



COMPARATIVE ANALYSIS OF GENERATED AND AVAILABLE DIGITAL ELEVATION MODELS (DEM) WITH DGPS SURVEY

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Abstract

These Cartosat-I is a remote sensing satellite meant for cartographic applications like generation of Digital Elevation Model (DEM) and was launched by Indian Space research organization (ISRO). In last few years we have experienced exuberance of Digital Elevation Models in diverse applications and utility in the fields of Terrain analyses, in geomorphology etc., The paper aims to show the comparison between the generated DEM with openly available source like cartosat-v1 from bhuvan and DEM generated with established ground control points with DGPS survey.

Keywords: Digital elevation model, Differential Global Position System (DGPS)

1 INTRODUCTION

The Digital Elevation Model is a digital representation of terrain as a raster (a grid of squares) of the earth's surface that stores Earth's elevation information. A Digital Elevation Model (DEM) represents altitude of Earth surface with latitude and longitude i.e. X, Y horizontal coordinates and height Z [1]. The terms Digital Elevation Model (DEM), Digital Terrain Model (DTM) and Digital Surface Model (DSM) are synonymously used in scientific literature. However, the term digital surface model represents the earth's surface and includes all objects like plants and buildings. But, DEMs represent a convenient way of storing elevation information and of making such information available to applications programs such as GIS. Most frequently the term is used to refer to a set of elevation data. Hence due to its expanding utilization and importance many national cartographic organizations are putting their efforts to generate DEMs of different characteristics. Remote sensing has the ability to cover a large area in a short time which leads remote sensing to be a very dominant tool in the modern-day geosciences. There are many applications of remote sensing in various fields, such as natural disasters, mineral and groundwater exploration, environmental studies, land use, forest studies etc. DEMs are used often in geographic information systems. DEM can also be obtained from direct topographic surveys but now are being obtained through remote sensing (Sharma et al., 2010).

National Remote Sensing Agency, has published a report on the evaluation of Indian National DEM generated from Cartosat-1 Data. This report provides the overall quality of CartoDEM version 1 in terms of absolute accuracy and a comparison with other globally available DEMs like ASTER and SRTM in terms of accuracy.

This assessment can give an indication of how accurate currently available DEM like CartoDEMs for general purposes. As indicated earlier, it is essential to assess the accuracy of the DEM from stereo data without using ground control points because the collection of control points requires a lot of money and time.

2 STUDY AREA

The B.V.Raju Institute of Technology, Narsapur, Medak District, Telangana, India. It is lying between the world coordinates of 78.253031 decimal degrees west longitude and 78.260499 decimal degrees East longitude, 17.729559 decimal degree North latitude, 17.722967 decimal degrees South latitude. The total area covered by the study area is 0.353327 square kilometers.



Figure 1: Boundary of BVRIT,Narsapur Overlaid on Georectified Satellite imagery taken from Google Earth pro

A. Georeferenced Satellite Imagery

Use The imagery of the study area is taken from the Google Earth Pro, then georectified with Control coordinates of DGPS Survey using ArcGIS Software. DATA USED

B. Cartosat-1:DEM-version-1

CARTOSAT1 is the first Indian Remote Sensing Satellite capable of providing in-orbit stereo images. The images were used for Cartographic applications meeting the global requirements. Cameras of this satellite have a resolution of 2.5m (can distinguish a small car).The Cartosat1 provided stereo pairs required for generating Digital Elevation Models, Ortho Image products, and Value added products for various applications of Geographical Information System (GIS).

C. Georeferenced Satellite Imagery

Use The imagery of the study area is taken from the Google Earth Pro, then georectified with Control coordinates of DGPS Survey using ArcGIS Software.

D. Control Data From DGBS Survey Of Study Area

Differential GPS (DGPS), or indeed any differential global navigation satellite system GNSS2(DGNSS) in general, greatly increases the potential accuracy of either GPS or GLONASS. By determining the major error sources at a base (or reference) station and applying the corrections thus derived to any other station (which may be mobile), these errors can be largely eliminated

1. Static and Kinematic GPS surveying techniques: High precision techniques based on post processing of carrier phase measurements
2. Differential GPS (DGPS): instantaneous low to moderate accuracy positioning and mapping technique based on pseudo range measurements.
3. Real Time Kinematic (RTK): versatile high precision techniques that use carrier phase measurements in an instantaneous positioning mode.
4. The DGPS RTK techniques, because they are able to deliver results in real time, are very powerful GPS positioning technologies.
5. There are essentially two types of conventional static GPS surveying techniques.

3 METHODOLOGY

The DGPS survey is carried out establishing Ground Control Points evenly spreaded through the study area. The altitude data from the DGPS survey of our study area is imported to ArcGIS software. The elevation point data of our study area is then converted to raster using Topo to Raster tool in spatial analyst tools in ArcGIS. The generated DEM from Cartosat-1:Version-1 of our study area is imported to ArcGIS then the raster is converted to point data ,by using From raster to point Tool in ArcGIS. The points obtained are again converted by highlighting gridcode/elevation field using topo to raster tool in ArcGIS software.

The data obtained by DGPS survey and the Data by cartosat-1:DEM-Version1 are Superimposed using a georectified image of the

study area in ArcGIS software. Where georectification of imagery which is taken from Google Earth Pro is done using DGPS control points in ArcGIS Software.

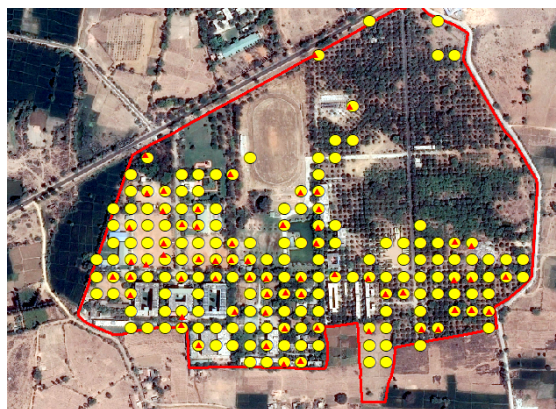


Figure 2: Super imposition of DGPS survey control points on generated points from cartosat-1:DEM-Version-1, the image is georectified satellite imagery taken from Google Earth Pro

4 RESULTS AND CONCLUSION

A. Comparison of DEM

In this study 112 Ground control points are established using DGPS survey where the elevations are collected. Elevations of the same points are extracted using Cartosat-1: DEM-Version-1 data provided by Bhuvan (A NRSC website). Elevation values of CartoDEMs including the one generated using DGPS survey show that, CartoDEMs have higher values of elevation because of the ellipsoid pattern adopted in their study. The change in elevation has occurred due to the change in datum. CartoDEM uses the datum based on geoid and for data for GCP are taken using DGPS, which uses datum based on spheroid and hence in the processing, the datum is taken as spheroid based. Hence, for the sake of comparison, all the values are to be reduced to the same datum.

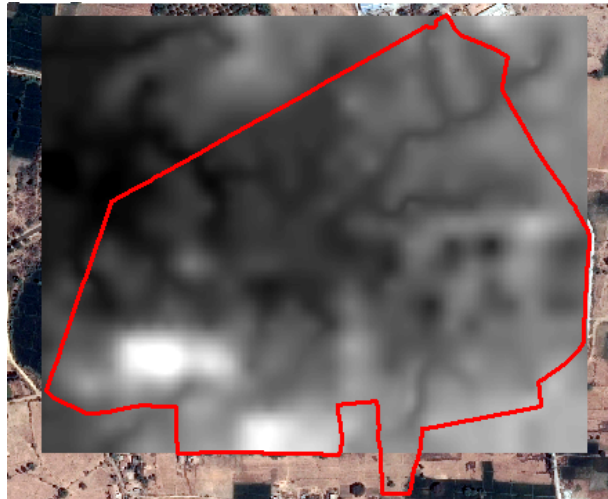


Figure 3: DEM of the study area created using DGPS control points on ArcGIS Software

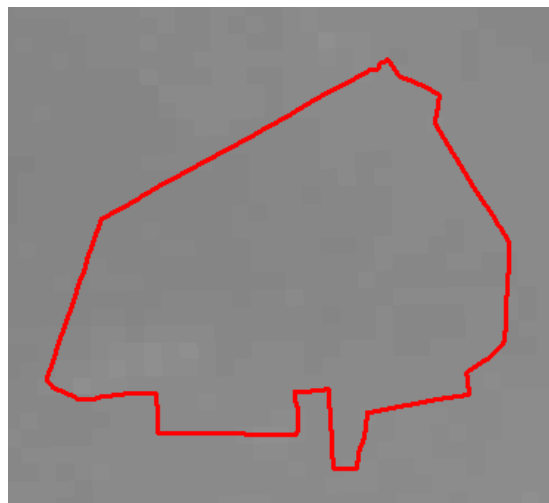


Figure 4: DEM of the study area taken from BHUVAN an open source NRSC web site. Cartosat-1:DEM-Version-1 of 78.253031 decimal degrees west longitude 17.729559 decimal degree North latitude, 17.722967 decimal degrees South latitude

B. Comparing TIN Generated using ArcGIS

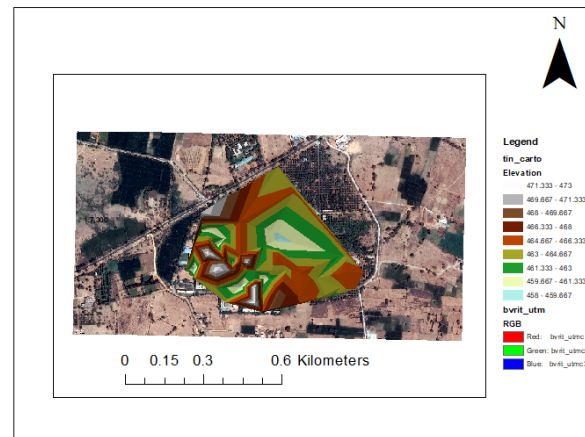


Figure 5: TIN model of study area created using Cartosat-1;DEM-Version-1 elevation data on ArcGIS Software

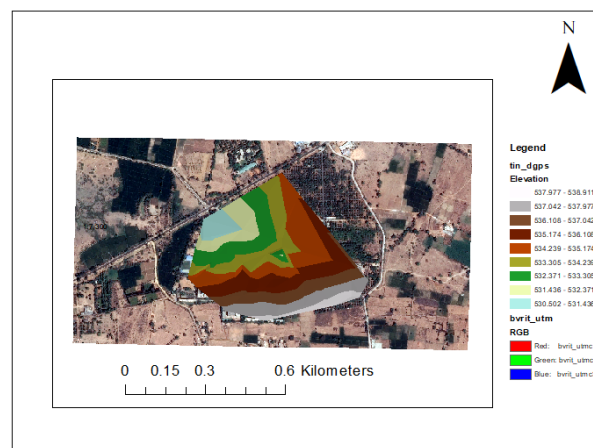


Figure 6: TIN model of study area created using DGPS Survey elevation data on ArcGIS Software

Table 1: ELEVATION DATA OF CARTOSAT-1:DEM-VERSION-1 AND DGPS SURVEY OF STUDY AREA

FID	Shape *	GCP	y	x	DGPS_Eleva	Cartosat_1	Relative_D
74	Point	GCP-75	1961881.09	209045.185	535.776	463	72.776
75	Point	GCP-76	1962283.988	209075.325	534.459	463	71.459
76	Point	GCP-77	1961849.654	209191.587	536.715	464	72.715
77	Point	GCP-78	1961853.534	209221.783	536.751	463	73.751
78	Point	GCP-79	1961873.813	209309.682	536.905	465	71.905
79	Point	GCP-80	1961820.26	209339.885	538.595	465	73.595
80	Point	GCP-81	1961976.518	208750.389	532.702	466	66.702
81	Point	GCP-82	1961926.627	208808.909	533.241	467	66.241
82	Point	GCP-83	1961800.761	208838.324	536.5	468	68.5
83	Point	GCP-84	1961763.374	208867.7	537.51	464	73.51
84	Point	GCP-85	1961916.579	208926.738	535.388	467	68.388
85	Point	GCP-86	1961881.351	208986.407	535.193	463	72.193
86	Point	GCP-87	1961725.63	209014.737	538.337	463	75.337
87	Point	GCP-88	1961881.09	209045.185	535.776	464	71.776
88	Point	GCP-89	1961943.893	209073.996	533.732	464	69.732
89	Point	GCP-90	1961849.654	209191.587	536.715	465	71.715
90	Point	GCP-91	1961873.813	209309.682	536.905	466	70.905
91	Point	GCP-92	1961875.276	209339.285	537.119	466	71.119
92	Point	GCP-93	1961910.123	208779.397	534.768	465	69.768
93	Point	GCP-94	1962006.566	208808.429	531.908	464	67.908
94	Point	GCP-95	1961800.761	208838.324	536.5	464	72.5
95	Point	GCP-96	1961976.315	208867.471	532.771	467	65.771
96	Point	GCP-97	1962070.376	208926.21	531.435	465	66.435
97	Point	GCP-98	1961759.326	208985.031	537.594	464	73.594
98	Point	GCP-99	1961725.63	209014.737	538.337	466	72.337
99	Point	GCP-100	1961732.99	209043.51	538.219	467	71.219
100	Point	GCP-101	1961943.893	209073.996	533.732	466	67.732
101	Point	GCP-102	1961879.673	209162.38	536.035	466	70.035
102	Point	GCP-103	1961849.654	209191.587	536.715	466	70.715
103	Point	GCP-104	1961976.315	208867.471	532.771	466	66.771
104	Point	GCP-105	1962070.376	208926.21	531.435	466	65.435
105	Point	GCP-106	1961913.975	208955.292	534.063	472	62.063
106	Point	GCP-107	1961759.326	208985.031	537.594	473	64.594
107	Point	GCP-108	1961732.99	209043.51	538.219	469	69.219
108	Point	BASE-AIB	1961792.409	209073.058	536.867	469	67.867
109	Point	BASE-GIR	1961879.673	209162.38	536.035	466	70.035
110	Point	GCP-109	1961913.975	208955.292	534.063	472	62.063
111	Point	GCP-110	1961819.618	208984.132	536.646	473	63.646
112	Point	GCP-111	1961783.804	209161.273	537.608	466	71.608

5 CONCLUSION

- DGPS is effectively used to find out the elevations and compute the Digital Elevation Models (DEM).
- The maximum and minimum elevations of the 112 points from DGPS Survey are 538.895 m and 531.435 m.
- The maximum and minimum elevations from the Cartosat Data are 463 m and 473 m.
- The highest difference in elevation in comparison with both DGPS Survey and Cartosat Data is 62.063.
- The lowest difference in elevation in comparison with both DGPS Survey and Cartosat Data is 73.751 m.
- In comparison between the generated DEM with DGPS survey with openly available source like cartosat-v1 from bhuvan it is found that the DEM with DGPS Survey is higher and the average elevation difference between them is about 67m.
- The elevations from the DGPS Survey are found to be more accurate in comparison.

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