to thin* and `stream-thin` as ouput;

2. Then end with the `r.to.vect` module to build a `stream.shp` vector layer from `stream-thin`;

3. Optionally reproject to your legal coordinate reference system[4].

[4] RGFG95 / UTM zone 22N (EPSG:2972) for French Guiana

5 References and further reading

- Wikipedia SRTM page
  http://en.wikipedia.org/wiki/Shuttle_Radar_Topography_Mission
- GRASS Wiki Creating watersheds page
  http://grasswiki.osgeo.org/wiki/Creating_watersheds
- GRASS GIS toolkit for Hortonian analysis of drainage networks
  http://dx.doi.org/10.1016/j.cageo.2011.03.003
- The Geospatial Desktop. Sherman G. 2012. Locate Press. ISBN 978-0986805219
  https://locatepress.com/gsd
- Open Source GIS, a GRASS GIS Approach. Neteler M. 2008. Springer. ISBN 978-0-38735767-6
  http://www.osgeo.org/books/grassbook