Indexed in
Scopus Compendex and Geobase Elsevier,
Geo-Ref Information Services-USA, List B of Scientific
Journals, Poland, Directory of Research Journals

International Journal of Earth Sciences and Engineering

www.cafetinnova.org

ISSN 0974-5904, Volume 09, No. 01

February 2016, P.P.194-197

Remotely Sensed ASTER and SRTM DEMs Performance Analysis on Bhopal Terrain

RISHIKESHAN C A AND ARPITA BARONIA
National Institute of Technology, Bhopal, INDIA
Email: *rishikesh.ca@gmail.com*

Abstract: The open source ASTER GDEM appears to be the highest resolution global digital elevation model, with 30 m resolution (1 arc second) worldwide. SRTM DEM available with 90 m resolution worldwide (3 arc second), moreover at U.S. geographic area it is available with 30 m resolution. In this research paper we have compared the ASTER GDEM with SRTM DEM of Bhopal district of the Madhya Pradesh. We have analyzed each DEM with terrain parameters derived from them, statistical histogram parameters and visual performance comparison through the image draping techniques. For a descriptive comparison, we looked at shaded reflectance maps, which generally provide a better depiction of the terrain than simple elevation maps and at the same time highlights quality issues in the DEM. The 3 arc second DEM available from SRTM giving essentially near equivalent performance to ASTER 1 arc second data. Much of GDEM, perhaps up to 20% of the data aligned in tiles, has data anomalies that degrade its use for most applications, so preferentially better option is to use the Shuttle Radar DEM.

Keywords: *Open source DEM, SRTM, contour, ASTER GDEM, Virtual GIS*

1. Introduction

The Advanced Space-borne Thermal Emission and Reflection Radiometer (ASTER) on NASA's Terra spacecraft collects in-track stereo using nadir- and aft looking near infrared cameras. Since 2000, these stereo pairs have been used to produce single-scene (60 x 60 km) digital elevation models having vertical (root-mean-squared-error) accuracies generally in between 10 m and 25 m. On June 29, 2009, NASA and the Ministry of Economy, Trade and Industry (METI) of Japan released a Global Digital Elevation Model (GDEM) to users worldwide at free of cost to the Global Earth Observing System of Systems (GEOSS). The ASTER GDEM is a 1 arc-second elevation grid distributed as 1°-by-1° tiles [5].

Several Earth and environmental applications like gravity-field modeling, hydrological studies, and identification of the topographic structure, flood simulations and aerial image ortho-rectification require Digital Elevation Models (DEMs). Accurately created DEMs are important to produce reliable information for mentioned applications like these [2]. SRTM was a mission that launched a space shuttle, and captured data from space. The DEM of SRTM covers the earth between latitude 60°N and 57°S [3]. The SRTM-DEM is generated by the synthetic aperture radar (SAR) technique to acquire the data. The SRTM 90m DEM have a resolution of 90m at the equator, and are provided in mosaiced 5 deg x 5 deg tiles for easy download and use. All are produced from a seamless dataset to allow easy mosaicing [4].

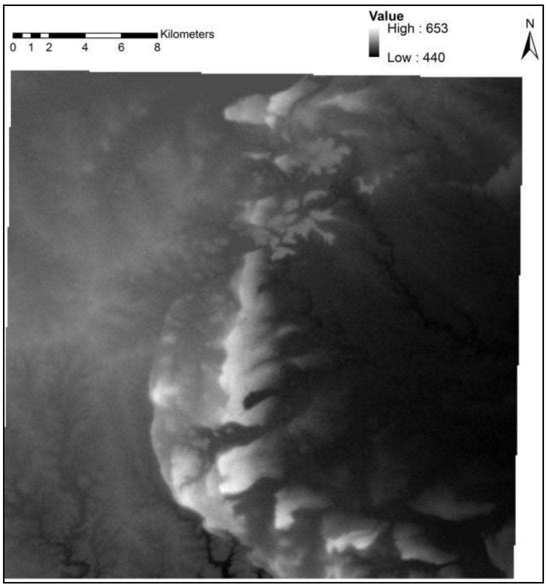
SRTM was a single pass, synthetic aperture radar interferometry (InSAR) campaign conducted in February 2000. For the first time a global high-quality DEM was achieved with a resolution of 1 arc sec (30 m) and 3 arc sec (90 m, free availability) covering the Earth's area between 60°N and 54°S [1]. Vertical errors of the DEM are±16 m and±6 m for absolute and relative accuracy, respectively; the horizontal positional accuracy is ±20 m at a 90% confidence level [2]. The Comparison between SRTM and ASTER derived DEMs allowed a qualitative assessment of the horizontal and vertical component of the error, while statistical measures were used to estimate their vertical accuracy. Elevation difference between SRTM and ASTER products was evaluated using the root mean square error (RMSE), which was found to be less than 50m [6].

This research evaluates the height accuracy of the open-source free to download global digital elevation models namely ASTER Global DEM and Shuttle Radar Topography Mission (SRTM) for the geographic terrain areas of Bhopal.

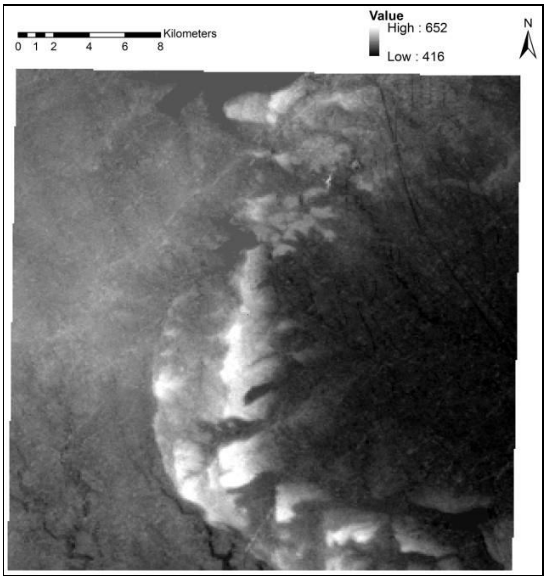
2. Study Area and Data Resources Used

Investigations have been carried out over Bhopal terrain of Madhya Pradesh state of India. Details of the satellite data used for these investigations are summarized in Table1.

1. The satellite data used in this research have been acquired from NRSC Hyderabad, India. The specifications of these data products are given in the table no. 1.
2. The ASTER GDEM and SRTM DEM data have been downloaded from the USGS earth explorer data centre.



(a) SRTM DEM



(b) ASTER GDEM

Figure 1 *Illustration of Bhopal subset of SRTM DEM and ASTER GDEM*

Table.1: *Data resources description*

S. No	Image used	Resolution (m)	Satellite	Area	Date of Procurement
1	PAN	2.5	IRS-P5 (Cartosat-1)	Bhopal	5th April 2009
5	ASTER GDEM	30 (1 ARC)	Terra satellite	Bhopal	17th October 2011
6	SRTM DEM	90 (3 ARC)	Shuttle Radar	Bhopal	1st October 2012

The DEM acquired from SRTM and SOI are shown in the figure 1(a) and 1(b) respectively. The Procured ASTER and SRTMDEM had very large geographic coverage; therefore I extracted a sub-surface from it which is covering our study site Bhopal. The commercial GIS software namely ERDAS imagine and ArcGIS were used for the analytical study and visualization purpose.

3. Methodology

This study evaluates the height accuracy and performance of the free to download ASTER GDEM and SRTM DEM. The Figure 2 shows the overall flow of the activities performed for the present investigation and the following are the core evaluation strategies adopted for their evaluation:

1) Histogram comparison
2) Terrain parameter based (aspect, hill shade and contour generation)
3) Visual comparison using Image draping

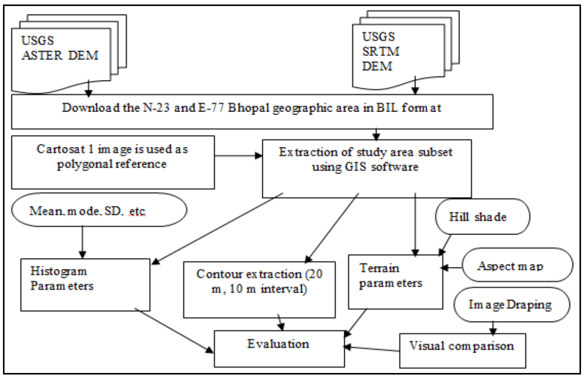
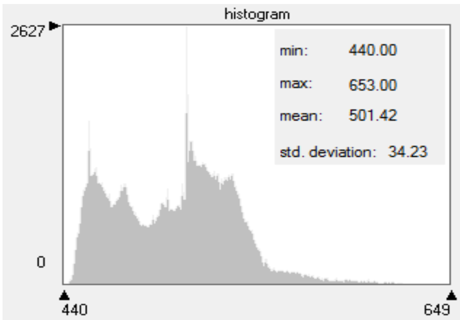


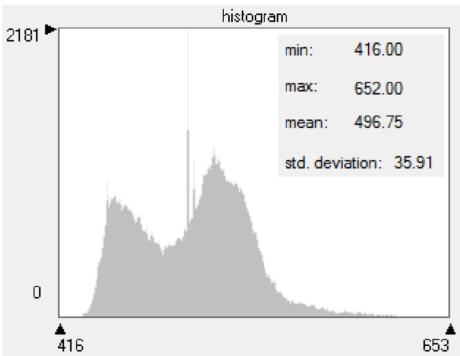
Figure 2 *Methodology adopted for comparative analysis*

4. Results and Discussions

4.1. Histogram Analysis



SRTM



ASTER

Figure 3 *Histogram comparison*

To evaluate these ASTER GDEMs and SRTM DEM we have employed strategies those based on terrain parameters, histogram statistics and visual appearance. The Histogram comparative analysis is carried out using Google earth image parameters of the same area to check the height accuracy especially for max and min values. The Figure (3) shows the outline of histogram performance of both the employed DEMS. ASTER GDEM given good performance and was with most accurate values as compared to the SRTM DEM in this case.

4.2. Terrain Parameter based Analysis

The hill shades generated from SRTM DEM and ASTER GDEM respectively is illustrated in figure 4.The image interpretation and field verification gives us the conclusion that ASTER GDEM gives the more details and almost exact hill shades when compared SRTM DEM. But in the case of terrain aspect, the SRTM DEM gives us more accurate details as compared to ASTER GDEM. The Aspect maps drawn from each DEM were shown in figure 5.

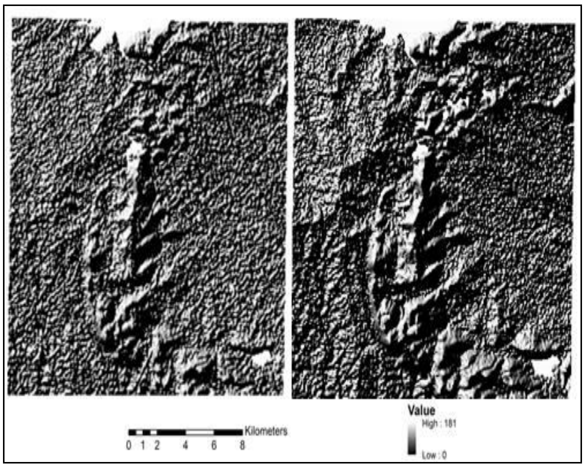
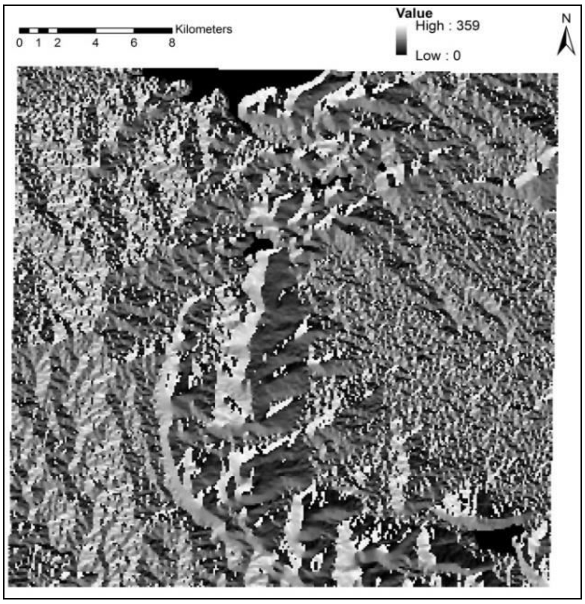


Figure 4 *Illustration of Hill shade view generated from SRTM DEM and ASTER GDEM respectively*



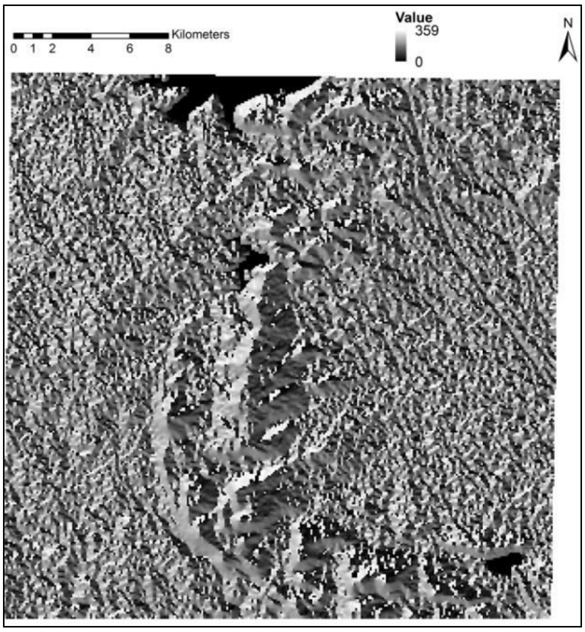


Figure 5 *Terrain Aspect of SRTM and ASTER respectively*

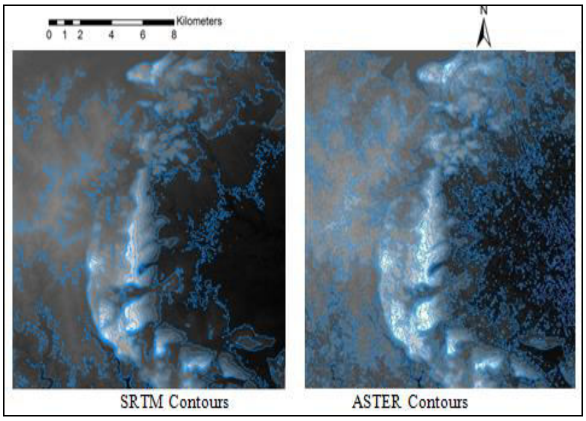


Figure 6 *Extracted contours of SRTM& ASTER DEM with 20 meter interval*

Table 2: *Comparison of contours*

Type DEM used	Number of contour generated	
	20m interval	10m interval
ASTER	3291	6713
SRTM	961	2153

The figure (6) illustrates the extracted contours from the ASTER and SRTM DEM with 20 meter interval by using the GIS software packages. The process of contour extraction is also carried out in 10 meter interval also and the outcome of those investigations is tabulated in table 2. Contours generated from SRTM DEM were found sparse and contours extracted from ASTER GDEM were of very dense, but induced noise is more in ASTER DEM as compared to SRTM. Therefore we can easily conclude that ASTER GDEM providing more details as of its fine resolution and SRTM DEM is giving smooth contours even with its lesser resolution.

4.3. Visual Comparison

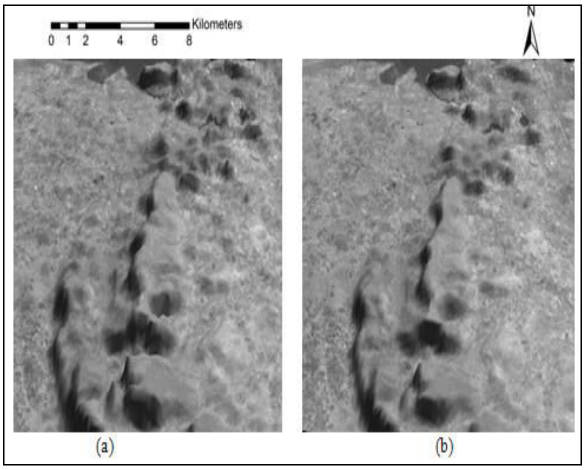


Figure 7 *(a) ASTER and (b) SRTM DEM when draped over a Cartosat1image*

The visual performance of ASTER and SRTM DEM analyzed in virtual GIS environment by employing image draping strategy. It is observed that even at the same vertical exaggeration value both the DEMs are exhibiting different vertical profiles, in our research we have applied vertical exaggeration value of 10 and the results are shown in figure (7). ASTER GDEM is giving more vertical exaggeration than SRTM DEM but vertical accuracy are not found as smooth as of the SRTM DEM's outcome when compared to ground reference features.

5. Conclusions

Following are the conclusions of present research work investigations

1. The 3 arc second DEM available from SRTM giving essentially near equivalent performance to ASTER 1 arc second data. In Much of GDEM, perhaps the data aligned in tiles, has data anomalies that degrade its use for most applications, so preferentially better option is to use the Shuttle Radar DEM.
2. Hill shades reliefs are nicely mapped in ASTER GDEM than SRTM DEM but aspect map generated from SRTM is found better than ASTER GDEM. The number of contours extracted from ASTER DEM data was found to be more numbers than the same from SRTM and this may be due to better resolution of ASTER DEM data.

In certain cases the ASTER DEM over-estimated the altitude values, while SRTM DEM under-estimated (or missed) the height values. However, there was no large deviation between the two methods, and both methods still have their own advantages that cannot be traded off.

References

[1] Van Zyl, J.J., The Shuttle Radar Topography Mission (SRTM): a breakthrough in remote sensing of topography. Act Astrona. 48 (5-12), 559–565, 2001.

[2] E. Sertel, "Accuracy assessment of ASTER global DEM over turkey*" A special joint symposium of ISPRS Technical Commission IV & AutoCarto in conjunction with ASPRS/CaGIS 2010 Fall Specialty Conference November 15-19,* Orlando, Florida. 2010.

[3] Rabus. B, Eineder. M, Roth. A., and Bamler.R. (2002) "The shuttle radar topography mission—a new class of digital elevation models acquired by spaceborne radar" *ISPRS Journal of Photogrammetry & Remote Sensing*, 57, 241–262

[4] Jarvis, A., H.I. Reuter, A. Nelson, E. Guevara, Hole-filled SRTM for the globe Version 4, *available from the CGIAR-CSI SRTM 90m Database (http://srtm.csi.cgiar.org),* 2008.

[5] Tetsushi T., Manabu K., Akira I., Dean G, Michael O., Zheng, Jeffrey D.,Tabatha K., Bill C., Jeff H.Michael A., Robert C.,Claudia C. "ASTER Global Digital Elevation Model Version 2 – Summary of Validation Results" NASA Land Processes Distributed Active Archive Center and the Joint Japan-US ASTER Science Team, 2011.

[6] K. G. Nikolakopoulos,e. K. Kamaratakis and N. Chrysoulakis,"SRTM vs ASTER elevation products. Comparison for two regions in Crete, Greece", *International Journal of Remote Sensing*, Vol. 27, No. 21, 4819–4838, 2006.