Asian Journal of Convergence in Technology **Volume 4 Issue III**
ISSN No.:2350-1146, I.F-5.11

Comparative Analysis of Digital Elevation Models: A Case Study of Kayadhu Watershedle

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Abstract*—TIn last few years, Digital Elevation Models (DEMs) have established more popular due to their diverse utility and applications in the fields like hydrology, forestry, precision farming, geomorphology etc. DEM is used for characterizing the topography and to derive the stream network, ridge line, thereby to study the landscape within the watershed area. DEMs from satellite imageries like Cartosat -1 is becoming popular with wide applications. The resolution is allowed for comparison is the DEM of ISRO (30m) (cartosat-1). These DEMs were created using different methods and technologies, and they can differ in how they represent the topography of the same area. This study shows that the differences in these DEMs and illustrates how these differences can produce various analytical outcomes when used to study local problems. The primary objective of this study is to compare the accuracy of Cartosat -1 DEM and DEM generated from Google earth. The google earth DEM is generated with the help of 'Triangulation' which is SAGA (System for Automated Geoscientific Analyses) tool. For the comparison of both the DEMs, Kayadhu watershed is taken as study area. The comparative analysis of DEM is carried out on the basis of the Stream network and contours of 5m, 10m and 15m interval with their respective lengths. The counts of contours of Cartosat -1 DEM for 5 m, 10 m and 15 m interval was found to be 27794, 27954 and 18184 respectively with contour lengths at that respective interval about 30503.2 km, 12803.7 km and 8421.45 km. The counts of contours of Google Earth DEM for 5 m, 10 m and 15 m interval was found to be 1485, 776 and 492 respectively with contour lengths at that respective interval about 8308.45 km, 4112 km and 2741 km. From this study the stream counts of Cartosat-1 DEM and Google Earth DEM was found to be 34449 and 52668 with stream length about 432 km and 1134 km respectively. This study has been carried out in open source environment viz. QGIS, SAGA, GRASS GIS and Google Earth. In this study, the Cartosat -1 DEM and Google earth DEM has minimum to maximum elevation from the mean sea level was found to be 336 m to 481 m and 408.7 m to 549.3m respectively. From the study, it is observed that Cartosat-1 DEM has more accuracy than DEM generated from Google Earth. Therefore, the Cartosat -1 DEM gives clear 3D topography than DEM generated from google earth.

Keywords*—QGIS, Cartosat-1 DEM, Google earth, SAGA, GRASS GIS.

I. INTRODUCTION

The most common and the simplest form of terrain representation in 3D are the Digital Elevation Models (DEMs). The satellite based DEMs can be assessed by comparing the elevation data generated from them with elevation data obtained from topographic maps. Digital Elevation Model (DEM) is a digital representation of terrain as a raster (a grid of squares) of the earth's surface that stores Earth's elevation information (Al-husban, 2017.). 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 techniques in various fields, such as natural disasters, mineral and groundwater exploration, environmental studies, land use, forest studies etc. (Lakshmi, S.E.,2017). DEMs are used often in geographic information systems. The DEM dataset is also referred as a primary (measured) DEM, whereas the Raster DEM is referred as secondary (computed) DEM (Patel, 2012). Existing satellite based DEMs still show large drawbacks with respect to consistency, availability, cost, degree of resolution, and coverage. Cartosat-1 DEM with 2.5m spatial resolution to be used in this study an attempt has been made to examine the accuracy of DEM derived from Google earth.

This paper assessing the quality of Cartosat-1 data through comparison with Google earth data sets. In this study the elevation data of Cartosat-1 DEM and DEM created from Google earth are compared. This study has been carried out in open source software QGIS, SAGA, GRASS GIS and Google earth

II. STUDY AREA

The study area is located between 75°99' E to 77°99' E longitude and 19°00' N to 20°00' N lattitude. The length of this river is 80 km and the total area of the Kayadhu watershed is 2194 Sq. Km. The river Kayadhu is entering the Hingoli district from the northwest turns at a right angle flows north-eastwards under the influence of a similar turn of the spur and joins the Painganga. The Kayadhu river bound the major part of the district. Hingoli district situated in a Godavari Basin and falls under the Painganaga basin with Kayadhu-Purna sub-basin. The district of Hingoli boasts of some small hillocks that are situated at a height of about 500 to 600 m from sea level. The Kayadhu river is the tributary of Painganga river. The reservoir dam on the Kayadhu river near the village of Sapli in the Kalamnuri taluka of the Parbhani district provides water for irrigation for around 55,000 acres. The water of this river benefits greatly the Hadgaon taluka. Hiwara hill range seperates the Kayadhu and Purna river basins. Due to erosion and weathering of adjacent hills and rock thick alluvium is found in some places. In district Deccan trap having horizontal layers of basalt are predominant. No other major minerals are found in district.

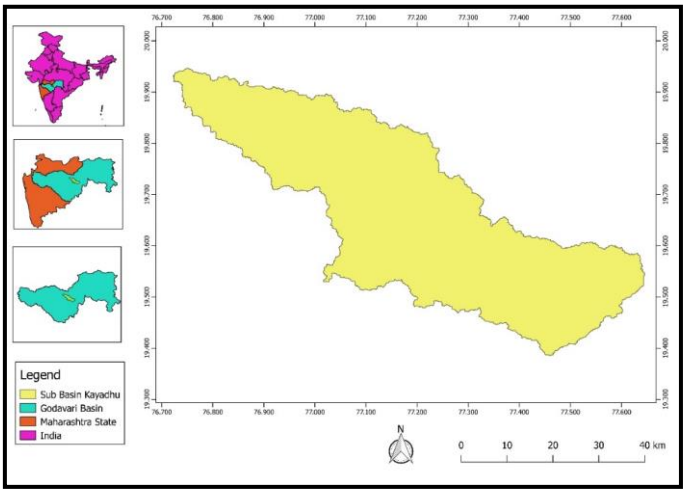

Fig1. Geographic location of study area

III. MATERIALS AND METHODOLOGY

QGIS is an Open Source Geographic Information System. QGIS currently runs on most Unix platforms, Windows, and mac OS. Google Earth is an open source software also used in this study. The Carto-DEM version-1 is downloaded from the Bhuvani.e Indian Geo- Platform of ISRO. The unique characteristics of CartoSAT-1 and planned products are given below (Murthy *et al*, 2008).

- Spatial Resolution - 2.5m
- Radiometric Resolution - 10bits
- Swath - 30km
- Product Dimensions - 30km * 30km
- National Level DEM – Carto-DEM

CARTOSAT-1
The CARTOSAT-1 spacecraft launched by the Indian Space Research Organisation in May 2005 is dedicated to stereo viewing for large-scale mapping and terrain modelling applications. It is configured with two panchromatic cameras, AFT (Afterward looking) and FORE (Foreword looking) with a spatial resolution of 2.5 m, which facilitates along-track stereo vision of the imaging scene. It covers a swath of ≈30 km with a base-to height ratio of 0.62.

SAGA
SAGA (System for Automated Geoscientific Analyses) is a free, hybrid, cross-platform GIS software. SAGA provides many geoscientific methods which are bundled in so-called module libraries. SAGA has been designed for an easy and effective implementation of spatial algorithms. SAGA offers a comprehensive, growing set of geoscientific methods. SAGA provides an easily approachable user interface with many visualization options. SAGA runs under Windows and Linux operating system. SAGA is a Free Open Source Software (FOSS).

GRASS GIS
Geographic Resources Analysis Support System (commonly termed GRASS GIS) is a geographic information system (GIS) software suite used for geospatial data management and analysis, image processing, producing graphics and maps, spatial and temporal modelling, and visualizing. It can handle raster, topological vector, image processing, and graphic data.

Google Earth
Google Earth is a computer program that renders a 3D representation of Earth based primarily on satellite imagery. The program maps the Earth by superimposing satellite images, aerial photography, and GIS data onto a 3D globe, allowing to see cities and landscapes from various angles

3.1 Methodology

The DEM comparison has been performed for the region of Kayadhu watershed of Hingoli district Maharashtra, India. High resolution Cartosat-1 DEM was downloaded from Bhuvan and it is compared with DEM generated from Google earth. In this study, the Cartosat-1 DEM with horizontal resolution of 2.5 meters was downloaded from the website https://bhuvan.nrsc.gov.in/bhuvan_links.php. Fig. 1 shows the geographic location of study area. DEM is mainly used for representing the terrain surface in 3D form and to interpret the topographic features. The contours of 5 m, 10 m and 15 m interval of the Cartosat –1 DEM were extracted. The count and length of that respective contour interval was calculated. The stream network of Cartosat-1 DEM was extracted by

using GRASS r. watershed tool. The count and length of the streams was calculated.

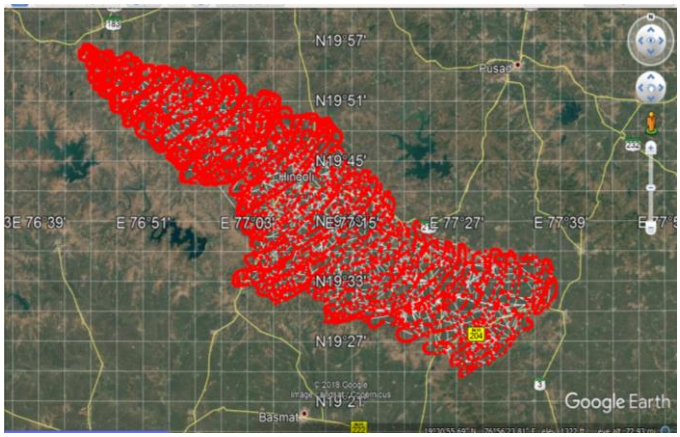

Fig. 2 Point data from Google Earth

In order to generate the DEM from Google Earth, some points were taken from Google Earth as shown in Fig.2. The altitude of that points was computed by using TCX converter software. Then the DEM was generated by using triangulation in SAGA tools. Similarly, the contours of 5m, 10m and 15m interval of that DEM were extracted also the count and length of that respective contour interval was calculated. The stream network of Google Earth DEM was extracted by using GRASS r. watershed tool also the count and length of the streams was calculated.

Also for visual comparison of Cartosat -1 DEM with DEM generated for google earth, 3D topography were made by using Qgis2threejs tool in QGIS.

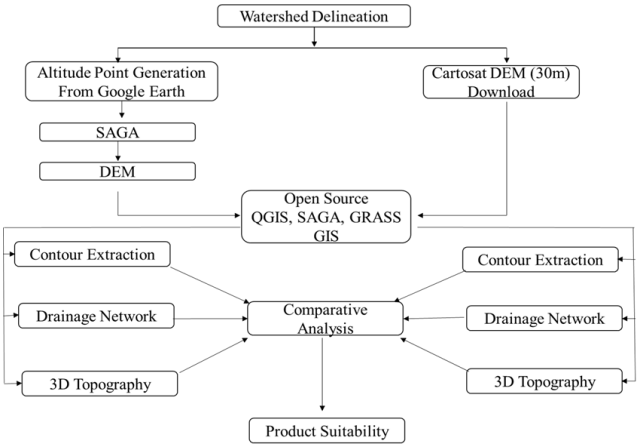

Fig. 3 Detailed methodology for the comparative analysis of Cartosat -1 DEM and Google earth DEM

IV. Results and Discussion:

The result shows that the comparison between Cartosat -1 and DEM generated from google earth. There was difference in elevation of both DEMs.

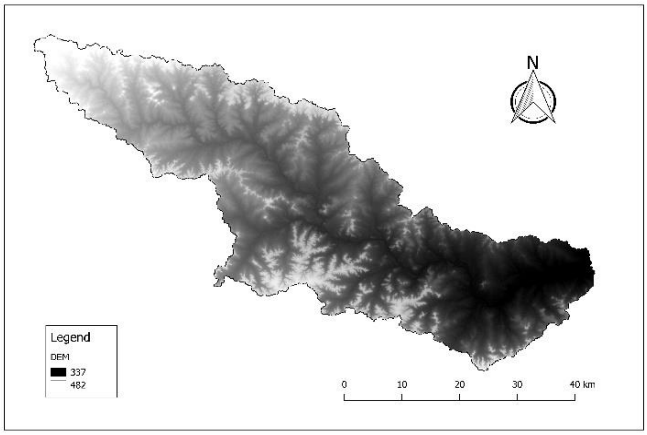

Fig. 4 a) Cartosat -1 DEM

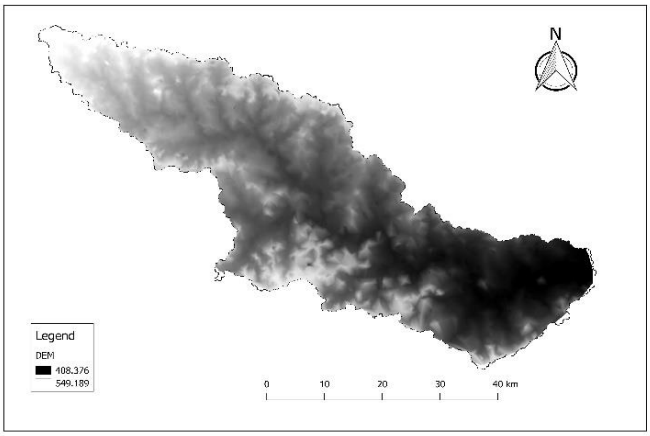

Fig. 4 b) Google earth DEM

The Cartosat -1 DEM has minimum and maximum elevation from the mean sea level is 337m to 482m respectively as shown in fig.4 a). The DEM generated from google earth has minimum and maximum elevation from the mean sea level is 408.376 m to 549.189 m respectively as shown in Fig. 4 b).

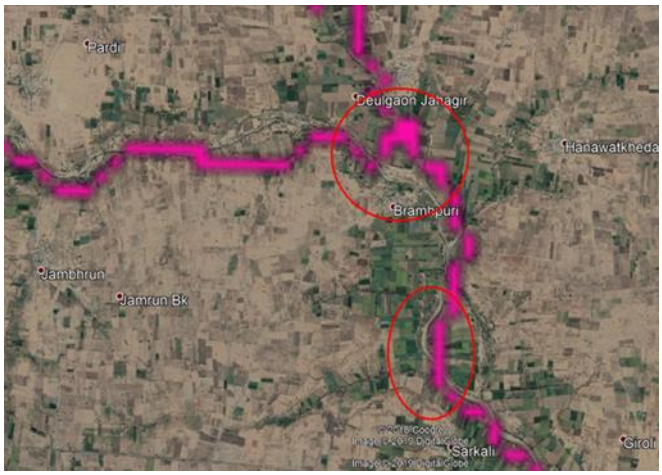

Fig .5 a) Google earth view of Cartosat -1 Streams

Fig. 5 b) Google earth view of streams from Google Earth DEM

When the Streams of Cartosat – 1 DEM was viewed on the Google earth pro shows that the nearly exact position of the streams as shown in Fig. 5 a) The streams of google earth DEM does not properly align as compared to streams of Cartosat -1 on the google earth as shown in Fig. 5 b)

Table 4.1 Comparison of Cartosat -1 DEM and Google earth DEM on the basis of contours

DEM	Contour					
	5 m		10 m		15 m	
	Count	Length (Km)	Count	Length (Km)	Count	Length (Km)
Cartosat -1 DEM	27794	30503.2	27954	12803.7	18184	8421.45
Google earth DEM	1485	8308.45	776	4112	492	2741

The comparison of Cartosat-1 DEM with Google Earth DEM on the basis of contours shows that the contours at 5m, 10m and 15m intervals of the Cartosat –1 DEM are more than the contours of Google earth DEM at respective interval. Also the length of contours at 5m, 10m and 15m intervals are larger than contour length of Google earth DEM at respective interval as shown in table 4.1

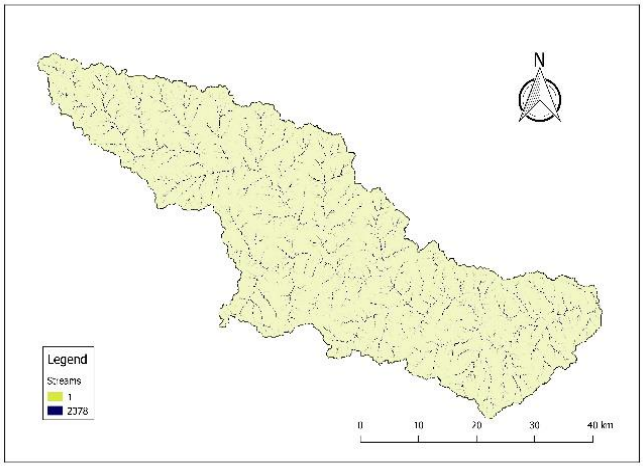

Fig.6 a) Stream network of Cartosat – 1 DEM

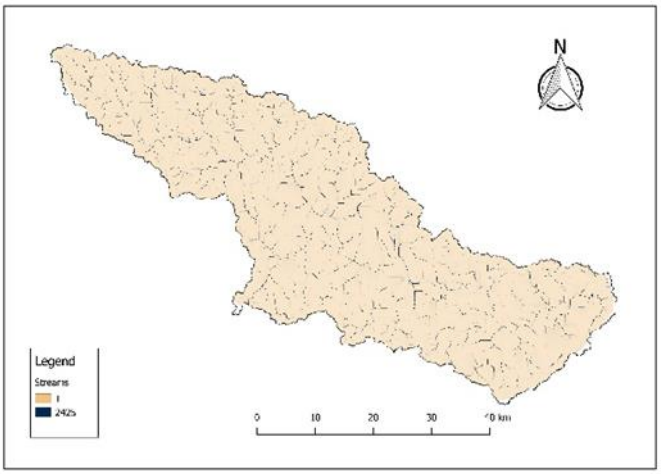

Fig. 6 b) Stream network of Google earth DEM

Table 4.2 Comparison of Cartosat -1 DEM and Google earth DEM on the basis of Stream Network

DEM	Stream Network	
	Count	Length (km)
Cartosat -1 DEM	34449	432
Google earth DEM	52668	1134

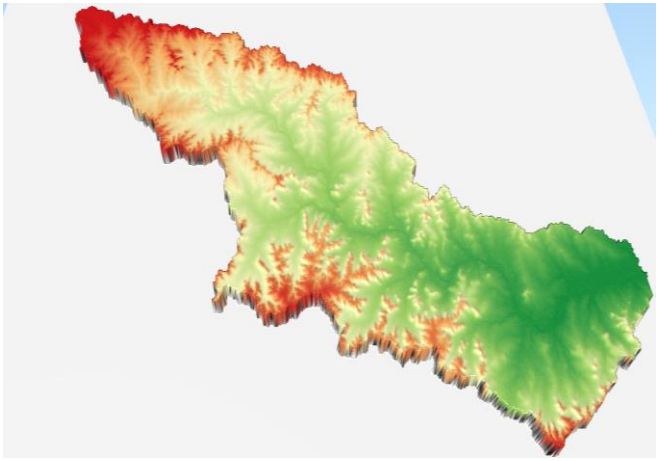

Fig. 7 a) 3D view of Cartosat –1 DEM

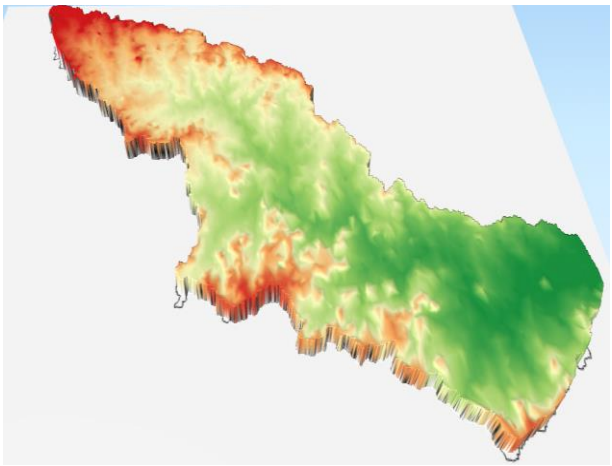

Fig. 7 b) 3D view of Google earth DEM

From the study the Cartosat -1 DEM shows better elevations in 3D view than Google earth DEM as shown in Fig. 7 a) and Fig. 7 b). Therefore, for 3D Topography analysis Cartosat -1 DEM is suitable.

V. CONCLUSIONS

This study compares the elevation, contours and stream network generated from Cartosat-1DEM and DEM generated from Google Earth. It is observed that the elevation value of Cartosat -1 DEM gives better result than the elevation values of Google earth DEM. Hence, there are maximum no of contours of Cartosat -1 DEM as compared to Google earth DEM. Google earth DEM does not give good elevation accuracy as compared to Cartosat -1 DEM. From the stream network it is concluded that the Cartosat-1 DEM gives less no of streams than Google Earth DEM. The google earth DEM gives fine streams. Therefore, for stream network Google Earth DEM are more suitable. Due to accurate elevation of Cartosat –1 the 3D topography gives better visualization than Google Earth DEM. This study is useful for environmental mapping tasks like avalanche hazard mapping, landform studies and 3D perspective terrain visualization. Cartosat-1 DEM provided good and satisfactory information on topographic related analyses especially in flat terrain region.

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