Digital Elevation Model Generation using SRTM

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ABSTRACT

A digital elevation model (DEM) is the most basic and interesting geographical data type. Different techniques are used for acquisition of DEM source data: aerial and spatial photogrammetry, radargrammetry, SAR interferometry, airborne laser scanning (LIDAR), cartographic digitization of existing maps, traditional and modern surveying techniques. DEM generation by means of optical satellite images is become very advantageous method: it offers updated information, large area coverage, quick data access and it is very cost effective. In present study area for DEM generation, Kaddam watershed of Middle Godavari river basin has been selected. Using Shuttle Radar Topography Mission we can obtain DEM in 90m and 30m data. The article presents main sources of data for DEM generation, the interferometry processing steps for DEM generation based on the Shuttle Radar Topography Mission data/model and the crucial threshold values are tried to explain.

Keywords: Digital Elevation Model, Optical satellite images, Kaddam watershed, SRTM.

INTRODUCTION

The digital elevation model is simply a statistical representation of the continuous surface of the ground by a large number of selected points with known coordinates in an arbitrary coordinate field. The new techniques of data acquisition and processing have been developed and new types of digital terrain models have come into sight: from highway to railway design to agricultural management, flight simulation, flood monitoring and many more. DEM may be arranged in a raster or random form. Instead of the expression DEM also the term digital height model (DHM) is used. Digital Elevation Models do play a fundamental role in mapping. The digital description of the three dimensional surface is important for several applications. Today the most often used photogrammetric product are orthoimages generated by means of a single image and a DEM. The very high resolution space sensors are mainly operating in a single image mode; stereo pairs are not taken very often. A correct geo-referencing is only possible based on a DEM. But these DEMs have to be created. The existing and not classified world wide DEMs usually do not have a sufficient accuracy and reliability for more precise applications or they may be too expensive. Interferometry SAR (InSAR) is based on the processing of complex SAR images acquired from slightly different points of view. InSAR was proposed by Graham in 1974 and applied for the first time at JPL (Jet Propulsion Laboratory's) in 1986 using airborne data. Today, a large number of research groups are working on DEM generation with InSAR data coming from different airborne and space borne systems. The importance of InSAR is related to its high spatial resolution and good potential precision and to the highly automated DEM generation capabilities. Using Shuttle Radar Topography Mission, the digital elevation model for Kaddam watershed of Godavari river basin has been obtained.

STUDY AREA

The Godavari basin is situated between East longitudes 73˚ 21′ to 81˚ 09′ and North latitudes 16˚ 07′ to 22˚ 50′ in the Deccan plateau covering large areas in the states of Maharashtra, Madhya Pradesh, Chhattisgarh, Orissa, Karnataka, and Andhra Pradesh. Godavari catchment is divided into eight sub basins. The study area is a part of 'Middle Godavari' (G-5) sub basin of River Godavari which lies between latitudes 17˚ 04′ and 18˚ 30′ north and longitudes 77˚ 43′ and 79˚ 53′ east. The watershed spreads over twelve mandals which fall under Adilabad district. The total basin area and entirely lies in the state of Andhra Pradesh.

REVIEW OF LITERATURE

Shuttle Radar Topography Mission (SRTM) consists of a specially modified Synthetic Aperture Radar (SAR) system that flew onboard the Space Shuttle Endeavour which was launched into space on the 11th of February 2000, During an 11-day mission SRTM had the goal to obtain data in order to generate the most complete high-resolution digital topographic database of the Earth. SRTM InSAR was using two radar systems with different wavelengths. One was the C-band radar system operated by the USA having a wavelength λ=5.6cm and the other was the X-band radar system with λ=3cm operated by Germany and Italy. The radar Interferometry technique implies the acquirement of two radar images from slightly different locations in order to calculate the surface elevation. The two antenna systems of the SRTM which were separated by a fixed distance of 60 meters (the mast) were collecting two radar data sets. The main antenna was operated in active and passive mode because it transmitted and received signals while the outboard antenna was just passive. The main antenna illuminated a portion of the Earth´s surface with a pulse of 1/10 of a microsecond using a beam of radar waves. The X-band data set can be bought with a point spacing of 1 arc second (≈30m) while the C-band data are available free of charge with a reduced spacing of only 3 arc seconds (≈ 90m).

METHODOLOGY

DEM Generation: Shuttle Radar Topography Mission is a good source of DEM data for almost anywhere in the world. It is available at 90 meter and, since the end of 2014, 30 meter resolutions.

The first thing to do is to make a note of the Extend of the study area you want to model; the maximum and minimum latitudes and longitudes. If you have a longitude above 180°, subtract 360. Decimal degrees, rather than degrees, minutes and seconds, will be required for clipping later, so convert yours if necessary and make a note of them.

30m Data generation

To generate DEM data from SRTM we should register and logged on in earthexplorer to access and to download DEM data.

The step by step methodology used is as follows: Under *Coordinates*, select *Decimal* and click *Add Coordinates*. Enter the latitude and longitude of one of the 4 corners of the extent. Add the other 3 corners similarly. Then above *Enter Search Criteria* select the second tab, *Data Sets.*

Find *Digital Elevation*, click on the plus sign to expand and find *SRTM*. Expand that and check *SRTM 1 Arc-Second Global*. Then go straight to the fourth tab, *Results*

After a few seconds you should see the tiles you need listed. For each one, Click on *Download options*

(5^{th} symbol) and then click *Download* beside *GeoTIFF*. Save the file, close the *Download Options* form, and repeat for each of your tiles. Note that the save form says the file is a zipped archive, but its extension is .tif and it is not zipped. Move the .tif files to the map folder.

RESULTS AND DISCUSSIONS

The acquired DEM data from SRTM 1 Arc-Second Global is used for generating watershed boundary for the study area. From the digital elevation model obtained, the file is opened in soil and water assessment tool, to create a watershed boundary.

In the large DEMs, the number of cells in a digital elevation model is probably the main factor influencing processing time; it is not the only one. DEM sizes are in millions of cells; for example the 100 million DEM has 10000 rows and 10000 columns.

The SRTM file which we obtained may be larger in size when compared with study area which we need to obtain the watershed boundary.

Figure 1. Digital Elevation Model of Middle Godavari G-5 Sub Basin

To extract the watershed from the digital elevation model, we need to add the watershed boundary in the Layers of SWAT model.

The procedure we follow to clip the watershed boundary from the digital elevation model, the following method is used: use Raster → Extraction → Clipper → select the clipping mode to mask layer → make sure the boundary shape file is selected → click OK to reproject → clear the completion message → Close the clipper form → remove the DEM file to check that we have DEM clipped to the shape.

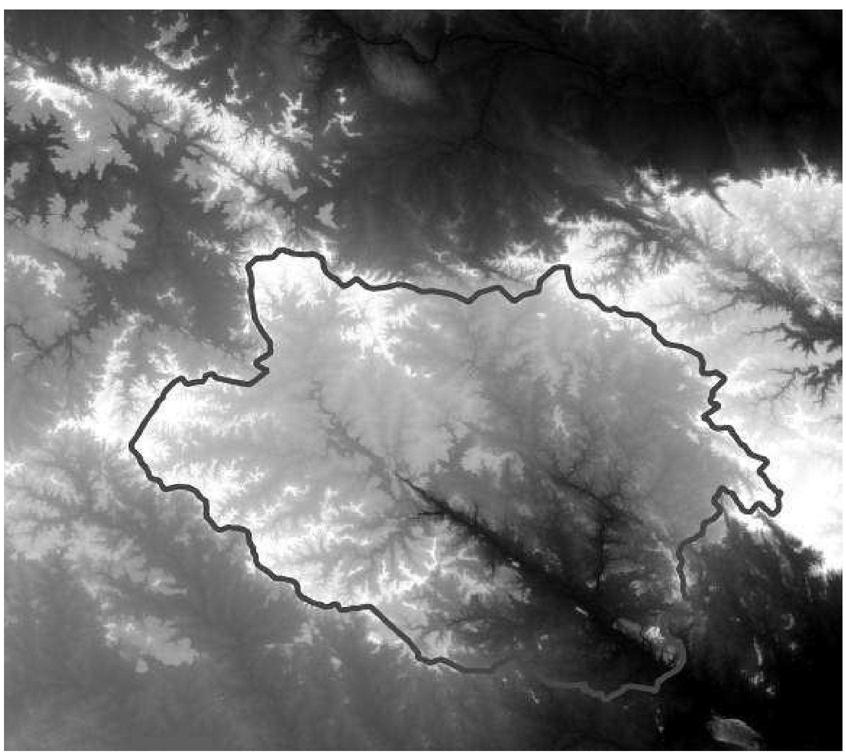

Figure 2. Digital Elevation Model with Kaddam Watershed Boundary

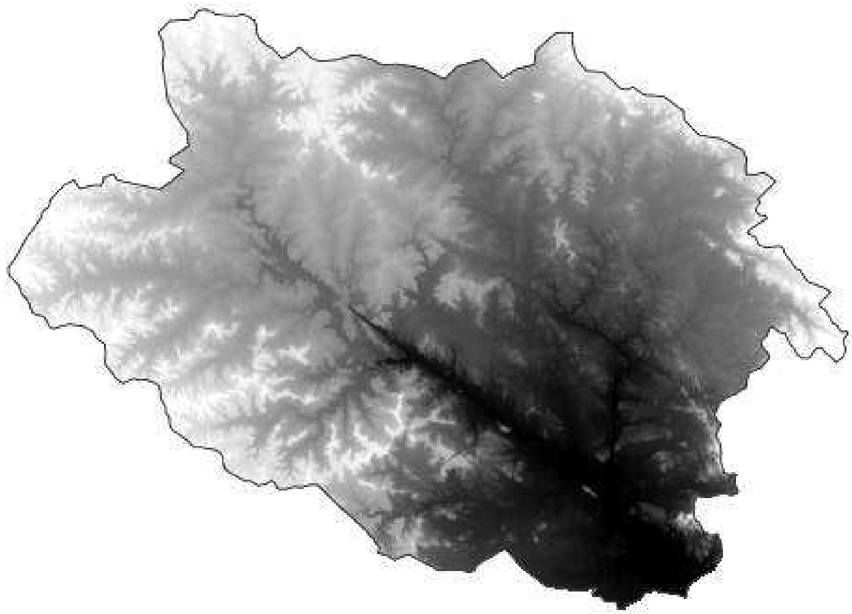

Figure 3. Kaddam watershed Digital Elevation Model

The above figure shows the study area (Kaddam Watershed) which is obtained from the digital elevation model.

CONCLUSIONS

With the rising number of high and very high resolution imaging satellites, with improved configurations and also by interferometry SAR, digital elevation models can be generated in any location with accuracy and with details which was not possible few years ago. For reaching satisfying results, images taken within the same orbit should be preferred. The generated digital surface models have to be reduced to digital elevation models. The project gives the ideal DEM of Kaddam watershed area and accuracy evolution from SRTM 1 Arc-Second Global. Further investigations analyzing the dependence on slope angles will be done.

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