Accuracy Comparison of 30m Resolution SRTM and ASTER Derived Digital Elevation Models over AL-khamisah Region Using RTK-DGPS Data

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Abstract. Digital elevation models are topographic models of the Earth’s terrain that have had the heights of vegetation, and other cultural landscapes digitally removed. The accuracy and morphologic details of the height models represent the quality. DEMs provide one of the most useful digital data sets for a wide range of users. This study is aimed at comparing and validating (in terms of elevation accuracy) SRTM and ASTER Global Digital Elevation Model (GDEM) with DGPS Points for AL-Khamisah region. Root-Mean-Square Error (RMSE) is used as the standard measure of accuracy for feature positioning. The results, of this study showed that vertical (RMSE) for ASTER DEM 4.92 m and for SRTM 2.10 m. The objectives of this study are to effectively evaluate the accuracy of ASTER and SRTM DEM datasets and determine which DEM most accurately represents low relief terrain. Findings of this analysis may be used as resources to determine the relevance of a particular DEM dataset in low relief terrain.

1. Introduction

DEM data's files contain of only height values of the aterrain, cover a specified area in a separate grid-like 3-D space of the specific surface in consideration. DEMs can be suitable for extracting and visualization of terrain parameters, cartographic map group and updating, modeling water flow or mass movement amongst others, [1 - 2].

Photogrammetry is a passive system which senses reflected solar radiation from ground surface and records the returns alphanumerically or on films [3]. The Advance Spaceborne Thermal Emission Radiometer (ASTER)-GDEM has been produced using this photogrammetry procedure. Advance Spaceborne Thermal Emission Radiometer (ASTER) is an fee multispectral imaging instrument built by METI and operates on the NASA Terra platform. Images are learned in 14 spectral bands using three separate telescopes and sensor schemes. These contain three visible and near-infrared (VNIR) bands with a spatial resolution of 15 m, six short-wave-infrared (SWIR) bands with a spatial resolution of 30 m, and five thermal infrared (TIR) bands that have a spatial resolution of 90 m. VNIR Band3 also is acquired using a backward-looking telescope, thus as long as along-track stereo coverage from which high-quality digital elevation models (DEMs) are generated as one of a suite of ASTER standard data products. ASTER DEM standard data products are produced with 30 m postings, and have Z exactitudes generally between 10 m and 25 m root mean square error (RMSE),[4]. Different photogrammetry, radar is an active system that prepares its own energy source for illuminating the land. The Shuttle Radar Topography Mission is an international project spearheaded by the US National Geospatial-Intelligence Agency (NGA) and the US National Aeronautics and Space Administration (NASA) has providing
digital elevation model (DEMs) for over 80% of the globe. The SRTM data's is available as 3 arc second (approx. 90 m resolution) DEMs,[5].

2. Study region
The study region is called (AL-khamisah, Thi Qar governmenmet ), which covers about (12.137683 Square Kilometers), the study region located in the South of Iraqi country, Latitude (34° 01' 93.9") to (34° 04' 22.2") N, Longitude (63 ° 70' 42.3") to (63 ° 84' 94.6") E. The survey for this area were accomplished using Differential Global Position System (DGPS), type Topcon Hyper-II. The coordinate system of this data set is defined using the following values which have the following projection data: Projection (UTM), Units(Meter), Zone(38).

3. Methodology

3.1. DEM Data Acquisition

3.1.1. DGPS Data
The data of terrain elevation from RTK (Real Time Kinematic)-DGPS Field Surveys for a part of AL-khamisah region. The field survey depends on the 2 GCPs (Ground Control Points) as Base points, which have been defined using the DGPS Static mode. These points are considered as reference points in all RTK gathering mode and later correction process, shown in table (1).

| GCPs | E (m)       | N (m)          | Duration     | Method |
|------|-------------|----------------|--------------|--------|
| B1   | 639701.511  | 3401328.789    | 04:23:00     | Static |
| B2   | 639701.095  | 3401329.013    | 02:29:25     | Static |

3.1.2. SRTM and ASTER GDEM Data
The DEM learned for the study was a 30 m spatial resolution SRTM which relates to the study region, which was downloaded from http://srtm.csi.cgiar.org, which it is obtainable in Geographic decimal degrees projection, with WGS84 horizontal datum and EGM96 vertical datum. Also, the ASTER DEM corresponds to the same study region. was downloaded from https://earthdata.nasa.gov/user, which are
posted on a 1 arc-second (approximately 30-m at the equator) grid, referenced to the World Geodetic System (WGS84)/1996 Earth Gravitational Model (EGM96) geoid.

3.2. Calculating Vertical Error of ASTER, SRTM DEMs
RMSE could then be calculated for each of the ASTER and SRTM elevation test raster's through comparing the differences in heights toward the respective RTK-DGPS interpolated DEM by overlaying the raster's. The RMSE procedures the dispersal of the frequency distribution of deviations between the original elevation data and the DEM data's, mathematically articulated as [6]:

\[
\text{RMSE}_{\text{DEM}} = \sqrt{\frac{\sum (Z_i - Z_j)^2}{n}} \quad \ldots \ldots \ldots \ldots \ldots \ldots \quad (1)
\]

Where: \((Z_i: \text{Elev GPS})\) is the orientation elevation (m) derived from GPS, and \((Z_j: \text{Elev DEM})\) is the consistent value derived from each DEM), and \(n\) corresponds to the total numbers of points [7]. The larger the value of the RMSE, the greater the difference between two sets of measurements of the same singularity. It would be usual, thus, to use this as a quantification of the uncertainty of one or both sets of amounts. Its widespread use can be attributed to the relative ease of design and reporting and the ease with which the idea can be assumed by most users of elevation data's [8].

4. Results and Analysis
To evaluate the accuracy of the mathematical techniques accuracy of the produced DEM from field survey and SRTM, ASTER data's, for study region, this procedure was followed:-

1. Producing the DEM from the DGPS and SRTM, ASTER (Resolutions 30m) by using the (GIS9.3) software. Figures (2), (3), (4.9) represent the raster digital elevation model for the study region.

Figure (2), shows the DEM for DGPS-30m data of the Al-khamisah region land, figure (3), shows the DEM for ASTER-30m data of the Al-khamisah region land and figure (4), shows the DEM for SRTM-30m data of the Al-khamisah region land.

Figures (2). The DEM for DGPS-30m data of the Al-khamisah region Land.
2. The histogram of digital elevation modal below shows the range of elevation points values around the mean value (consistent to DGPS points) for study region. The mean values for Al-khamisah region Land in table 2: are 5.6748 and 3.9757 for SRTM and ASTER data correspondingly. Standard deviation (SD) are 1.8147 for SRTM dataset, whereas SD are
4.4385 for ASTER dataset. Both the mean values and the standard deviation of elevation values suggest that both DGPS and SRTM provide better alternatives for associated topographical applications.

**Figure 5.** Tables for SRTM DEM, and ASTER DEM (equivalent to DGPS) for Al-khamisah region Land.

| Statistical parameters | DGPS (30m) | SRTM (30m) | ASTER (30m) |
|------------------------|------------|------------|-------------|
| Min                    | 3          | 1          | -4          |
| Max                    | 11         | 11         | 8           |

Table 2: ASTER, SRTM, and DGPS Statistical analysis Al-khamisah region Land.
3. The value of Root Mean Square Error (RMSE) considered by using equation (1), RMSE for ASTER DEM 4.92 m and for SRTM 2.10 m. Through the use of SRTM results show much better than ASTER.

5. Conclusions
With the results of the DEM analysis, the measure of how well the ASTER and SRTM DEM datasets respective models spatially fit the respective terrain can be evaluated. The elevation range depicted in Figure 5 indicates that there is greater variation in the ASTER and SRTM DEM datasets. Herein paper, two near-global DEMs, SRTM and ASTER-GDEM, are associated and corroborated against a reference DEM applied on Al-khamisah region.

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