White Paper

Medium Resolution
Digital Terrain Models
From SRTM Sources

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Introduction

Access to good quality terrain databases has always been a challenge in RF planning. Three layers are commonly used: the Digital Terrain Model (DTM), the Clutter (land cover), and the Imagery or vectors. High Resolution terrains (1 to 5 meters) include man-made obstructions (buildings, bridges, roads) and sometimes vegetation. Medium Resolution terrains (10 to 100 meters) represent the 'bald earth' altitudes. The chase for Medium Resolution DTMs is a well known activity. It is the responsibility of each country's government to maintain a decent geodetic network and topographic maps. They decide to make the information available or not to the public. For some areas, free download of 10m terrains off the internet are possible, for others, jail time risk if caught carrying topographic maps. Sometimes, the DTMs are available and can be purchased, sometimes, they are so expensive that it is cheaper to produce them from topo maps, sometimes, they simply don't exist, but thanks to the remains of the Cold War, Russian topographic military maps helped generate 'better than nothing' files.

The chase is over.

The Shuttle Radar Topography Mission (SRTM) was put together by a joint effort between the National Geospatial-Intelligence Agency (NGA) and the National Aeronautics and Space Administration (NASA). The mission was to capture the most complete/accurate high-resolution digital topography of Earth. During the mission, Space Shuttle Endeavour used a specially designed imaging radar system consisting of C-band and X-band interferometric synthetic aperture radars (InSAR). During the 11 days of February 2000, SRTM was able to record 80% of Earth's landmass between 60ºN and 56ºS. As a result, an accurate 1sec resolution DTM was produced (about 30m). This DTM meets interferometric terrain height data specification (ITHD): 30m x 30m in spatial sampling with absolute 16m vertical accuracy and absolute 20m horizontal accuracy. The products released to the public were resampled to 3sec (about 90m).

All the tests carried out show that the quality of the SRTM terrains for RF planning exceeds by far any DTM made from topographic maps at a scale 1:100,000 and lower (resolution 50m and above). This article describes the process for preparing DTMs from SRTM sources using ICS Map Server.

Source and Import

There are a number of sources for SRTM terrains. The one I recommend and will describe uses the 'low-level' 1 degree x 1 degree format. Its location is http://edcftp.cr.usgs.gov/pub/data/srtm/. The tiles are grouped by continent and are essentially 16bit BIL files. The file name gives the Lower Left coordinate of the tile. For example, N18W078.hgt is the 1degree tile containing 1201x1201 altitudes at 3sec resolution, covering the following block:

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N19W078            N19W077



           N18W078.hgt



N18W078            N18W077
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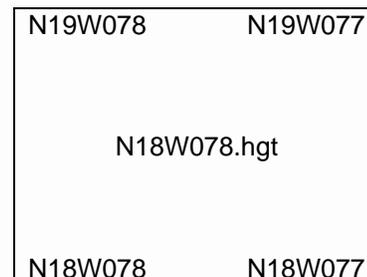
The first step is to identify the files that need to be downloaded. The ICS Map Server cartographic calculator can help. Common errors include forgetting the tiles that cover partially the area of interest (AOI), and the usual West and South coordinates… that are still negative.

The source files are zipped and sometimes only one file at a time can be downloaded. As long as the user has to stand in front of his PC, the best is to left-click the file and extract is to the destination directory directly. It saves the process of unzipping after download. ICS Map Server has a batch import from HGT to IC2 under the Import/Export menu. The files imported will have their header filled with the proper coordinates in Seconds relative to the WGS84 datum (4SEC).

Once imported, they can be opened through the classic Contour Treatment or Disc Options menus. Some characteristics are immediately noticeable. The DTM is information rich: even flat areas have a grainy aspect that gives the DTM a realistic appearance. Some areas are undefined (NoData) and need to be interpolated. The sea and the lakes are rugged and need to be cleaned for aesthetical reasons.
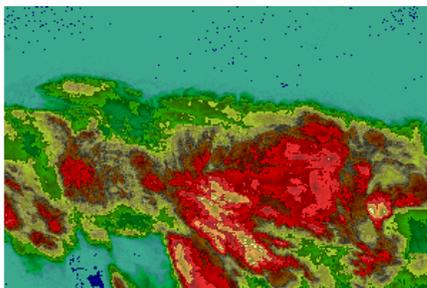
Direct Import of SRTM tile

Area of Interest Processing

Any local metric projection supported by ICS Map Server can be used for the AOI definition. In the case there is no requirement to work in a specific grid; the UTM is the natural choice. A UTM zone covers a band of 6 degrees. The zone number can be calculated from the longitude: $Z = (186+LON)/6$. Again, do not forget that a Western longitude is a negative number. For example, the N18W078 tile gives the zone $(186-78)/6 = 18$, the projection code will then be 4UTN18 (WGS84 datum, UTM North, zone 18). In the case the zone value has decimals, the integer value has to be retained. In the case the AOI spans over more than one UTM zone, the most dominant zone should be used.

The most natural metric resolution for an SRTM projection is 90m. It matches also the resolution of a great source of 30m data, the Landsat 7 imagery. However, nothing prevents a projection to an AOI at 50m, or even 30m, but it should only be driven by the necessity to match a certain resolution, knowing that it does not result in a more accurate DTM than the 90m one.

Once the destination IC2 created, the Disc Option - Geoconvert - Matrix takes care of projecting the SRTM tiles into the AOI. The red crosses show the location of the corners of the files to be geoconverted in the destination matrix.

Whatever the file resolution for the AOI, some NODATA interpolation is necessary. Open the IC2 in a Memory Session, check the consistency of the layer, fill the possible missing blocks (missing tiles in the water) and run a Black Box interpolation. In the case the result is satisfactory, then the DTM is ready for planning. In a coastal area, a clean-up of the shore and water makes the end result 'prettier', but will not change much in terms of planning.

Cleaning the coastline is an easy process that consists of creating a matrix similar to the DTM that essentially contains two values, Zero and NODATA, that will be inserted into the DTM layer. Coastline vectors can be found in various internet sources. ATDI has placed the DCW worldwide vectors on its ftp.atdi-us.com / upgrades / ICS_Map_Server / poworld-4sec.zip. After creating the IC2 'mask' matrix, open it in memory session and play the DCW vectors, making sure the input grid and output grid match the vector and matrix coordinates (4SEC in the case of the DCW vectors).
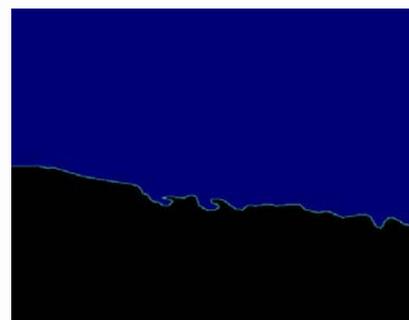

IC2 Mask

The following tricks apply: close the lines where the fill function may traverse, use the fill contour option, use a Flag value for the coast different from the Fill value in order to be able to 'undo' a leaking Fill operation, keep a finger on the Esc key. Once done, change all but NODATA (-9999) to Zero, save then insert into the SRTM projected

matrix, making sure the Insert All option is unchecked. Sometimes, the coastal areas show unwanted negative values, a transform operation All<0 to 1 cleans the DTM appearance.
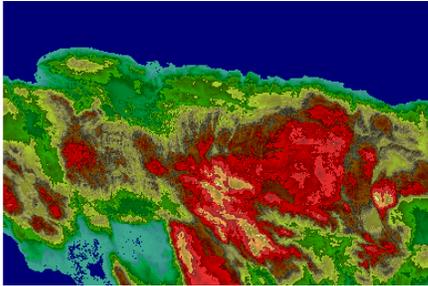
Final DTM

Conclusion

The creation of a good 90m DTM from multiple SRTM tiles takes a fraction of an hour, less if we consider the coastline clean-up operation unnecessary. A common reserve may come-up from RF Planners that are used to 20 to 30m resolution DTMs. It is a valid reserve only when the source information used for the generation of these DTMs exceeds the accuracy of the SRTM, which often is not the case. The access to these DTMs is a revolution for RF planning in most of the world, where the information was not available or so expensive it was reserved to a limited number of privileged users. It is a first layer that is complemented by the access to Landsat7 photos that covers the necessary clutter and image requirements.

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