Scholars Journal of Engineering and Technology
Abbreviated Key Title: Sch J Eng Tech
ISSN 2347-9523 (Print) | ISSN 2321-435X (Online)
Journal homepage: https://saspublishers.com

OPEN ACCESS

Digital Elevation Model (DEM) from Google Earth Pro and Freely Downloadable DEMs – A Case Study

Celine George[1*], Karthika Mohan[2]

[1]Senior Principal Scientist & Head, Centre for Water Resources Development and Management (CWRDM) Sub Centre, Manimalakunnu, Oliyappuram P. O., Koothattukulam – 686 662, Ernakulam (Dist), Kerala, India
[2]Poject fellow, Centre for Water Resources Development and Management (CWRDM) Sub Centre, Manimalakunnu, Oliyappuram P. O., Koothattukulam – 686 662, Ernakulam (Dist), Kerala, India

DOI: https://doi.org/10.36347/sjet.2024.v12i08.002 | **Received:** 27.06.2024 | **Accepted:** 05.08.2024 | **Published:** 09.08.2024

***Corresponding author:** Celine George
Senior Principal Scientist & Head, Centre for Water Resources Development and Management (CWRDM) Sub Centre, Manimalakunnu, Oliyappuram P. O., Koothattukulam – 686 662, Ernakulam (Dist), Kerala, India

Abstract **Original Research Article**

Digital Elevation Models (DEMs) play a crucial role in watershed modelling and hydrological analysis. In recent years, the availability of high-resolution satellite imagery and remote sensing data has made it easier to generate DEMs using different software and platforms. Google Earth Pro (GEP) is one such platform that offers a user-friendly interface for generating DEMs, making it a popular choice among researchers and practitioners. However, the accuracy and reliability of the DEMs generated by GEP in different regions and under different environmental conditions have not been fully investigated. The increasing development activities change the earth's topography, which in turn makes it necessary more frequent production of DEM. As it is a costlier task urban areas are given priority. This article focuses on a new methodology for generating DEM from GEP for a small area in the Ernakulam District of Kerala State, India. DEM prepared from GEP is then compared with different DEMs like SRTM 30m, ALOS PALSAR 12.5m and Cartosat 10m as well as ground surveyed values. It is observed that DEM prepared from GEP is as precise as other freely available DEMs as well as Cartosat 10m. Hence this DEM can be used for planning micro level developmental activities for smaller areas.
Keywords: Digital Elevation Model, Srtm Dem, Alospalsar, Cartosat, Google Earth Pro.

INTRODUCTION

Digital Elevation Model (DEM) is a digital cartographic dataset in three (xyz) coordinates and are produced from various techniques such as photogrammetry from aerial photos and satellite images (Ayhan *et al*., 2006; Casson *et al.*, 2003), radar images (AbuBakr *et al*., 2013), laser scanning using airborne Light Detection and Ranging (LiDAR; Allen *et al*., 2012) and classical ground survey methods (Hirt *et al.*, 2010). Their precision and accuracy will depend on the sensor used, technique, scale and type of terrain (Florinsky, 2012). Some of the global elevation information obtained by any of these techniques is publically available. The free availability of elevation data has opened good source for collection of topographic information for research and alertness. Detailed information about the earth's surface is increasingly required for simulations of natural problems such as landslides, floods etc. For hydrologic analysis, topographic information plays a vital role in watershed delineation, determining the flow directions etc.

The earth's topography is changing rapidly due to increase in the land development. As the production of DEM is a costly task, it is updated at large interval of time. Further, only urban areas are given priority rather than remote areas. Only a few studies have been carried out to compare the global DEMs with each other or with local DEM (Dawod and Al-Ghamdi, 2017; Ouerghi *et al.*, 2015).

In this paper the Google Earth is introduced as another source to retrieve the elevation data in terms of DEM by deploying an open source elevation converter using the online utility GPS Visualizer. A comparative assessment has been done between SRTM DEM, ALOS PALSAR DEM, CARTOSAT DEM and Google Earth Pro generated DEM so that an alternative elevation data can be introduced for the conventional available DEM for micro level infrastructural planning for a smaller area.

MATERIALS AND METHODS

Study Area

A small area which covers midland and low land area in Ernakulam district of Kerala, India has been selected for this study. The particular area has been selected because since some elevation data obtained from total station survey work was available. The study area lies between 09°57’17.86” & 09°58’29.1” N latitude and 76°22’4.84” & 76°23’33.83” E longitude covering an area of 5.96 km^2.

Data Used

The digital elevation models are a powerful tool for visualizing and analyzing terrain data and they have many applications in fields such as geology, geography, environmental science, civil engineering etc. Following are the DEMs used in this study.

SRTM 30m DEM

The Shuttle Radar Topography Mission (SRTM) 1-arc-second data file for the study area was downloaded from the USGS Earth Resources Observation and Science (EROS) Center web site. SRTM DEM (Shuttle Radar Topography Mission Digital Elevation Model) data is a high-quality digital elevation dataset that provides accurate topographic information about the Earth's surface. SRTM DEM data provides elevation values in meters for each pixel in a grid-like format, making it a valuable tool for a wide range of applications, such as geology, environmental science, hydrology, and urban planning. The SRTM DEM data has become one of the most widely used elevation datasets for scientific research and practical applications. SRTM 1 Arc-Second Global (Digital Object Identifier (DOI) number :/10.5066/F7PR7TFT) elevation data offer worldwide coverage of void filled data at a resolution of 1 arc-second (30 meters) and provide open distribution of this high-resolution global data set free of cost (https://www.usgs.gov). Earth Explorer issues SRTM data with a regularly spaced grid of elevation points in three file formats of which the Geo-referenced Tagged Image File Format (GeoTIFF) is a TIFF file with embedded geographic information. This is a standard image format for GIS applications.

ALOS PALSAR 12.5m DEM

ALOS PALSAR DEM is a digital elevation model derived from ALOS PALSAR satellite imagery. ALOS PALSAR is an L-band synthetic aperture radar (SAR) that operated from 2006 to 2011 and captured high-resolution images of the Earth’s surface in all weather conditions and day and night. ALOS PALSAR DEM has a spatial resolution of 12.5m, which means that each pixel represents an area of 12.5 by 12.5 m on the ground. ALOS PALSAR DEM covers most of the global land areas except Antarctica, Greenland, Iceland and northern Eurasia. ALOS PALSAR DEM is useful for various applications such as landform analysis, flood simulation, route modelling and avalanche hazard mapping.

ALOS PALSAR DEM is generated by applying radiometric terrain correction (RTC) on the original SAR data. RTC produces a geometrically and radio metrically corrected image in Geo Tiff format. The RTC products are available at both 12.5m and 30m resolutions for different polarizations. ALOS PALSAR DEM can be downloaded from AFS Data Search (https://search.asf.alaska.edu/) web site and selecting the area of interest.

CARTO 10m DEM

Cartosat DEM is a digital elevation model derived from Cartosat-1 satellite imagery. Cartosat-1 is an Indian remote sensing satellite launched in 2005, which carries two panchromatic cameras that can capture stereo images of the Earth’s surface. Cartosat DEM has a spatial resolution of 10m, which means that each pixel represents an area of 10m by 10m on the ground. Cartosat DEM covers the entire Indian subcontinent and is used for various applications such as landform analysis, flood simulation, route modelling and avalanche hazard mapping. Cartosat DEM is one of the finest DEM products available for the Indian region, as it works more accurately over plain and moderately undulating lands (Agarwal *et al*., 2020). However, it also has some limitations, such as high mean errors and root mean square errors in rugged high altitude topographies.

DEM Extraction from Google Earth Pro

For preparing the DEM from Google Earth Pro, first the study area was identified after enabling the terrain layers in the layers window of Google Earth. Now using the create path tool, a path was created via points throughout the study area. This was saved as a kml file. Preparing DEM from the kml file involves different steps. The kml file was first converted to elevation data file using the GPS Visualizer online platform to get an output as a gpx file or a txt file. GIS software was used for further processing. Here in this study, using QGIS the txt layer was converted to shape file and finally using interpolation techniques DEM has been prepared from this shape file.

For comparing the different DEMs of the study area SRTM with 30m resolution and ALOS PALSAR with 12.5m resolution were downloaded from corresponding websites and also Cartosat with 10m resolution which was purchased from NRSC were used. All the DEMs were converted so as to have the same resolution of 10m.

Errors and Accuracy

DEM accuracy is commonly estimated by calculating the RMSE of elevation computed by comparing DEM points and reference (ground-truth) points (Ivanov and Kruzhkov, 1992; Bolstad and Stowe, 1994). Accuracy of DEMs is evaluated in terms of common error statistics such as Mean error, mean absolute error, RMSE etc., for particular region or continent (Sharma *et al*., 2010; Bulatovic *et al*., 2012).

Root Mean Square Error Evaluation

Methods of accuracy estimation are based on the analysis of the differences observed between the elevation values provided by two different sources. The estimator RMSE is computed as follows:

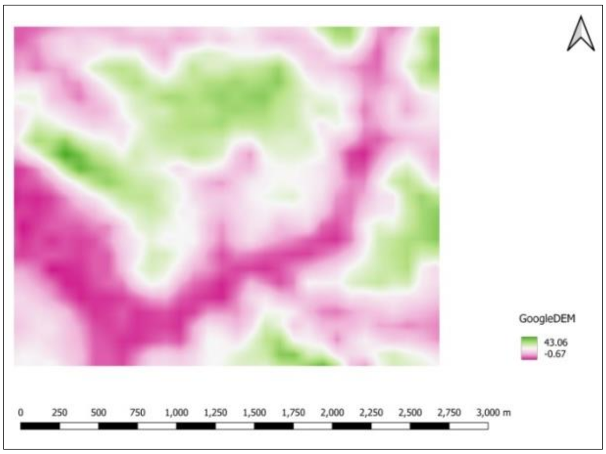
$$\text{RMSE} = \sqrt{\sum_{i=1}^{N}\left(y_i - y_j\right)^2 / (N-1)} \qquad (1)$$

Where y_i is an elevation point from the resulting DEM y_j the value of the corresponding point on the reference surface and N is the number of sample points.

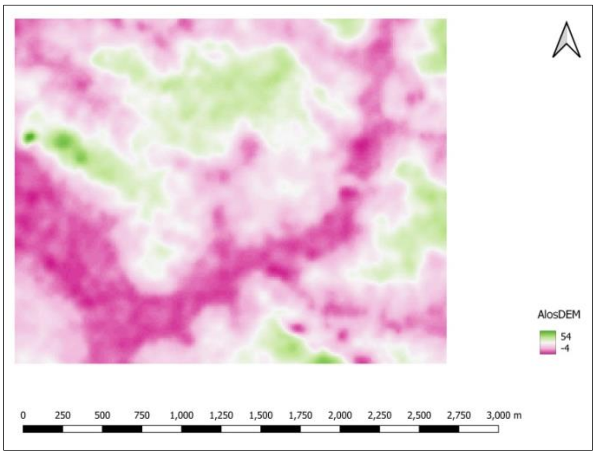
Also the absolute arithmetic mean and standard deviation of these differences are computed and compared.

RESULTS AND DISCUSSIONS

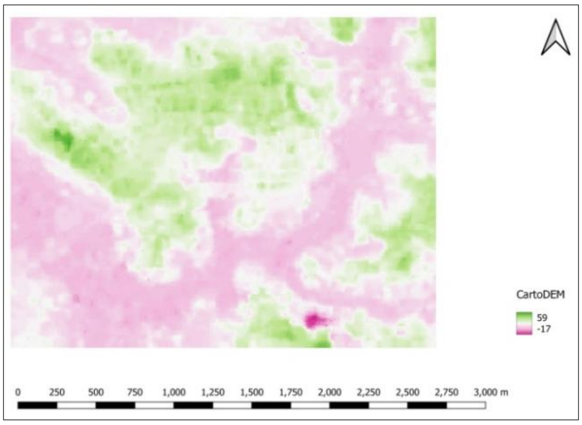
The digital elevation model (DEM) prepared from the Google Earth Pro, downloaded DEMs of SRTM, ALOS PALSAR and purchased Cartosat DEM for the study area is shown in Figure1.



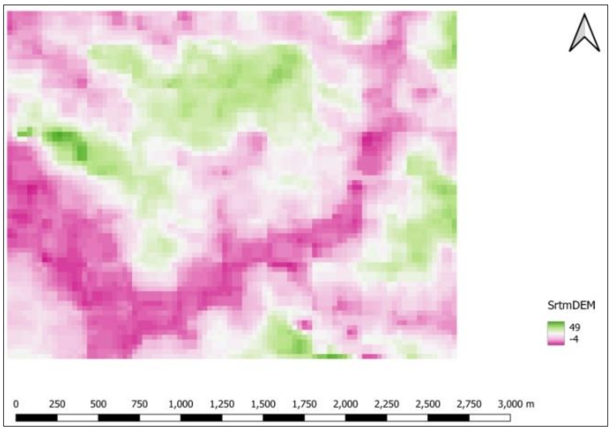
i) GEP DEM



ii) Alos Palsar DEM



iii) Cartosat DEM



iv) SRTM DEM

Figure 1: DEMs prepared for the study area

About 900 ground surveyed elevation points were available for the study area. The elevation values of these corresponding points were extracted for all the DEMs prepared. For this the plugin tool 'Point Sampling Tool' of QGIS is used. The absolute arithmetic mean, Standard deviation and the RMSE were computed for these extracted elevation data and are given in table 1.

Table 1 Comparison of different DEMs with the ground data

PARAMETERS	*Mean Elevation*	*Max. Elevation*	*Min. Elevation*	*Arithmetic mean*	*Standard deviation*	*RMSE*
Ground Points	16.33	53.87	0.70			
GEP DEM	15.86	34.51	0.68	1.08	2.63	2.84
SRTM DEM	15.38	38.00	1.00	2.56	2.83	3.82
Cartosat DEM	18.32	47.00	2.00	3.91	3.53	5.27
Alos Palsar DEM	15.11	37.00	-1.00	2.48	2.70	3.66

Source: Karthika *et al*., 2023

From the above table, as the error values are very less the Google Earth Pro DEM can be considered acceptable for research purposes. Further this finding will be useful for researchers who are having difficulties in collecting DEM for their studies. Researches do not need to spend money or conduct tedious surveying or analysis of data, if the same accuracy can be obtained from Google Earth Pro. The accuracy and resolution of the GEP DEM depends on the number of points in the path created on Google Earth Pro. The more the number of points, the fine is the resolution and accuracy of DEM prepared. Finer resolution maps are required for flood mapping as well as other hydrological model studies.

The study has to be extended to different physiographic regions, land cover areas etc. and more analysis including relief parameters has to be carried out to arrive at a conclusions regarding the acceptability of the GEP DEM for different regions and land cover in planning and development purposes. For this study area, the DEM prepared is found to be good in flood mapping and other analysis purposes. GEP DEM prepared is as precise as freely available DEMs as well as 10m Cartosat DEM, which is a paid one. Hence GEP DEM can be used as an alternative elevation data for micro level infrastructural planning for smaller areas. This methodology enables researches to prepare elevation data for their studies with relatively less error, without much difficulty.

REFERENCES

- AbuBakr, M., Ghoneim, E., El-Baz, F., Zeneldin, M., & Zeid, S. (2013). Use of radar data to unveil the paleolakes and the ancestral course of Wadi El-Arish, Sinai Peninsula, Egypt. *Geomorphology, 194*, 34-45.
- Agarwal, R., Sur, K., & Rajawat, A. S. (2020). Accuracy assessment of the CARTOSAT DEM using robust statistical measures, Model, Earth Syst. Environ, 6, 471-478. https://doi.org/10.1007/s40808-019-00694-9
- Allen, T. R., Oertel, G. F., & Gares, P. A. (2012). Mapping coastal morphodynamics with geospatial techniques, Cape, Henry, Virginia, USA. *Geomorphology, 137*, 138-149.
- Ayhan, E., Erden, O., Atay, G., & Tunc, E. (2006). Digital orthophoto generation with aerial photos and satellite images and analyzing of factors which affect accuracy, *XXIII International FIG Congress*, Munich, PS5.8.2 (0552).
- Bolstad, P. V., & Stowe T. (1994). An evaluation of DEM accuracy: Elevation, slope and aspect. *Photogrammetric Engineering and Remote Sensing*, 60, 1327-1332.
- Casson, B., Delacourt, C., Baratoux, D., & Allemand, P. (2003), Seventeen years of the 'La Clapière" landslide evolution analysed from ortho-rectified aerial photographs. *Engineering Geology, 68*, 123-139.
- Dawod, G., & Al-Ghamdi, K. (2017). Reliability of recent global digital elevation models for geomatics applications in Egypt and Saudi Arabia, *Journal of Geographic Information System, 9*(6), 685- 698.
- Florinsky, I. V. (2012). *Digital Terrain Analysis in Soil Science and Geology*. Academic Press, Elsevier, USA, 379.
- Hirt, C., Filmer, M. S., Featherstone, W. E. (2010). Comparison and validation of recent freely-available ASTER-GDEM ver1, SRTM ver4.1 and GEODATA DEM-9S ver3 digital elevation models over Australia. *Australian Journal of Earth Sciences, 57*, 3, 337-347.
- Ivanov, V. I., Kruzhkov, V. A. (1992). Evaluation of the optimal discretization step for a digital elevation model. *Geodezia i Cartografia, 5*, 47-50.
- Karthika, M., & Celine, G. (2023). "Preparimg a digital elevation model from google earth pro and its comparison with other DEMs – a case study from Kerala", 35th Kerala Science Congress, 10-14 February 2023. *ksc.kerala.gov.in/wp-content/uploads/2017/07/35KSC_f.pdf*
- Ouerghi, S., ELsheikh, R. F. A., Achour, H., & Bouazi, S. (2015). Evaluation and validation of recent freely-available ASTER-GDEM V. 2, SRTM V. 4.1 and the DEM derived from topographical map over SW Grombalia (test area) in North East of Tunisia, *Journal of Geographic Information System, 7*(3), 266-279.