



**Global
Land Cover
Network**



“PATCHED” SRTM DATA

INTRODUCTION

In February 2000, the Shuttle Radar Topography Mission (SRTM) successfully collected Interferometric Synthetic Aperture Radar (IFSAR) data over 80 percent of the landmass of the Earth between 60 degrees North and 56 degrees South latitudes to generate the most complete high-resolution digital topographic database of Earth.

SRTM consisted of a specially modified radar system that flew onboard the Space Shuttle Endeavour during an 11-day mission. SRTM is an international project spearheaded by the National Geospatial-Intelligence Agency (NGA) and the National Aeronautics and Space Administration (NASA).

SRTM DEMs are now being distributed by several agencies both public and private at three spatial resolutions and at two quality levels:

- 1 arc-second (about 30 m) DEM of the United States
- 3 arc-second (about 90 m) DEM of the world
- 30 arc-second SRTM-GTOPO30 product (about 1 km) corrected by GTOPO30 30 arc-second DEM

The 1 arc-second data set at 30 m resolution is available only for the North American continent. The SRTM30 data set is an improved version of the GTOPO30 data set, which is a global coverage of elevation data at 1 km resolution. Most interest is on the 3 arc-second data set at 90 m resolution because it is a near-global coverage at higher resolution than GTOPO30. It is available in two versions: “unedited” and “edited”. The first is considered “unfinished” according to USGS standards. NASA (<ftp://e0dps01u.ecs.nasa.gov/srtm/>) is making available unfinished SRTM tiles to users through remote download.

ERRORS IN ORIGINAL SRTM DATA

SRTM “unedited” data contains regions of no-data, specifically over water bodies (lakes and rivers), and in areas where insufficient textural detail was available in the original radar images to produce three-dimensional elevation data. No-data regions due to insufficient textural detail were especially found in mountainous regions. The existence of no-data regions in a DEM makes it difficult to use, especially when continuous surfaces are required.

Several international organizations are processing “unfinished” SRTM to correct errors and fill gaps. Given the need for immediate availability of mosaicked and corrected elevation data for its activities and programmes, FAO-NRCE initiated his own program of post-processing raw 3 arc-second SRTM tiles to fulfil the objective of distributing to members of the GLCN network national coverage of base data sets such as elevation and multi-temporal Landsat images.

DATA PROCESSING

1. USGS processing

USGS performed a set of corrections and quality control on the raw SRTM data to produce an edited version for distribution (<http://edcsns17.cr.usgs.gov/srtm/>). Following is the list of corrections USGS carried on:

- Spikes and wells exceeding 100m from surrounding elevations have been removed.
- Oceans have been set to 0 meters.
- Lakes greater than 600m in length have been flattened and set to a constant height.
- Rivers wider than 183m have been stepped down in height to highlight them, and islands with a major axis exceeding 300m or relief exceeding 15m have been depicted.
- In addition, tile edge pixels have been matched to adjacent pixels to ensure edge matching when they are combined.
- Voids of 16 continuous pixels or less have been filled by interpolation while large ones have been left.

Data are complete for 95% of the coverage area and meet or exceed the 16m vertical and 20m horizontal accuracy requirements (90% confidence).

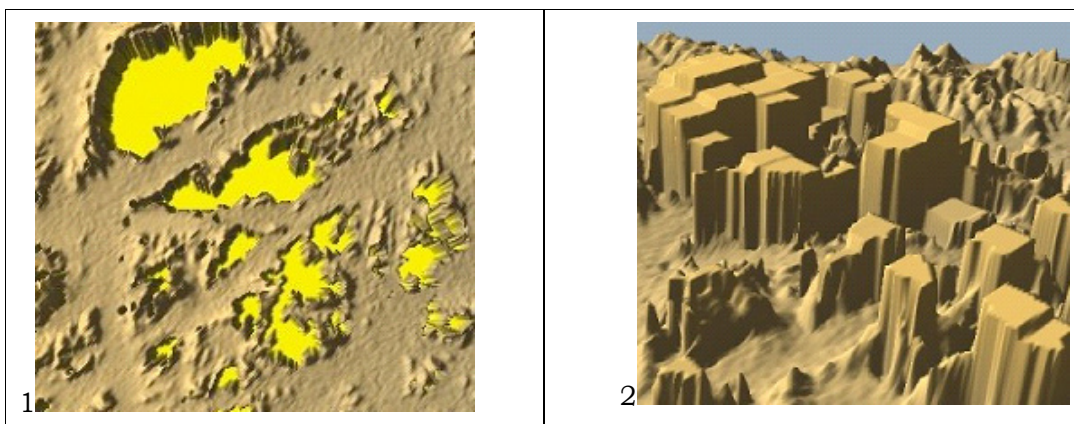
2. FAO-NRCE processing

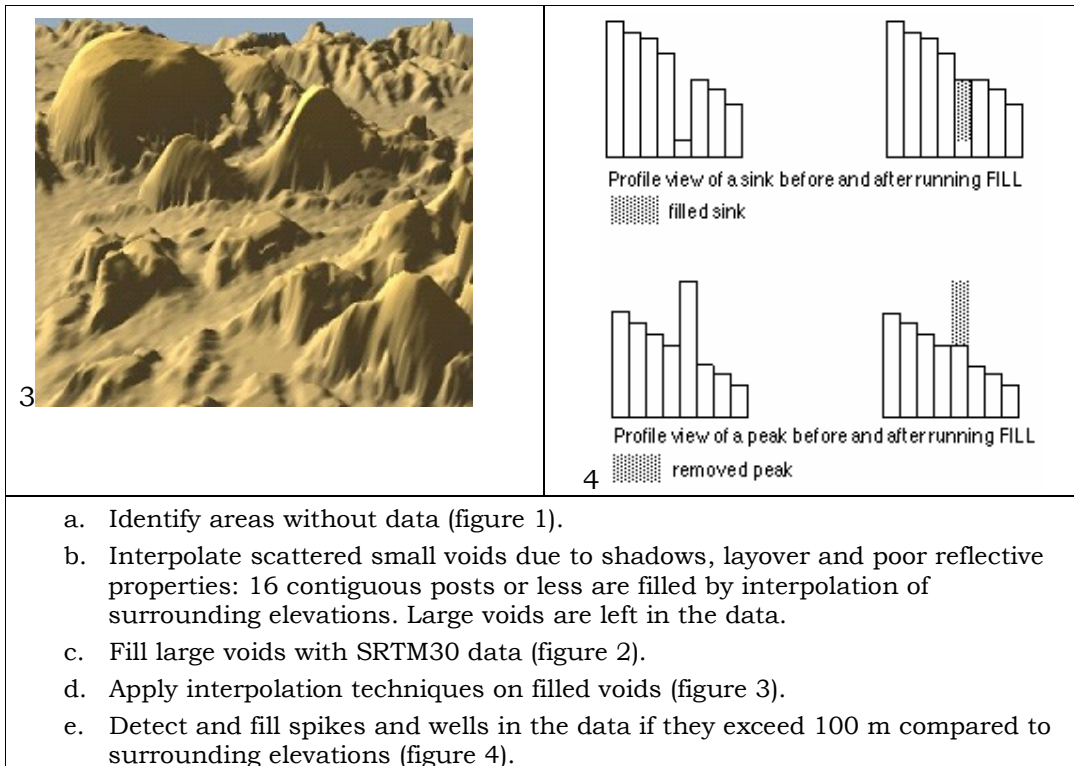
The need for seamless mosaics of edited SRTM data in which most of the voids are filled with values drove FAO-NRCE in testing two alternative procedures for patching 90m SRTM data. The work was done inside the **Global Land Cover Network** initiative.

a. using SRTM30:

1. If voids sized 16 contiguous posts or less, they were filled by interpolation of surrounding elevations.
2. Large voids have been identified and filled up with re-sampled and interpolated SRTM30 data.
3. Spikes and wells in the data are detected and voided out if they exceed 100 meters compared to surrounding elevations.

Following is a visual example of the steps carried on:

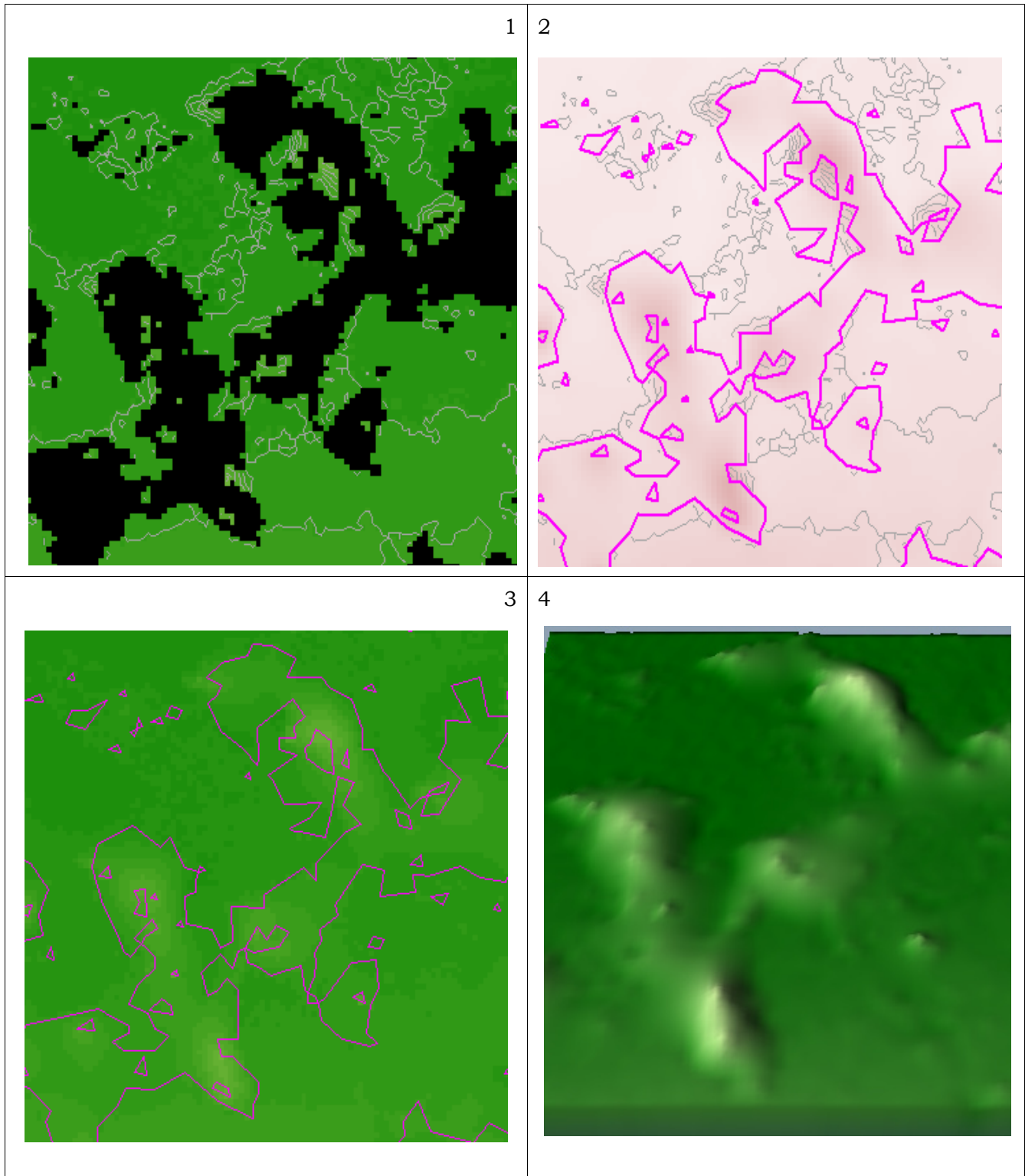




b. using an hydrologically sound DEM by ESRI-Arc/Info model:

1. generates 10 m interval contours from the original SRTM data (figure 1).
2. interpolates the contours to produce a hydrologically sound DEM (figure 2); the TOPOGRID algorithm of Arc/Info was applied. This process interpolates through the no-data holes producing a smooth surface of elevations where no data was originally found.
3. The interpolated DEM is then used to fill data voids in the original DEM (figure 3).

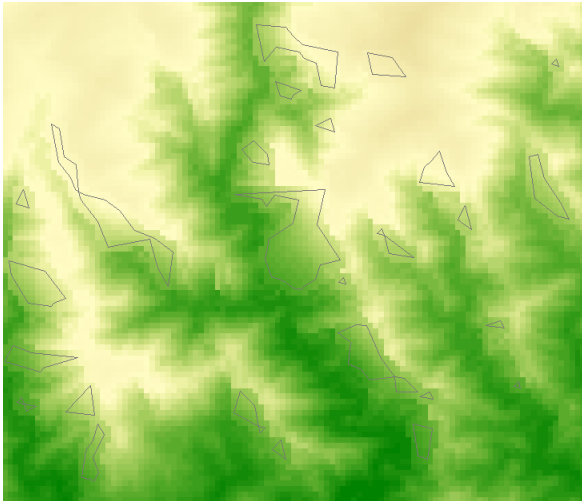
This technique was derived by the work of the CGIAR-CSI team who applied it to generate a global edited SRTM data set (<http://srtm.csi.cgiar.org/>).



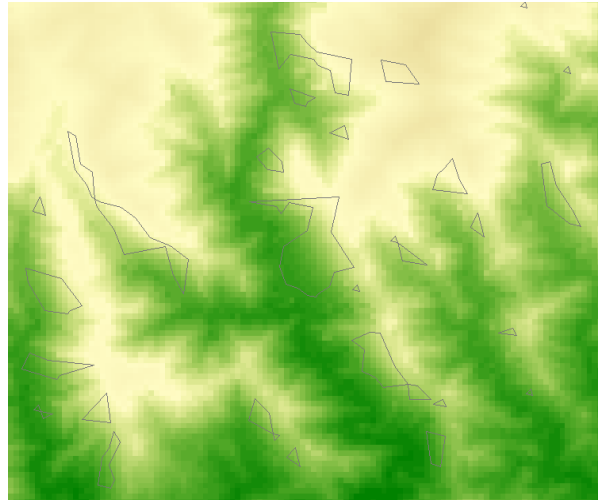
Results:

Comparing the results in a few test areas with low, hilly and medium-high land, it was clearly detected a much better terrain perception using the interpolated “hydrological” DEM. Therefore, we decided to adopt the interpolated DEM to fill up voids in the SRTM raw data. The pictures below show an example; boundaries show the filled-up areas:

Filled voids using SRTM30



Filled voids using interpolated DEM

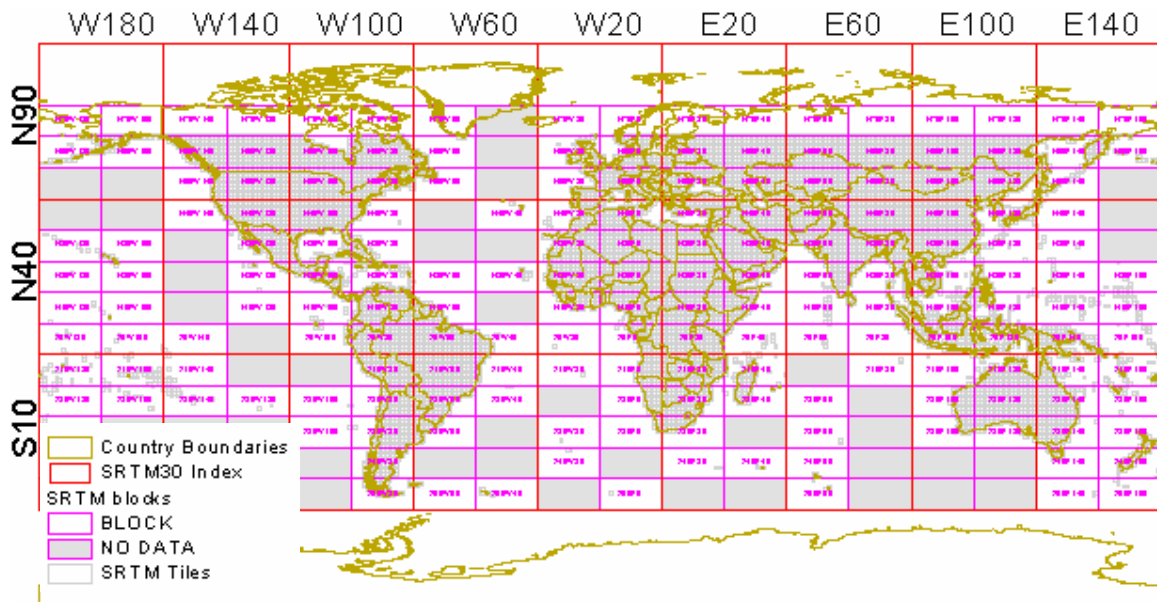


More tests will be performed on very high mountains areas to see if adjustments to the procedure are necessary to improve the result. In fact, this technique may not work perfectly for very steep slopes. Also, as accurate coastline and inland water layers are available, a correction for these areas will be applied in order to remove artefacts generated by the sensor or surface characteristics.

OUTPUT

The edited SRTM tiles were merged in 20 by 10 degree mosaics. 184 blocks make the total coverage of elevation data.

index of SRTM blocks

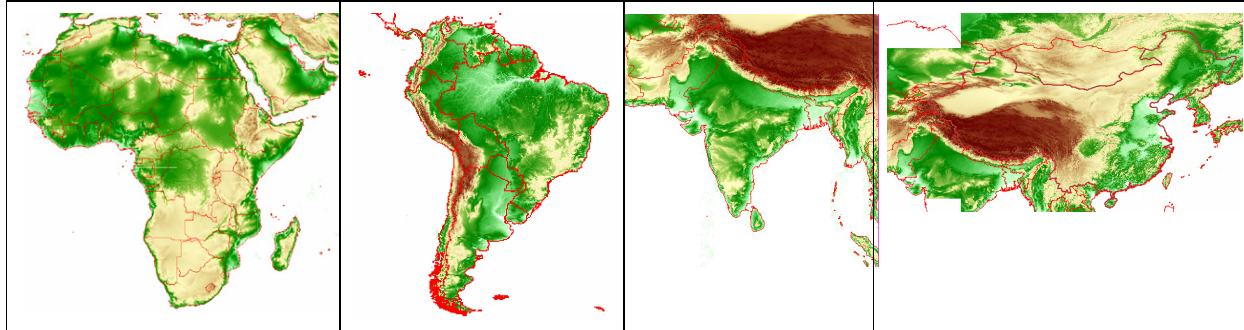


example of block

Global Land Cover Network (GLCN)				2005				Italian Cooperation						
N40E40	40	N	40	E	SOE160	0	S	160	E	S40W180	40	S	180	W
N40E60	40	N	60	E	SOE20	0	S	20	E	S40W20	40	S	20	W
N40E80	40	N	80	E	SOE40	0	S	40	E	S40W80	40	S	80	W
N40W100	40	N	100	W	SOE60	0	S	60	E	S50E0	50	S	0	E
N40W120	40	N	120	W	SOE80	0	S	80	E	S50E140	50	S	140	E
N40W140	40	N	140	W	SOW100	0	S	100	W	S50E160	50	S	160	E
N40W20	40	N	20	W	SOW140	0	S	140	W	S50E60	50	S	60	E
N40W40	40	N	40	W	SOW160	0	S	160	W	S50W40	50	S	40	W
N40W80	40	N	80	W	SOW180	0	S	180	W	S50W60	50	S	60	W
										S50W80	50	S	80	W

CURRENT STATUS

Using the **interpolated DEM** to correct original SRTM data, the GLCN's Land Cover Topic Centre at FAO-NRCE has completed the global coverage.



PROJECTION INFORMATION

Global Projection *Geographic*
 Horizontal Datum *World Geodetic System 1984 (WGS84)*
 Vertical Datum *WGS84 Earth Gravitational Model (EGM 96) geoid*
 Vertical Units *meter*

DISTRIBUTION

SRTM Level 1 (3 arc second) data for global coverage will be distributed by FAO-NRCE as

20x10 Degree seem less mosaics
 ArcGrid and GeoTIFF formats
 on DVD-ROM and large storage devices

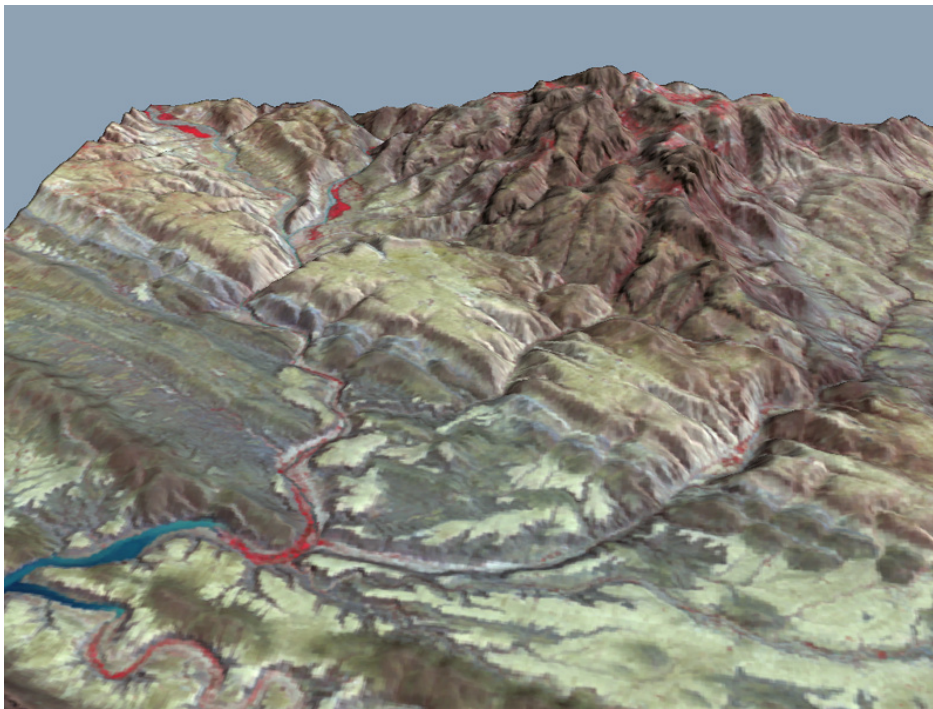
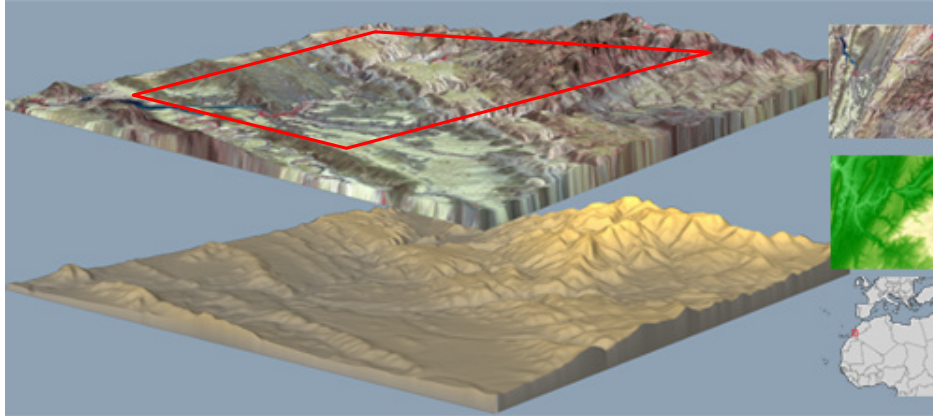
DIGITAL DATA FORMATS

ArcGrid is an Arc/Info proprietary format. Some other software packages can read the ArcGrid format.

TIFF for SRTM is a 16 bit signed integer grid format. No Data is stored as -32768.

DEM APPLICATIONS

- 3-D views and fly-through



- Hydrologic Analysis, Support Land Cover Classification, Cartography etc.

CONTACT INFORMATION

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