HASAN KALYONCU UNIVERSITY
GRADUATE SCHOOL OF
NATURAL AND APPLIED SCIENCES

COMPARATIVE EVALUATION OF VERTICAL ACCURACY OF GROUND CONTROL POINTS FROM ASTER-DEM SRTM-DEM WITH RESPECT TO ALOS-DEM

M.Sc. THESIS
IN
CIVIL ENGINEERING

BY
MUHİTTİN GÜVENÇ

FEBRUARY 2020

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M.Sc. Thesis
In
Civil Engineering

Hasan Kalyoncu University

Supervisor
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by
Muhittin GÜVENÇ
February 2020

	GRADUATE SCHOOL OF NATURAL & APPLIED SCIENCES INSTITUTE **M.Sc. ACCEPTANCE AND APPROVAL FORM**

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I declare that all information contained in this document has been received and presented in accordance with academic rules and ethical behavior. I also declare that, in accordance with these rules and practices, I have fully cited and mentioned all materials and results that are not original for this work.

MUHİTTİN GÜVENÇ

ABSTRACT

COMPARATIVE EVALUATION OF VERTICAL ACCURACY OF GROUND CONTROL POINTS FROM ASTER-DEM SRTM-DEM WITH RESPECT TO ALOS-DEM

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Supervisor:Assist. Prof. Dr. Hüseyin Çağan KILINÇ
February 2020
58 pages

The concept of Digital Elevation Model (DEM) has put on by Miller in the 1950s. Digital Elevation Model is a continuous surface of the elevation from which terrain attributes (slope, aspect, curvature, topographic index, drainage area and network) are extracted. DEM represents the topographic surface with a set of three-dimensional coordinates, and it also represents the numerical representation of the ground surface, mainly for computer operations. Shuttle Radar Topography Mission is a project conducted in collaboration between NASA, the U.S. National Geographic-Intelligence Agency (NGA), the U.S. Department of Defense, DLR and Agenzia Spaziale Italiana. The Advanced Space borne Thermal Emission and Reflectance Radiometer Global Digital Elevation Model (ASTER GDEM) is a product generated from optical data collected by the ASTER instrument onboard NASA's Terra satellite. ALOS DEM, The Japan Aerospace Exploration Agency (JAXA) released "ALOS World 3D – 30m (AW3D30)" open global DEM, the global digital surface model (DSM) dataset with a horizontal resolution of approximately 30-meter mesh (1×1 arc second). The purpose of this study, the distribution of GCPs AW3D30, SRTM and ASTER city of Gaziantep to say, is to analyze the impact of vertical accuracy on Turkey. The study area Gaziantep is located between 36^{o} 28' and 38^{o} 01' eastern longitudes and 36^{o} 38'and 37^{o} 32'northern latitudes. The vertical accuracy of each points selected from ASTER, SRTM regard to ALOS DEMs were estimated by using methods explained in methodology over GCP's vertical component (Z component) of ASTER, SRTM and ALOS, seriatimly. The results observed from the RMSE, R-RMSE, MAE, NRMSE and RMSE% of selected GCPs were plotted. The vertical accuracy are derived by finding the difference between the points Z component (from ALOS DEM) and the points Z component computed from different SRTM DEM and ASTER DEM for finding the vertical accuracy. The results indicate that the vertical accuracies can be improved for all the plotted points. We also compared the vertical accuracy of ALOS AW3D30 with respect to ASTER and SRTM datasets on different land cover types such as plain area, open forests, city area, hilly part areas. The land cover types and terrain slopes jointly contribute to the accuracy variations of the samples, and the latter is likely to have a greater impact than the former. The analysis indicates that ALOS AW3D30 provides the best accuracy of analysis vertical accuracy of ground control points, followed by SRTM, and then by ASTER GDEM2 DEMs.

Keywords: Digital Elevation Model, SRTM, Aster, Alos, Topographic Surface, Vertical Accuracy

ÖZET

ASTER-DEM SRTM-DEM
YER KONTROL NOKTALARININ ALOS-DEM İLE
İlGİLİ DİKEY DOĞRULUĞUN
KARŞILAŞTIRMALI DEĞERLENDİRİLMESİ

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Şubat 2020
58 sayfa

Sayısal Yükseklik Modeli (SYM) kavramı 1950'lerde Miller tarafından ortaya atılmıştır. Sayısal Yükseklik Modeli, arazi özelliklerinin (eğim, en boy, eğrilik, topografik indeks, drenaj alanı ve ağ) çıkarıldığı sürekli bir yüzeydir. SYM, bir dizi üç boyutlu koordinat ile topografik yüzeyi temsil eder ve ayrıca temel olarak bilgisayar işlemleri için zemin yüzeyinin sayısal yüksekliğini temsil eder. SRTM sayısal yükseklik modeli NASA, ABD Ulusal Coğrafi İstihbarat Ajansı (NGA), ABD Savunma Bakanlığı, DLR ve Agenzia Spaziale Italiana işbirliği ile yürütülen bir projedir. Gelişmiş Uzay kaynaklı Termal Emisyon ve Yansıtma Radyometresi Global Dijital Yükseklik Modeli (ASTER GDEM), NASA'nın Terra uydusunda bulunan ASTER cihazı tarafından toplanan optik verilerden üretilen bir üründür. Japonya Havacılık ve Uzay Araştırma Ajansı (JAXA) tarafından, yaklaşık 30 metrelik (1 × 1 ark) yatay çözünürlüğe sahip küresel dijital yüzey modeli (DSM) veri kümesi olan "ALOS World 3D - 30m (AW3D30)" bu çalışmada kullanılan diğer bir veridir. Çalışma alanı olan Gaziantep ili 36^{o} 28 've 38^{o} 01' doğu boylamları ile 36^{o} 38 've 37^{o} 32' kuzey enlemleri arasında yer almaktadır. ALOS, SRTM'den ALOS sayısal yükseklik verilerine göre seçilen her bir noktanın dikey doğruluğu, SRTM ve ALOS'un dikey bileşeni (Z bileşeni) üzerinden seri olarak açıklanan yöntemler kullanılarak tahmin edilmiştir. Seçilen zemin kontrol noktalarının RMSE, R-RMSE, MAE, NRMSE ve RMSE% 'sinden gözlemlenen sonuçlar çalışmada belirtilmiştir. Dikey doğruluk Z bileşeni (ALOS DEM'den) ve dikey doğruluğu bulmak için farklı SRTM DEM ve ASTER DEM'den hesaplanan noktalar Z bileşeni arasındaki farkın bulunmasıyla elde edilmiştir. Sonuçlar dikey doğrulukların tüm çizilen noktalar için geliştirilebileceğini göstermektedir. Bu çalışmanın amacı, AW3D30, SRTM ve ASTER verilerinin Gaziantep'teki dağılımının Türkiye'ye düşey doğruluğun etkisini analiz etmektir Ayrıca bu çalışmada ALOS AW3D30'un düz doğruluğu, açık ormanları, şehir alanı, engebeli parça alanları gibi farklı arazi örtüsü tiplerindeki ASTER ve SRTM veri setlerine göre dikey doğruluğu karşılaştırıldı. Analiz sonucunda, ALOS AW3D30'un yer kontrol noktalarının dikey doğruluğunun ardından SRTM ve ASTER GDEM2 DEM'lerin en iyi analiz doğruluğunu sağladığı görülmüştür.

Anahtar kelimeler: Sayısal Yükseklik Model, SRTM, Aster, Alos, Topografik Yüzey, Dikey Doğruluk

To My Family…

ACKNOWLEDGEMENTS

First of all I would like to express my deepest gratitude to my supervisior of Assist. Prof. Dr. Hüseyin Çağan KILINÇ, Assist. Prof. Adem YURTSEVER and Assist. Prof. Yunus OZTÜRK Also, I would like to express my sincere appreciation to Assoc. Prof. Dr. Hüseyin Çağan KILINÇ for the support, guidance and insights that he has provided me throughout the study. I would like to thank my family, for her endless helping Furthermore, I would like to thank my mother and Miyase GÜVENÇ, Ömer GÜVENÇ and other friends and to those related to my study.

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SYMBOLS AND ABBREVIATIONS

yy.: Year

Km: Kilometer

Km^2 :Kilometer Square

Km^3 : Cubic Kilometer

m : Meter

m^2 : Meter square

m^3 : Cubic meter

cm : Cantimeter

mm : Milimeter

sn: second

^{0}C : Santigrat Degree

TUIK : Turkish Statistical Institute

ÇED : Environmental Impact Assesment Report

MGM : General Directorate of Meteorology

GASKI : Water and Sewerage Administriation of Gaziantep Province

AFAD : Disaster and Emergency Directorate

UNESCO: United Nations Educational, Scientific and Cultural Organization

GAP : Project of Southeast of Turkey

DPT: State planning organization

UÇEP: National envrionmental action plan

SÇD: Water frame directive

NHYP: River basin management Project

SKKY: Water pollution control management

TÜSİAD: Turkish industrialists and businessmen association

ESKY: Integrated water resources management and approach

INTRODUCTION

1.1 General Overwiev

The concept of the Digital Elevation Model (DEM) was first implemented by Miller in the 1950s. According to Miller, DEM can be defined as a numerical representation of the topographic surface. So far, numerous studies have been conducted and different definitions have been given. The digital height model (DEM) is defined as any digital representation of the continuous variation of the relief in space. The digital height model is a continuous height range from which soil attributes (slope, appearance, curvature, topographic index, drainage area and network) are extracted (Mukherjee et al., 2013). The most important step in photogrammetric processes is the mathematical modeling of the terrain surface. DEM is the numerical and mathematical expression of real objects. DEM is based on ground height. (Burrough and McDonnell, 1998). DEM represents the topographic surface with a set of three-dimensional coordinates and also represents the numerical representation of the terrain surface, mainly for computer operations. DEM is a mathematical model that represents the state of a certain variable in relation to an earth point in a numerical sense. DEM; It is a topographical database. DEM refers to the numerical representation of all artificial and natural details of the physical earth (Saygılı, 2004). Digital raster height models, which represent continuous terrain heights above a common base level, are often used in automated hydrological analyzes and in the extraction of water extraction functions such as sewer networks, slope and basin length, secondary, soil erosion and flood simulation (Zhang et al., 2013; Gomes et al. al., 2015). Compared to conventional terrestrial analysis methods, the digital height models generated by high-resolution satellite images provide important information quickly, accurately and reliably. The digital elevation model (DEM) is a structure suitable for showing the constantly changing topographic surface of the earth. This model is a general data source for field analysis and other 3D applications. With the increase of DEM programs, the creation and recording of the location data, DEM applications and products in different programs increase over time. With a DEM, topographic data is available that can easily be calculated for terrain properties. (Moore et al. , 1993). DEMs are considered useful in many research areas, because they are primarily related to natural disasters by a DEM (Hengl and Evans, 2009), archeology as subtle changes. DEM, hydrology such as derived drainage networks and soil catchment areas that lead to sediment load (Lane et al., 1994) and for the glacier and Glacier analysis (Bishop et al., 2001). Therefore, the DEMs, which shows us surface of the terrain, are of fundamental importance for a number of different studies that are usually of interest to geomorphologists as a starting point for further analysis. Nowadays, countless worldwide digital height models (DEM) are available for free on the internet. With the rapid development of remote sensing and photogrammetry, data sources and processing technologies for generating DEM (border derivatives, photogrammetric DEM, DEM LIDAR and RADAR) have developed rapidly (Li and Zhao, 2018). As a result, more and more worldwide DEM products are becoming available. In February 2000, for example, the Space Shuttle Topography Mission (SRTM) delivered a worldwide package of high-quality DEMs. On June 29, 2009, the Advanced Global Digital Elevation (GDEM) model of the Emission and Space Reflection Thermometer (ASD) was released with a resolution of 1 arc second. TanDEM-X DEM is a new dataset made by the German The Aerospace Center (DLR) with a global coverage and spatial resolution (ie horizontal) of 12 m and a new standard for global DEM in terms of the representation of Geometric resolution, precision and capacity must represent a complex topography (Tadono et al., 2018). More recently, the 3D-DEM of the 3D-30m (AW3D30) of the Advanced Earth Observation Satellite (ALOS) was launched in May 2016 by the Japan Aerospace Exploration Agency (JAXA). The DEM record is another DEM product that is widely used worldwide. global elevation of 30 arches (GTOPO30), global terrain elevation data with different resolutions 2010 (GMT2010) and WorldDEM (Yue et al., 2017). Given the increasing availability of data and better computer performance (software), the latest hydrological analyzes use the GIS (Geographic Information System) as the most important methodical analysis approach for the development of precise solutions (Kaptan, 2008). In addition, the use of GIS is of great importance for the accuracy of the control points. Geographic information systems is an automated tool that analyzes, stores, processes and displays geographic information, usually on a map. A geographic information system (GIS) is a system for recording, storing, editing, analyzing, managing and presenting all types of geographical data. The key word for this technology is geography - this means that part of the data is spatial. In other words, data that somehow relates to places on earth. The GIS concept was first introduced in the early 1960s and then researched and developed as a new discipline. In the history of GIS, Roger Tomlinson was a pioneer of the concept that developed the first iteration for storing, collecting and analyzing land use data in Canada. While the system developed in Canada in the 1970s and 1980s, it was powered by mainframe hardware with data sets for the entire Canadian land mass in the 1990s. In the nineties, the software company Esri ArcView published, a desktop solution for card systems. The influx of internet has led to widespread acceptance of GIS during the millennium and the technology has reached governmental institutions.

1.2 Aim of the Study

The purpose of this study, the distribution of GCPs AW3D30, SRTM and ASTER city of Gaziantep to say, is to analyze the impact of vertical accuracy on Turkey. The study area Gaziantep is located between 36^{o} 28' and 38^{o} 01' eastern longitudes and 36^{o} 38'and 37^{o} 32'northern latitudes. The city has a total area of 6222km^2, corresponding to 1% of Turkey. The city is dominated by rolling and rugged land. 20 GCPs which were located on different types of land cover were selected for assessment. This article also addresses a comparative assessment of the vertical accuracy of ASTER and SRTM DEM over ALOS-3D. Field work in the study area focused on vertical accuracy research between GCPs selected from SRTM, ASTER and AW3D30 DEM.

1.3 Structure of the Thesis

Chapter 1-Introduction: Chapter 1 is a brief introduction to the research topic. This section reports on the setting of the overall scope and specific objectives. An overview, purpose and structure was presented to the study.

Chapter 2-Literature review: This section is a literature search on previous studies on GIS and other control points analysis to examine vertical accuracy.

Chapter 3-Study area: Chapter 3, the general background of the study area of Gaziantep province geography, vertical accuracy, geology features and management of control points.

Chapter 4-Methodology: Chapter 4 shows the broad scope of processing and analysis that can be done with ArcGIS tools.

Chapter 5-Results and discussion: This chapter is about the results of the development and analysis of the field of study.

Chapter 6-Conclusions: General results about general results are explained

2.LITERATURE

Gajjar et al. (2017) tried to make certain definitions by using Hathmati basin using Digital Altitude Model (DEM). At the same time, a very important aspect in these works is the reliability of DEM, which means the safety of DEM during the study. If the results from DEM are not realistic and correct results, it can never be expected to accurately identify the basin studied, to enter the system or to give the desired results. For this reason, this study, which has been made and researched, is open source DEM, namely 30-m ASTER, 30-m SRTM and 30-m ALOS (AW3D30). Results are obtained based on the comparison of various morphological units of measurement, such as the values created by the results. For the precise depiction of these mini-basins that are intended to be studied, it is aimed to create Agree-DEM with the help of drains, ArcGIS 10.2 and Arc Hydro Tool, and by editing the data in the hand and entering the system, not manually, in automatic DEMs. Considering the result that has been done and every process that needs to be based on, the comparisons have been made with serious studies using the basin regression analysis obtained from ASTER, SRTM and ALOS, and certain results have been obtained based on these. The basin area separated from SRTM DEM is 1988.41 km-2 while the ASTER and ALOS based basin is 2008.55 km-2 and 1990.90 km-2. Regression analysis comparing the entire area of these mini-basins that have been studied and linking them to certain results gave R99 for SRTM and ASTER-based 0,9979, SRTM and ALOS-based, and ALOS and ASTER-based mini-basin. . The area of the basins where SRTM and ALOS are based and studies are almost similar to the value of R-2 and matches the result of the studies with the obtained basin length and almost the same result. While the circumference of the water basin determined as SRTM based is 1464.35 km, the perimeter of the ASTER based basin is 0.25% short and 0.6% long for ALOS based basin. An R-2 obtained from regression analysis compared to the environment of SRTM and ASTER-based mini-basins reveals 0.9796, 0.9705 for SRTM and ALOS-based basin and 0.9879 for ALOS and ASTER-based basin. The research conducted is based on certain reasons and for these reasons SRTM may be more suitable for deriving the morphological parameters of the Hathmati basin.

Zhang et al. (2018), ASTER, SRTM, ALOS, and TDX did some work to calculate the accuracy of DEM and compare it with the results of how accurate it was and examined these studies. In the studies studied, ASTER, SRTM, ALOS and TanDEM-X (TDX) DEMs for Hispaniola island found different results with GPS and LiDAR measurements and compared these results with each other. In comparisons made as a result of the examinations made to reach a conclusion, the root mean square error (RMSE) and 90% quantity (LE90) are based on multiple error measurements, including absolute error. RMSE and LE90 values for ASTER, SRTM, ALOS, TDX DEMs are 8.44 and 14.29, 3.82 and 5.85, 2.08 and 3.64 and 1.74 and 3.20 m respectively, when necessary comparisons are made with> 2000 GPS measurements with altitude below 7 m. In contrast, the RMSE and LE90 values for the same DEMs were 4.24 and 6.70, 4.81 and 7.16, 4.91 and 6.82 and 2.27 and 3.66m. It has been expanded with the area that LiDAR has, and the expanded possessed different different types of additional land surface, however, it led to differences in the prevention of errors, thereby seeing that different methods would have different results in the research. Comparing RMSEs in different ways, filtering TDX DEMs by using four different types of methods, and based on the results of the studies carried out, the accuracy of the studies performed for the height estimation of the ground is 20-43%, which is a very serious ratio, increasing more. that is, it has increased. Preferring an empirical Bayesian criging method and using the interpolation of the ground pixels through a progressive morphological filter, and thanks to this, the DTMs produced a 1.06m and LE90 1.73m RMSE and 1.30m RMSE and 2.02 An RMSE of m resulted in the result. LiDAR data. Considering the results of TDX and LiDAR DTMs, the unexpected differences experienced in the submerged areas are for the 3, 5, 10 and 15m water level increase scenarios, which are much narrower than the underwater differences between ASTER, SRTM, ALOS and LiDAR. to -4%, which is an important difference. TDX DEMs offer options for high resolution global DEMs with accurate results from previously undetected altitude results in the world so far. In developing countries where higher accuracy data cannot be detected, it is recommended to match on a local scale.

Tadono et al. (2016) studied preliminary accuracy studies and analyzes of ALOS AW3D 30 meter spherical surface models were performed using archived ALOS PRISM stereo or triplet image pairs. As a result of the study, it was found that the data could be used commercially not only for research communities but also in geographic information systems and various applications. Preliminary validation results of 30 meters models were reached. It has been explained that the gaps in ALOS models can be removed and improved by different interpolation methods.

Based on the work of Grohmann (2018), he has done many studies on visual analysis and height histograms and has achieved serious results from these studies. When TanTM TM's XTM and ASTER GDEM are compared against each other, ASTER GDEM realizes that it has a more effective horizontal resolution. In wetlands with open vegetation, the bottom elevations of TanDEM-X make it noticeable that thanks to the radar signal, that is, it has a deeper influence in its aid, and it shows that it will be clearly noticeable when looking at the results. These differences allowed DEMs (DoDs), mast oscillations in SRTM results, and the DEMs that perform studies such as the incompatibility between ASTER GDEM and the adjacent posi- tions in the ALOS AW3D30 to make the production-specific problems understandable on the system. As a result of the moving window process used to show the 12 m data as a sample of 15 m pixels again, there is a systematic difference in the elevation between the TanDEM-X 12m, TanDEM-X 15m and SRTM due to the steep slopes of the coasts. In order to evaluate whether the area under study makes any difference from these bad problems, and whether it is faced with different results, it is generally preferred to produce a DoD with SRTM before using ASTER GDEM or ALOS AW3D30 in any analysis. DoDs also highlighted the changes and changes in land use between SRTM (2000) and TanDEM X (2013) results of operations, either naturally or with human intervention to the environment. The results show that there is a very high level of detail and consistency for TanDEM-X data, which means that the effective horizontal resolution of SRTM is more dense and different than the nominal 15m, and there is a photogrammetric error and error process in ASTER. GDEM is ALOS AW3D30.

Evansa et al. (2008), this study, which has reached certain conclusions, is produced from the data provided by the Cartosat-1 system and compares the accuracy of different digital height models (DEM) and works on the difference between them. The Cartosat-1 satellite, launched by the Indian Space Research Organization (ISRO) in May 2005 and guiding this study, can be viewed by carrying two panchromatic cameras that can acquire stereoscopic data along the path of the orbital trail. This data, obtained by cameras and connected to results, always provides the potential to produce high quality DEM for almost any area of study on the Earth's surface. Cartosat-1 DEMs produced for the Drum Mountains study site in western-central Utah were compared with a set of reference datasets. Vertical accuracy was compared with NED, ASTER and SRTM DEMs. Horizontal accuracy, comparisons were made with Digital Orthophoto Quad data. Cartosat-1 DEMs can give very good results compared to the most accurate reference DEMs.

Rawat et al. (2018) in their work and achieved significant results, they have done very serious studies on the vertical accuracy of the Shuttle Radar Topography Mission (SRTMDEM) and the Advanced Space Alien Thermal Emission and Reflection Radiometer (ASTERDEM) in Uttar Pradesh Shahjahanpur Region of India. He made major comparisons with the CARTOSAT-1DEM of the village of Roja. While some studies on CARTOSAT-1DEM (IRS-P5) allow vertical accuracy data analysis between SRTMDEM and ASTERDEM to be evaluated by quantitatively / qualitatively agreeing to reach certain results, DEM is used to evaluate the results that are proportional to the studies performed. held and worked to take measures. The results of the original SRTM, that is, there were some gaps in digital representation, and movements and studies were carried out through these gaps; these gaps were initially attempted to be filled logically to successfully obtain the correct vertical height from the DEM. The data obtained, namely the results, are seen in relation to the studies conducted, where some control points (GCPs) on the ground show the results of SRTM-based measurement results of 186.65m root mean square error (RMSE), and studies based on ASTERDEM revealed 137.65m RMSE. This indicates that ASTERDEM performs better than SRTMDEM in studies to determine vertical accuracy. In other words, choosing ASTERDEM is often the right choice. The mean relative root mean square error (R-RMSE) of the twenty GCPs was 1.0 and 1.25 for ASTERDEM and SRTMDEM, respectively. Comparison of the vertical accuracy of the points obtained from ASTERDEM and the result of the application according to CARTOSAT-1DEM is a determination coefficient (R2) of 0.59, normalized root mean square error (N RMSE) 1.26, average absolute error (MAE) 30.82% and RMSE 6.3%. According to the data given by these vertical accuracies, it is noticed that the vertical accuracy of ASTER according to CARTOSAT-1DEM has reached a better agreement than SRTMDEM for 20 points selected from the orographic plain. In this study, what needs to be understood is to show that SRTMDEM is not suitable for settlements and make a difference.

According to this study by Li and Zhao (2018), which has achieved certain results, it is the digital elevation model of the newly approved global 1 arc-second advance terrain observation satellite (ALOS) World 3D - 30 m (AW3D30) (DEM) Typical landforms across China using ICESat / GLAS) data in different ways. In spite of this, the shuttle radar topography mission (SRTM) 1-arc seconds (SRTM1) and global DEM version 2 (GDEM2) should also be studied with care as it will have different results. The overall data obtained reveals that when the main comparisons are made with SRTM1 and GDEM2, the average horizontal shifts, i.e., the changes, the RMSEs are 5.30 and 10.07 m in the x direction, 5.64 and 11.75 min y, respectively, making certain differences. It is not possible to realize that the AW3D30 detects the highest accuracy with RMSE, 4.81 m, then SRTM1 (5.86 m), and then

GDEM2 (14.14 m), and that it is comfortable to analyze. Our result shows that vertical accuracy can change by working with horizontal alignment, and this change will also result in improvement. This analysis, which is conducted and studied, is realized as a result of researches that the slopes in different percentages in the field and the different cover types covered by the land affect the vertical accuracy together in the studies carried out thanks to the AW3D30 and that the first one always has a different effect, that is, a greater effect than the second one. It is one of the results of the study to realize that the data given by the hydrological potential assessment, the drainage connection areas obtained from the AW3D30 are more accurate than SRTM1 and GDEM2, however, all DEMs are not solvable and difficult to solve based on local altitude information only. reveals river extraction restrictions on the flat area. As a result of this work and the results it provides, it provides a comprehensive understanding of the AW3D30 and SRTM1 and GDEM2 as the most usable system as applications that require accurate Earth surface descriptions offer the most accurate and reliable results when compared between freely and comfortably used DEMs. It is highly recommended to use AW3D30 on it.

Elkhrachy (2017), working on the Digital Elevation Model and continuing her studies, is compulsory to use many field process analysis in the world. In the study, the quality of DEMs obtained by SRTM version 3 and ASTER version 2 were compared with each other and certain results were obtained. The reference levels obtained from the altitudes obtained from the GPS and the topographic map have been found to be suitable for use to compare the vertical accuracy of SRTM and ASTAR DEMs in Najran, Saudi Arabia. GPS reference elevations helped to achieve ± 5.94 m and ± 5.07 m values for used SRTM and ASTER DEMs, however, the accuracy obtained from the topographic map, considered as reference height, was ± 6.87 m for SRTM and ASTER DEMs. and ± 7.97 m. The 30 m SRTM height data for our work area comfortably reveals more than the absolute vertical accuracy of ± 16 m published in the SRTM data specification.

Santillan et al. (2016) conducted a study and made significant efforts, asked for an examination of the average sea level (MSL) differences of 274 different area control points measured in DEM derivative and open areas, and examined and analyzed a 5.68 m Root Average Square Error (RMSE), + The average difference of 4.36 m and the standard deviation of 3.66 m. RMSEs of the AW3D30 vary between 4.29 m (built-in) to 6.67 m (pasture) under or between different types of vegetation or ground cover. This work done and completed is an AW3D30 applicable to existing global DEMs such as SRTM-30m and ASTER GDEM Version 2 for specific applications that compare and evaluate AW3D and also require highly sensitive DEMs such as flood modeling and hazard hopes to contribute to a number of studies in identifying as difference.

According to Saygılı (2008), in this study first height differences between the SRTM 3 arc second data and DTED data was investigated by using Microdem, PCI Geomatica and Global Mapper Software. Next DEM, which has 10 meters resolution, was produced from 1/25.000 scale topographic map. Also height differences between SRTM data and the produced DEM were calculated. Differences between the SRTM and DTED1 are over than differences between the SRTM3 and DTED2 datas. So SRTM3 data can be used as the DTED1 data. Topography is basic to many earth surface processes. Digital Terrain Model is a general term used to describe the physical and topographic information of earth’s surface by choosing appropriate interpolation function. RADAR data is very significant data for Digital Elevation Models (DEM). SRTM is an active radar system which uses Interferometry to produce high quality 3-D topographic maps. SRTM is a joint project between USA, Germany and Italy to collect radar data for 80% of the earth. DEM derived from the Shuttle Radar Topographic Mission (SRTM) are now freely available in a resolution of 3 arc-seconds. These data can be very useful for topographic applications.

Gajalakshmi and Anantharama (2015) described some special details that they have made and that they have achieved through great efforts. The main goal and aim of their work is to compare the accuracy of DEM produced from two different types of satellite sources, optical based sensory satellite data - Cartosat-DEM. This study has been studied on the Southpennar basin of the studied area, which is slowly fluctuating. This study, in which two different areas were evaluated with the results obtained continuously, was conducted under two categories; It is obtained through altitude data and land derivatives. By acting step by step, the study reveals that the rising result data of Cartosat-DEM is lower than SRTM-DEM, in a different situation. It is observed that it is higher. In the visual analysis obtained as a result of the studies carried out, the contours obtained from Cartosat-DEM and SRTM-DEM are aligned with each other regardless of the resolution.

Thanks to his major studies (2019), Gürbüz had the opportunity to examine the evaporites using DEGOR, FOPGA and ASTER. Evaporites are addressed as substances used for industrial manufacturing with serious economic values and are represented by chemical sedimentary rocks that accumulate in land and sea environments. Evaporite sources, which are very rich in terms of calcium sulfate, such as gypsum and anhydrite, typically occur in ecological areas with arid climatic conditions, as might be expected. These rocks are very important for oil and natural gas exploration not only for the studies carried out or targeted for paleo-environment and paleo-climate purposes, but also because they have the possibility of trapping where the formation of such hydrocarbons increases and has a certain population. In some Anatolian Tertiary lands such as Çankırı-Çorum, Sivas, Ulukışla, Tuz Gölü, Haymana and Beypazarı basins, it contains the upper surfaces of the areas covered by different terrestrial and marine evaporite resources. In this study, Aksaray and Niğde provinces (middle of Turkey) gypsum minerals tape ration, dekorrelasyo stretch (DEC) was characterized oriented principal component (FOPC), and sulfate index obtained using the ASTE images using the method of data have been finalized. While the studies are continuing, some samples collected for a specific purpose are asked and made to measure geochemical and spectroradiometers. The best results were obtained thanks to the FOPCA and DECOR methods.

Demissew et al. (2019) made serious studies on the rise and slope gradient of the use of the land for certain purposes in the mountainous regions of Ethiopia in their studies that they have made and have made serious efforts. In this study, in 1986, 2003 and 2017, Landsat TM, Landsat ETM and OLI data, and the topographic features derived from the ASTER digital elevation model were used reliably to assist in mapping land use / land cover (LU / LC) in an agricultural field in general. northwestern mountainous Ethiopia. Based on the results obtained, the LU / LC maps were created using supervised classification, and the LU / LC changed the mapping for the period 1986-2003 and 2003-2017 by making certain statistical comparisons and evaluations. The study showed that the proportion of these lands occupied by agriculture increased from 85.4% of the total area in 1986 to 93.3% in 2017. This increase faced a 3.5% reduction in a forest area, a 1.9% decrease in pasture land and a 1.8% decrease. LU / LC changes mostly occurred in regions with a slope of 0 to 30. This study has the potential to contribute to the increasing literature ie variable topographic factors on LU / LC, with the aim of providing new and practical information for managers and planners for a region that is not often done and rarely studied.

Askalany et al. (2018) made some examinations in their work. These reviews have shown differences with the data of the Shuttle Radar Topography Mission (SRTM), although they have revealed quantitative evidence about the hydrological properties of the basin, such as relief, geometry and drainage properties. Thanks to the opportunities provided by the meteorological TRMM satellite, it provided precipitation data to the basin areas. The results of the data integration enabled the identification of natural disaster hazards, such as potential floods, landslides, represented by sub-basins, however, as a result of the analysis of the predicted land use data by applying the results of VNIR analysis, most of the southern Quseir city hosted serious hazards. probability is foreseen. Several dams and reservoirs should be built to minimize the envisaged hazards. The dangers envisaged by this will allow the region to relax, albeit somewhat. Thanks to these and such strategies, the area will provide reasonable water resources that can help sustainability and future developments, as the area receives a reasonable amount of precipitation during a rainstorm. At the same time, thanks to HEPPs, the electricity supply of the region will increase.

Çağlar et al. (2018) worked on evaluating the vertical accuracy of the digital elevation model (DEM) of the Advanced Terrain Observation Satellite (ALOS) Earth 3D 30 m (AW3D30) using the runway method (RWYM). RWYM uses longitudinal profiles of parts that are reliable and ubiquitous reference data. A reference dataset used in this project consists of 36 tracks worldwide. We found that the AW3D30 has a relatively low root mean square error (RMSE) of 1.78 m (one sigma).However, when analyzing the results, a common ascent anomaly was found. We came to the conclusion that this abnormality is the result of an uncompensated sensor noise and a data processing algorithm. We also note that the traditional accuracy assessment of a DEM does not allow the identification of such abnormalities in a DEM.

Boori et al. (2018) in his regular and stable work, especially

The need for groundwater continued to increase day by day due to the increasing population in the world, the expansion of irrigation areas, the need for water increasing day by day and the economic progress. With this need, that is, increased demand, a modeling was made to use groundwater resources more regularly. Some regions of countries that have groundwater potential, such as land, basin, etc. It is limited by integrating highly effective thematic surface areas such as feeding together. Usage, slope, soil, drainage density, geomorphology etc. Thematic layers are prepared from remote sensing satellite images, data obtained and used from underground and secondary data. High resolution satellite images from CartoDEM (30 m), SOI toposheet, Landsat 8 (30 m) and Google Earth were used to create thematic maps. As predicted, this program should not be difficult to use. ArcGIS software was used to process these data sets. The weight is determined for each thematic map based on its characteristics and its relationship with groundwater. All thematic layers are combined in a GIS domain and the assigned weight values for each polygon in the feature table are added. The above factors were emphasized according to their relevance to efficiency, sensitivity and groundwater potential. In addition, the emerging groundwater potential map is divided into five classes: very high, high, medium, low and very low according to the hydro geomorphological situation. The results, as predicted, provide essential information and can be used by local authorities for a more convenient management of groundwater.

According to Zhao and Zhang (2018), examined compared the hydrologic networks extracted by typical global DEM data using matching difference (MD), correctness (C) and figure of merit (FM) indexes. Then, the reference hydrologic network (RHN) was interpreted based on remote sensing images. Finally, the DHNs were evaluated and compared by referencing the RHN using different indexes. Research results show: four DHNs have similar distribution in mountain regions but much different performance in flat regions; all the indexes (including MD, C and FM) indicate that about the quality of the DHNs, the best is the AW3D30 data, then the SRTM1 data, the next is the SRTM3 data, and the GDEM-v2 data has the worst quality; through analyzing the MD distribution in different slope classes for the four global DEM datasets, the MD mainly distributes in flat region, and then sloping region, but seldom in steep region. Overall, AW3D30 has the best quality, a little better than SRTM1 and much better than SRTM3 and GDEM-v2; SRTM3 and GDEM-v2 datahave much worse quality, and GDEM-v2 data is the worst in the four global DEM datasets. Considering that the AW3D30 data is originated from the DEM dataset with 5m resolution, it may exerts more effect in future digital topographic analysis.

According to Gökmen (2018), LIDAR, photogrammetry, stereo satellite images and interferometric synthetic aperture radar (InSAR) techniques are used for the production of these three dimensional (3D) models. Compared to each other, these methods work with the LIDAR three-dimensional laser scanning technique and have higher accuracy than other methods. Because high-resolution aerial photographs take a lower order of magnitude than optical satellite images, a much stronger object can be extracted. However, optical cameras that operate with optical sensing logic and optical satellite sensors need solar energy because they cannot produce their own energy. Because of this, they work according to weather conditions and cannot shoot at night. In the InSAR technique, although the object extraction is less accurate than optical systems, data can be obtained at any time of the year without being influenced by night and day atmospheric conditions. In this study, global surface models consisting of SRTM satellites, which accomplish the modeling of the entire world (except for the polar regions) used in the InSAR method, and ALOS AW3D global surface models obtained from PRISM sensor images of the ALOS satellite developed by the Japanese Space Agency, the analysis of these sources of discontinuities is targeted. Towards this goal, the two satellite data from 30 m grid spacing DYM models are made of the height difference formed accuracy of analysis for all Turkey produced DYM produced.

In this study, which was conducted by the province (2018) and has serious efforts on it, it has worked on the performances of SRTM1 and ASTER DEMs, which appear in the recent market and are close to absolute accuracy on the global gravimetric geoid modeling. . Serious researches have been conducted on a regional scale by evaluating the exact precision of the models, together with the results obtained by GPS / leveling results distributed with a particular system, so that a test area, ie a specific location (Konya Closed Basin) is needed. Then, two very different gravimetric geoid models calculated by the help of the KTH (Swedish Institute of Technology of Technology) method, which are derived from SRTM1 and ASTER, that is to say, derived DEMs, with a very limited amount of gravity data in the test area, and success in the mountain area. Gravimetric and geometric geoid models were combined on the basis of the trimmer surface to completely eliminate the problems and problems provided by the system and to overcome the accuracy of the optimal combination and analyzed geoid models. In this way, it led to serious results. As a result, there is no significant difference between geoid models. However, it is recommended that the ASTER Model can be used in some areas where the SRTM1 Model cannot be used comfortably and efficiently.

Karabulut (2016), examined the morphometric analyses of determined parts of Çağlayan, Kabisre, Musabeyli and Koyunluyusufözü drainage basins which have different features in terms of morphological, hydrological, climatical conditions and vegetation cover were done by using GIS. The morphometric analyses were done by using different DEMs in terms of created system; ASTER GDEM (30 meter resolution) derived from stereo images, SRTM DEM (30 meter resolution) derived from radar technique and TOPO-DEM (30 meter and 10 meter resolution) derived from 1/25000 scaled topographical maps. The selected morphometric parameters like Bifurcation Ratio, Stream Length Ratio, Length of Overland Flow,Drainage Density, Form Factor, Elongated Ratio, Basin Relief, Ruggedness Number, Time of Concentration and Hypsometric Integral were implemented on four different DEMs for each study area. The results were evaluated,commentated and checked through field works. The usability of ASTER GDEM and SRTM DEM data were examined by being compared to TOPO-DEMs which have 30m and 10m resolution in terms of the potentials of reflecting the land topography.The usability of ASTER and SRTM DEMs were tested on basins don't have topographic data. SRTM DEM(30 m) data which is related to study areas were released in 2015 by USGS. This study is important in terms of the usage of this new data and the evaluation of usage of different DEM data in basin morphometry studies. According to anayses, the results of ASTER and SRTM DEMs gave approximate values, especially SRTM results gave best fit with the results of TOPO-DEM. Hence,ASTER GDEM and SRTM data can be used for basin morphometry studies.

According to Öztürk (2015), there seems to be an increasing demand for high precision and current strength DEM (Digital Height) models for scientific applications, economic and defense industries around the world in recent years. In addition to high precision, there should be minimal costs for the most efficient use of DEM. As long as a DEM meets expectations, its use continues to spread. This means that applications are also more practical. In 2000, NASA (National Aviation and Space Administration) launched the Shuttle Radar Topography Mission (SRTM) to produce the most up-to-date and comprehensive model DEM to date. Launched by NASA as part of this project, the Endeavor Space Shuttle explored areas between 60 ° North and 56 ° South for eleven days. In this way, 1 form x 1◦ cell forms were obtained with data with a resolution of 30 m (90 m outside the USA). This study investigated to what extent EGM2008 (World Gravity Model 2008) affects the accuracy of SRTM DEM. To investigate the effects, EGM96 (World Gravity Model 1996) and EGM2008 were first compared and tested in the study area. Later, EGM2008 was replaced by EGM96 as the vertical date for SRTM DEM. According to the results, EGM2008 improves the accuracy of DEM in just a few decimeters, despite large differences between the EGM96 and EGM2008 in the test areaThis also results in greater reference distortion between leveling points. For this reason, it is suggested that the current version of SRTM DEM can be easily used in geodetic applications. It is considered appropriate to use EGM2008 as vertical data in SRTM DEM in applications that require high precision, especially when the accuracy of EGM96 is not sufficient.

Dan et al. (2019) worked on creating a high resolution DEM based on spatial and terrestrial remote sensing data, the first to combine satellite radars, terrestrial radars, photography and global DEM to create a high resolution DEM without data. Create. TDX data of rising and falling tracks were combined to form the basic DEM. Instead of using a grid format to combine DEMs made from different datasets with different resolutions, we developed a method based on three-dimensional point clouds: 1) iterate to minimize ~ 1m SfM and Vertical inconsistencies between 5-meter TRI heights and 10-meter horizontal heights. TDX DEM using the closest point algorithm (ICP); 2) Then combine multi-point clouds to create the final DEM with no gaps in the data. Use an adaptive algorithm that uses two search distances to make the transition across the edges of different data sets more smoothly. We evaluate the new 10-meter DEM by comparing the simulated submarine areas obtained with the two models of LaharZ volcanic rivers (for Lahars) and VolcFlow (for pyroclastic rivers) and make significant differences with the SRTM 30-meter DEM. Our LaharZ simulation in the new DEM shows a longer Lahar exit distance. For pyroclastic flows, the new DEM and VolcFlow simulation produce high channel flows in the steep parts of the river channel and produce a thicker amount of sludge than those obtained with 30 m DTM-SRTM. Quantitative and qualitative geomorphological analyzes show that existing DEMs must be created with a high spatial resolution (~ 10 m or better) to improve the volcanic risk assessment for active volcanoes.

Motagh et al. (2017), TanDEM-X single-pass interferometry digital high resolution terrain models with contours on mountainous regions. This study shows the potential to use TanDEM-X (TDX) single-pass radar images to analyze intra-year and intra-year glaciers. changes in mountainous terrain. In February 2012, March 2013 and November 2013, we will discuss in detail the processing steps required to create three reliable digital elevation models (DEMs) with a 10 m spatial resolution that can be used, based on the SAR images obtained from Kyrgyzstan. examine the glacier mass balance. We explain the stages of the interferometric process and the effect of a priori information on the height required to model the long-wave topographic effects. We also focus on the alignment of the DEM and the effect of the radar signal on the rise of ice and snow surface to ensure optimum comparison of the DEM. Finally, since February 2000, we have been comparing glacier altitude changes between DEMs for three TDX DEMs and C-band radar topography services (SRTM). We offer a new approach to calculate changes in the height of the glacier, the height and slope of the terrain. We emphasize the superior quality of TDX DTMs compared to SRTM DTMs, explain the remaining uncertainties of DEMs, and discuss the limitations arising from the lateral structure of the radar sensor.

Vassilaki and Stamos (2020) tried to create a truly global DEM with greater sensitivity, resolution and coverage, which is the main goal of the TanDEM-X mission. The mission is innovative for many reasons. As a result, extensive research on their technologies has been published. This study aims to bridge the gap in the literature between the scientific use of TerraSAR-X and TanDEM-X data and the practical use of the final TanDEM-X-DEM. DEM control is done in unimportant regions of the world, some of which are test areas for international scientific societies. LIDAR data and DSMs are used as reference height information and other commonly used general DEMs are used. Visual inspection and accuracy analysis in 14 locations in Europe, the USA and Antarctica show the clear superiority of TanDEM-X-DEM in the global DEM family, regardless of latitude, soil type and land cover. TanDEM-X-DEM is morphologically more detailed than DEM AW3D30, ASTER and SRTM, which corresponds to the best pixel range worldwide. It is more complete than other global DEMs, especially in polar test sites. Sensitivity analysis shows that TanDEM-X-DEM with RMSE in the range of 1.0 to 8.7 m is more accurate than other global DEMs, with AW3D30, ASTER, 1 second SRTM arc and 3 second SRTM between 8.3 and 2. 8.3 to 80.0 m, 3.0 to 8.7 m and 7.3 to 20.5 m, 49.0 m Accurate analysis also shows that TanDEM-X DEM has better positioning accuracy and is based on reference data The use of calculated 3D deviations has almost no effect on RMSE. As a result, TanDEM-X-DEM seems to pave the way for next-generation global DEMs and restart SARs as the latest technology for global surveying applications and other applications.

Rossi et al. (2012) examined the production of TanDEM-X calibrated crude DEM. The TanDEM-X mission began successfully on June 21, 2010 with the launch of the TerraSAR-X (TSX) satellite, the German TDX radar satellite, which was placed in close orbit, and the installation of the first space bistatic interferometer. Processing of raw SAR data in raw DEM is performed by a single processor, integrated TanDEM-X (ITP) processor. The quality of the gross DEM is an essential parameter for planning activities. A new quality indicator has been obtained in this article. The interferometric measurement, the phase without envelope and the stereo-radargrammetric measurement are based on the comparison of the geometric offsets calculated in the phase of registration of the nucleus. By specifying the accuracy of the phase to be discarded, it is a useful parameter to identify the problematic scenes that will be sent back to the double processing chain of the opening / opening of the basic phase to reduce the phase opening errors. The stereo-radargrammetric measurement is also used in operational mode for the absolute calibration of the gross DEM, thanks to the precise estimate of the absolute phase shift. This article examines the interferometric algorithms applied for the operational production of DEM DEM TanDEM-X, with particular attention to quality evaluation and calibration.

Hewson et al. (2019) describes the methods available to apply ASTER data for geothermal exploration in East Africa. The study area includes part of the East African cleft system on the border between Tanzania and Kenya. The area includes geologically mapped irregular volcanic soils, with coverage limited to detailed scales of various inheritance and cartography agencies. This study summarizes the technology, the processing method and the preliminary results of applying ASTER images to map the composition and thermal anomalies due to geothermal activity. Field observations from geothermal sources of Lake Natron in Tanzania were used and compared with the spectral composition and temperature results of the soil surface derived from ASTER. This study also includes geothermal fields published in Kenya, part of the study area.

Rajasekhar (2018) worked on the ArcGIS 10.4 software with functions that automatically extract the lines from the Digital Elevation Model (DEM) from Cartosat, ASTER and SRTM with different spatial resolutions. The results of the extracted lines show that ASTER-DEM (Thermal emission and reflection radiometer in advanced spatial space) has the lowest number of lines reflecting Cartosat and SRTM (shuttle radar topography task) DEM shows an average number of lines . Cartosat DEM is the most suitable method for accurately removing contours rather than ASTER and SRTM. This study shows that Cartosat DEM data are best suited for removing lines in Indian states. They provide the most comprehensive geological structural information across all datasets. The lengths and intensities of the removed lines are determined using a statistical method. The generated data are based on the intensity of the origin and the rose chart. Cartosat DEM data is the most suitable method for examining very small areas because this data can be used to obtain geological and structural information.

3.MATERIALS

3.1 General

Gaziantep is the firts city in the Southeastern Anatolia Region, whereas it is the ninth largest city in Turkey. City, with its geographical location is located at the junction of Southeast Anatolia Region and Mediterranean Region. The city of Gaziantep is the largest in the Southeastern Anatolia region and the ninth largest city in Turkey with its metropolitan status accompanied by its current population, economic state, potential for tourism and administrative system (Sönmez, 2018). With its population by the year 2019 2.028.563 Gaziantep is the ninth biggest province in the country in terms of urbanization Southeastern Anatolia Region "which is the most developed city in Turkey" in terms of the industry and trade is one of the leading cities. Gaziantep is the 9th largest city in Turkey. Gaziantep is 36^{o} 28 'and 38^{o} 01 "east longitude and 36^{o} 38' and 37^{o} 32" north latitude at the intersection of the Mediterranean and Southeastern regions of Anatolia (Figure 3.1). Most of them are located in the western part of Southeastern Anatolia, the rest in the eastern part of the Mediterranean. There are Osmaniye, Hatay, Şanlıurfa, Kahramanmaraş, Adıyaman, Kilis cities and Syria country around Gaziantep city (EIA, 2014). The surface area of Gaziantep is 6222 km2 and the surface area of the country is approximately 1 percent. The city center is 850 m above sea level. The undulating and rough terrain dominates the city. The Nur mountains, which form the borders of Hatay and Osmaniye, are in the south. The other mountainous area of the city parallel to Nur Mountains is between Islahiye and Kilis starting from Syria in the South extending to the border of Kahramanmaraş and Adıyaman in the North and Fırat River in the east. Located 1496 meters east of İslahiye, Sof Mountain is the top of the city. The basic levels of the urban area are İslahiye, Barak, Oğuzeli, Araban and Yavuzeli. The most important resource for Gaziantep is Fırat (GASKI, 2013). Euphrates, the longest in western Asia (2800) is the km long river in the east and Turkey comes into play. Cross Syria and Iraq to join the tigers in Shatt-Al Arab that flow into the Persian Gulf.

Figure 3. 1 Location of Gaziantep Province

3.2 Geography and Geology

Late conflicts of the Cretaceous and Miocene period of the Arab, anatolian and Eurasian plates created conditions for the formation of surface and underground structures in the Gaziantep basin. The structural development of the dead land was affected by the late Cretaceous (Maastrichtian) location of the Kocali-Karadut-Ofiolita complex, which caused a decrease in the northwest of the Kastel basin during the first Alpine orogeny. Dead Sea error has occurred in the Red Sea basin and Miocene Gaziantep in the northwest of the Gulf of Suez to affect structural development and propagation in the northeast of southeastern Turkey. These two important tectonic events caused many underground effects in the region in terms of tears and clinical surface, errors, fractures, floral structures and basalt rivers (Coşkun and Coşkun, 2000). The geological map of the province of Gaziantep is shown in (Figure 3.2).

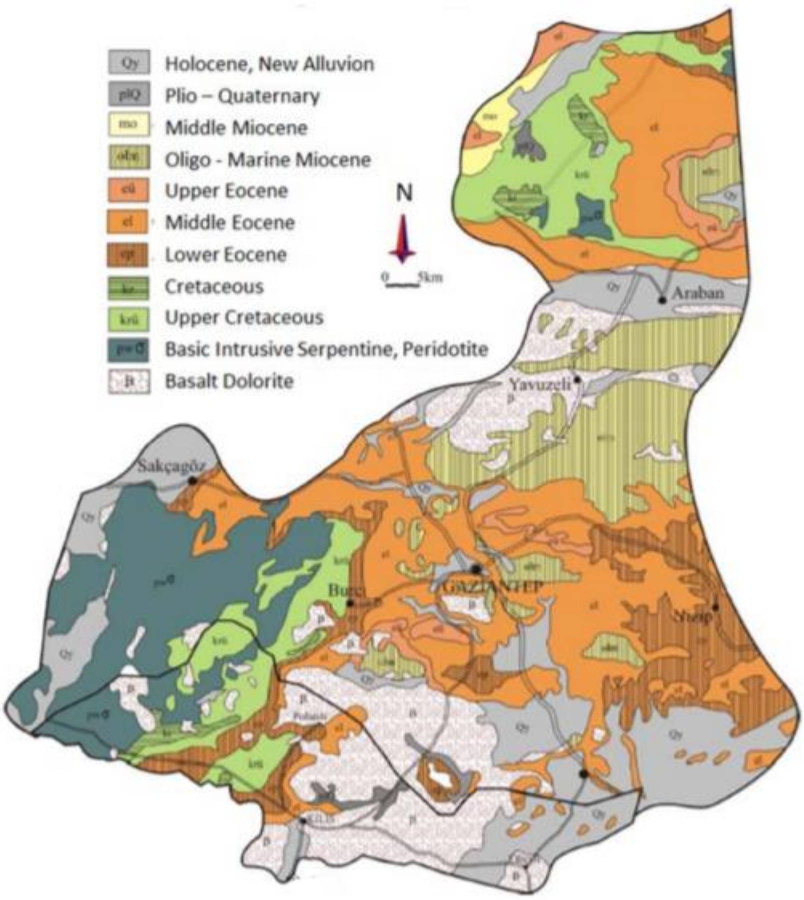

Figure 3. 2 Geological Map of Gaziantep Province (Source: The General Directorate of Mineral Research and Exploration (MTA)

3.3 Meteorology

Climate due to its location, Gaziantep is a mixture of Mediterranean and continental climate. The weather is particularly hot in June, July, August and September. It is very cold in December, January and February. The average annual temperature is 14.9 ºC. According to 78-year-old data, the maximum average temperature was measured around 35.1 °C observed in August 2000, and the minimum average temperature was 0.7 °C (below zero) recorded in January 1965. Annual average rainfall 552.8 mm (mm) (TUIK, 2013) and the seasonal precipitation regime is winter, spring, autumn and summer (Table 3.1).

A large part of Gaziantep province is in the steppe area of Southeastern Anatolia. The northwestern part of the province is a gateway between the Mediterranean vegetation and the steppe cover of Southeastern Anatolia. The Southeastern Anatolian steppes cover the areas south of the spring formed by the Kahramanmaraş-Gaziantep line of the Taurus Mountains and the longitude passing through Siirt.

The step character is more dominant and semi-desert. The northern part of the southeastern steppe area between the Karaca mountain Mardin threshold and the Taurus mountains extends from Kilis to Cizre. To the west of the Southeastern Anatolia steppe area, Gaziantep Province is stuck between the main core area of the steppe and the rainy coastline affected by the Mediterranean climate. It is a limestone plateau with a height of 500-600 meters covered with olive and pistachio trees.

The Gaziantep plateau and the border areas in the south are covered with red-brown very chalky and clayey soils. These soils formed on basalts and limestones in the region are 30-100 cm deep but natural vegetation steppe plants are everywhere in bare areas. When we move from the city center to the west and northwest, the transition to the Mediterranean region begins and therefore small oak forests are found in the olive groves and pistachios.

Table 3. 1 Weather condition of Gaziantep province

Ave. temperature	+14.9°C
Maximum temperature	44.0°C
Minumum temperature	-17.5°C
Sunny Days (Annual)	86.4 hour
Ave. of Humidity	50%
Ave. of Rainy Days	84.5 days
Ave. Rain	552.8 mm
Ave. Snowy Days	13 days
Ave. Nipping Days	56.5 days
Maximum Snow Elevation	100cm
Wind Direction	Northwest Wind
Ave. Max. Temperature(JULY)	35.6°C
Ave. Min. Temperature(JANUARY)	-0.3°C

Table 3. 2 Long-term (1940-2018) Annual average temperatures of Gaziantep province

Gaziantep	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.
Ave.Temp. (°C)	3	4.2	8.2	13.2	18.6	24.1	27.8	27.4	22.8	16.2	9.4	4.9
Ave.Max. Temp. (°C)	7.7	9.3	14.1	19.6	25.5	31.3	35.3	35.3	31.2	24.3	16.2	9.9
Ave.Min. Temp. (°C)	0.8	0	3.1	7.4	11.9	17	21	20.9	16.2	10.2	4.5	1.1
Ave.Sunny Days (hour)	3.4	4.3	5.4	7.1	9	11.6	11.2	10.3	9.1	7.2	5.3	3.4
Ave.Rainy Days	13	12.5	12.2	10.6	7	2.1	0.6	0.5	1.5	6.5	8.7	12.2
Montly Total Rain Amount	100	84.1	74	54	31.5	6.3	2.6	2.1	5.6	38.4	67.7	98.8

Table 3.2 is about annually average temperatures which are belong to Gaziantep province between 1940 and 2018 for one year (monthly) period. Average temperatures, average maximum temperatures, average minimum temperatures, average sunny days, average rainy days, maximum temperatures, minimum temperatures indicated with (°C). Monthly total rain amount indicated with (kg/m^2).

3.4 Population

Turkey Statistical Institute (TUIK), municipalities and 3 counties forming the census started Gaziantep population centers from sources in local web page were taken and shown in Table 3.3. In March 2011, due to the start of the inner turmoil of Syrian citizens immigrated to Turkey Gaziantep is the city where most take place. According to the data of Gaziantep Provincial Directorate of Disaster and Emergency, the population (migration) of Syria in the center of Gaziantep is given in (Table 3.4).

Table 3. 3 Population of Gaziantep province between 1965-2019

Year	Population
2007	1560023
2008	1612223
2009	1653670
2010	1700763
2011	1753596
2012	1799558
2013	1844438
2014	1889466
2015	1931836
2016	1974244
2017	2005515
2018	2028563

Gaziantep Province was also affected immigration from Syria to Turkey. According to the General Directorate of Immigration, the total population of Turkey is 80 million 810 000 525 Syrians. Between 2011 and 2015, 326,333 Syrians arrived in Gaziantep. Some Syrians living in Gaziantep live in settlements outside the camps. Gaziantep's highest Syrian population (142596) is in Şahinbey province. Yavuzeli is the district where there are at least Syrian refugees (161). The number of asylum seekers living in the camps is 35,847 (table 3.4). According to 2018 latest migration number staying around Gaziantep city center is approximately 383260.

3.5 History of Gaziantep city

Gaziantep, which is one of the oldest cities in the world with a history of approximately 5600 years, has been home to many civilizations throughout history. Gaziantep is an important trade and culture of the region in every period has been central. Antep is a very old settlement; It has always had an important place in terms of strategic position in Anatolia due to its fertile soil and rich product diversity. Its presence on a branch of the Silk Road has further increased its commercial importance. On the other hand, the presence of the junction at the gate opening from Anatolia to Syria and the Mediterranean Sea strengthened Antep's position (Kellecioğlu, 2016). Gaziantep is an acres of urbanism and housing in the late Ottoman period point. The settlement of Ayıntap was signed with the Armistice of Armistice in 1918 when the Ottoman Empire accepted the defeat in the First World War. As a result of the rapid recovery of the city itself, the number of the population, which decreased during the war, increased rapidly after the war. The emergence of new residential areas and the need for development of the city has created. Then the war was started on April 1, 1920 to free the enemies and the city was rescued from the occupation on December 25, 1921. The development stages and directions of Gaziantep city center were shaped by the planning approach that started in 1930 (Uğur, 2016; Gezinmez, 2019).

3.6 Study site

The AW3D30 DEM in southeastern Turkey, downloaded from http://www.eorc.jaxa.jp/alos/en/aw3d30/ address. It was also downloaded as three part from the related link in GeoTıff format: N037E038, N037E037, N037E036. The data used in this study was 30-m spatial resolution digital elevation model (DEM) generated from SRTM- 30m high resolution which is most accurate data in the world and it is easy to delineate watershed because of its high resolution. SRTM data has taken from State Hydraulic Works. Also ASTER GDEM was downloaded from the related link https://asterweb.jpl.nasa.gov/gdem.asp (Figure 3.3). The DEM is generated in two types; AVE (average) and MED (median). In this study AVE is preferred to use. Vertical control points and levelling points were taken from General Directorate of Mapping (GDM). Points were used as reference points in the conduct of our surveys. Also the standards of Third Order Geodetic Levelling were taken into account in order to check the reference points.

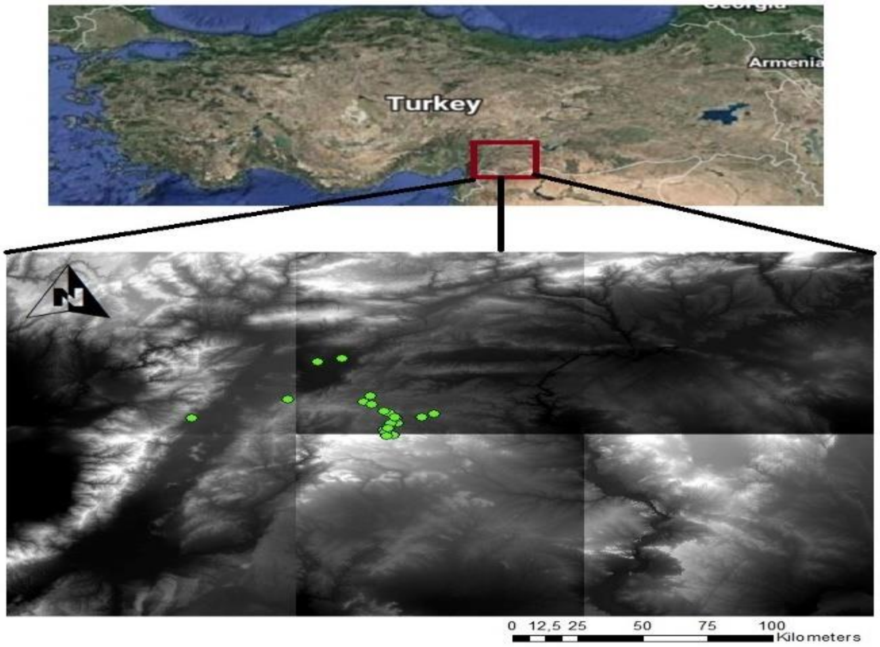

Figure 3. 3 Location map of the study area and GCPs related with dem data

3.7 Datasets descriptions

GCPs can be considered as the most important ingredient in establishing a correct relationship between the remote sensing data set (DEM ALOS, ASTER and SRTM). GCPs are taken according to the permanent properties on the Earth's surface, known as X, Y and height coordinates, that is, Z. The horizontal control specifies only X and Y, while the vertical control specifies only Z Therefore, a complete GCP has X, Y and Z, that is, the corresponding position and height coordinates. A different GPS (TOPCON DGPS MODEL HIPER GA, GR-3, GB-1000) was used to collect GCP, and 20 of these GCPs were collected in the work area.

This section contains a description of the analyzed data sets. Table 3.4 provides an overview of the features of imaging systems and the accuracy of the data sets used in this study. RMSE horizontal accuracy or circular error with 90-95% reliability (CE90, CE95) and RMSE vertical accuracy or linear error with 90-95% reliability (LE90, LE95). It should be noted that the DEM selected for this analysis can also be called DSM (Digital surface models) because it does not represent the "bare" topographic surface in vegetation or urban areas (in this case, digital models around the terrain) - DTM) signal dense vegetation radar for weak SRTM. Due to the use of optical images sensitive to penetration and the cloud layer in ASTER GDEM and ALOS AW3D30. In the case of SRTM, C band data has been shown to penetrate significantly in the vegetation (Carabajal and Harding, 2006; Hofton et al., 2006).

Table 3. 4 Characteristics and global accuracy of the datasets used in this study

Dataset	Imaging system	Wavelength	Pixel spacing	Horizontal Accuracy	Vertical Accuracy
SRTM	SAR C band	5.66 cm	30m	<20m (CE90)	<16m (LE90)
ASTER GDEM	Optical	0.78-0.86 µm	30m	30m (CE95)	20m (LE95)
ALOS AW3D	Optical	0.52-0.77 µm	5m	5m (RMSE)	5m (RMSE)

3.7.1 ASTER DEM

There are many DEM products for the global monitoring and analysis of the world. The global digital elevation model of thermal emission and spatial reflection radiometer (ASTER GDEM) is a product produced by optical data collected by the ASTER device on NASA's Terra satellite (Hengl and Reuter, 2011). The ASTER sensor (advanced thermal space emission and radiometric reflection - Yamaguchi et al., 1998) was launched in December 1999 on the Terra satellite, providing the ability to produce stereoscopic images along the wave along the part. It is close to infrared (0.78-0.86 μm) with a rare (3N band) and rear telescopes (3B band) with a spatial resolution of 15 m (Figure 3.4).

In 2009, version 1 of ASTER GDEM (Global DEM) covering all terrains ranging from 83 ° N to 83 ° S was released (ERSDAC, 2009). ASTER GDEM V.1 was produced by automatically processing the entire ASTER file (about 1,500,000 scenes from 2000 to 2008) (Abrams et al. 2010; Tachikawa et al. 2011a). ASTER GDEM V.2 was launched in 2011 (Tachikawa et al., 2011a) and included the first version of processing algorithms, inclusion of scenes obtained between 2008 and 2011 (about 250,000 scenes), better data geographic reference and spatial resolution of 120 m to 70 m. an increase in effectiveness. With 95% security, ASTER GDEM has an estimated accuracy of 30 m horizontally and 20 m vertically (Tachikawa et al., 2011b) (Grohmann, 2018).

3.7.2 SRTM DEM

The task of measuring radar radar was a collaboration between NASA, the National Geographic Intelligence Agency (NGA), the U.S. Department of Defense (DoD), DLR, and the Italian Space Agency (ASI, Italy). The space mission STS-99 of the space shuttle Endeavor flew for 11 days in February 2000; Its main goal was topographic mapping of continental areas between 60 ° N and 60 ° S (about 80% of the Earth's land masses) with InSAR (Farr and Kobrick, 2000; van Zyl, 2001; Rabus et al., 2003). The SRTM mission was a milestone in topography remote sensing (van Zyl, 2001) and produced the most complete and highest resolution DEM in the world (Farr et al., 2007). A comprehensive global assessment revealed that the data met and exceeded the absolute accuracy of the 16-meter (90 percent) mission, usually with two factors (Rodríguez et al. 2006). Since its launch in 2005, the user community has embraced the availability of SRTM data in many operational and search configurations using data.

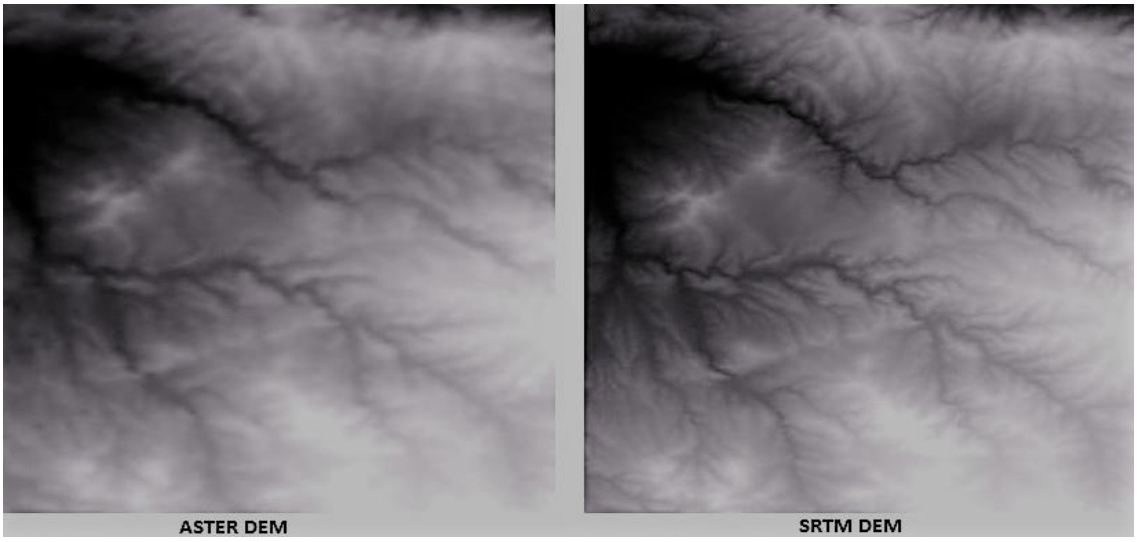

Figure 3. 4 SRTM and ASTER DEM visualization

3.7.3 ALOS DEM (Reference DEM)

At last in May 2015, The Japan Aerospace Exploration Agency(JAXA) released "ALOS World 3D – 30m(AW3D30)" open global DEM, the global digital surface model(DSM) dataset with a horizontal resolution of approximately 30-meter mesh (1×1 arc second) (Anonymous, 2019). The free version of the DEM, studied in this paper has 1 arc second resolution, which is equivalent to about 30m at the Equator. The dataset is published based on the DSM dataset (5-meter mesh version) of the "World 3D Topographic Data", which is the most precise global-scale elevation data at this time, and its elevation precision is also at a world-leading level as a 30-meter mesh version (Tadono et al., 2015).

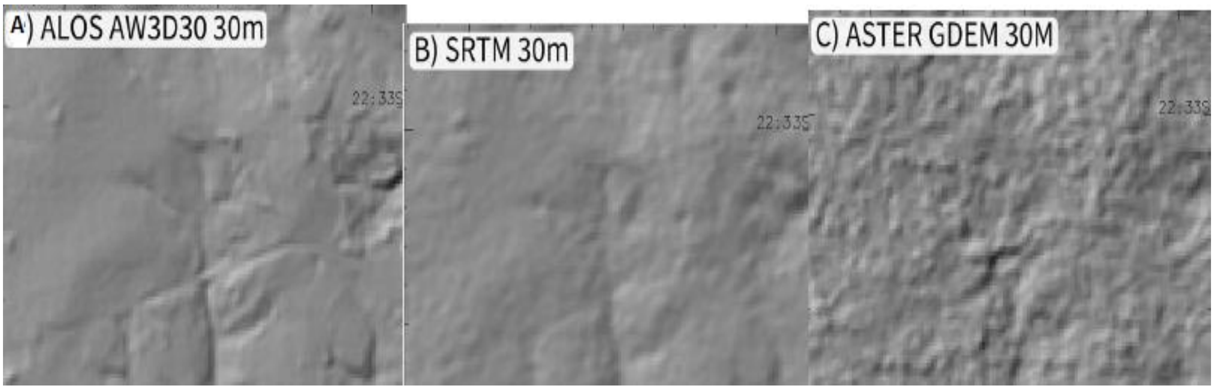

Figure 3. 5 Shaded relief images related with dem types (Source: Grohmann (2018))

3.8 Reference Elevation Data

The basic data used in the analysis consist of 20 ground control points or GCPs located in various parts of Gaziantep (Figure 3.3). For this study, we applied a closed circuit level detection starting from a known height point and closing or returning to the same known height point. Leveling conducting our investigation, Turkey Overview Map Command and Resource Information Authority created by vertical measures / criteria we use. Research was firmly adhering to third-degree geodetic leveling procedures, standards and specifications established by the Federal Geodetic Control Committee (FGCC). The accuracy of the leveling questionnaire for each course was evaluated by verifying that the maximum ring closures (MLC) did not exceed 12 mm (Anderson & Mikhail, 1998); where D is two (or approximate) distance of the movement length of the ring. MLC is calculated by obtaining the difference between the actual height values obtained by determining the closing reference control point.

Horizontal positions of the GCPs (WGS84 longitude and latitude) Garmin 550t GPS receiver (set portable global positioning system) for. In each PCG, geographic coordinates were measured with a time-based average (minimum 2-minute observation time) until the accuracy of the location specified in the receiver was less than 10 m. A shape file was created from the collected GCPs and reflected back to UTM51 using ArcGIS 10.6 software. Control points are installed in relatively fixed areas (for example, roads, sidewalks, bridges and other similar concrete structures of a given ground cover). Checkpoints include eight (8) kinds of land cover, especially mountainous part (3 points), lowland (4), village (2), open forest (3), (e. Forests, palm trees and mangrove vegetation;). Since DEMs have been produced using data collected since 2000, we believe it is appropriate to use the best available land cover map (scale 1: 250,000) to group PCGs by land cover types.

4. METHODOLOGY

4.1 Statistical Analysis

According to the ALOS AW3D30 DEM datasets, the accuracy of the points selected between ASTER and SRTM DEM was checked for accuracy from ALOS DEM to Z components SRTM and ASTER with respect to Z components from ALOS DEM has been checked. In this study ALOS DEM was considered the reference for analysis of differences betweeen other DEMs.

4.1.1 Root Mean Square Error (RMSE)

Vertical square root error (RMSE) is a common metric used in earth sciences to measure the accuracy of continuous variables such as DEM elevation. In this study, RMSE is a frequently used measure of the difference between fixed values (ALOS DEM data) and estimated values from any known source (SRTM DEM and ASTER DEM data). These individual differences are also called residues, and RMSE adds them to a single measure of predictive power (Rawat et al., 2018). The two best advantages of RMSE are that they provide second-order loss function and uncertainty measurements in calculated values. The result of the analysis of the mean square error (RMSE) defines the degree of correspondence between the SRTM DEM, ASTER DEM and ALOS DEM values and the calculated values. Low RMSE values show a better result. The fixed value RMSE (Z ALOS = DEM component Z) related to the estimated (ZCOMPUTED) is defined as the square root of the mean square error:

$$\text{RMSE}= \sqrt{\sum_{1}^{n} \frac{(Zalos - Zcomputed)^2}{n}}$$

(1)

where, Z_{ALOS} is the values of ALOS AW3D30 and $Z_{COMPUTED}$ is estimated values from SRTM and ASTER DEMs.

4.2.2 The Root Mean Square Relative Error (RMSE-R)

The average square error(R-RMSE) used to compare the Z values calculated by DEM SRTM and ASTER according to the constant value of the ALEM DEM for data corresponding to the SREM and ASTER location point. The resulting R-RMSE value is defined as a percentage and represents the standard variation of the estimator. R-RMSE determines the same weight as any overestimation or impairment of data statistics.

RMSE-r equation defined as =

$$\sqrt{\sum_{i}^{n} \frac{1}{n} \left(\frac{ZALOS - Z\text{COMPUTED}}{ZCOMPUTED}\right)^2} \qquad (2)$$

4.2.3 Mean Absolute Errror (MAE)

The MAE measures the average error size in a series of predictions, regardless of their direction. In the test sample, it is the average of absolute differences between prognosis and true observation, where all individual differences have the same weight. The always average absolute error defined is the average of all absolute errors. Although MAE is used to measure the proximity of approaching a result, RMSE represents the standard deviation of the sample from the differences between expected values (yt) and observed values (y); Where n is the number of observations and R. The correlation coefficient measures the strength and direction of the linear relationship between yt and y. It measures accuracy for continuous variables. MAE and RMSE can be used together to diagnose errors in a number of estimates. RMSE is always greater than or equal to ODE. The greater the difference between them, the greater the variance of individual errors in the sample. If RMSE = MAE, all errors have the same amplitude. The average absolute error was examined with the calculated values observed by ALOS DEM. Here, n = number of points observed by ALOS DEM

$$MAE= \frac{\sum_{i}^{n}(ZALOS - ZCOMPUTED)}{n} \quad (3)$$

4.2.4 Normalized Root Mean Square Error (N-RMSE)

Standardization of RMSD facilitates always try comparison between datasets or some different type of models on different scales. This value is often referred to as the deviation or error of the normalized middle root quadrant (N-RMSD or N-RMSE) and is usually expressed as a percentage with lower values indicating a lower residual variance.

$$N\text{-}RMSE=RMSE/Z_{ALOS} \quad (4)$$

If near-zero NRMSE means excellent value from ALOSDEM, the NRMSE association indicates that the calculated value (from SRTM and ASTER DEMs) is not more effective than the data average (as observed from ALOSDEM).

4.2.5 Coefficient of Determination (R^2)

The coefficient of estimation is a measure of the statistical some multiple used to assess the extent to which a model describes and predicts future results. Indicates the degree of variability described in the dataset. The coefficient of determination, commonly known as "R-square", which will continue to be known, is always preferred as a guide to measure the accuracy, clarity and authenticity of the model. The coefficient of determination is often used to explain how much a factor can make due to its relationship with another variable, ie how much it can change the variable. For this reason, it is largely based on trend analysis and results in a value between 0 and 1. The closer the value is to 1, the better the adjustment or relationship between the two factors. The coefficient of determination is the square of the correlation coefficient, also known as "R", which allows you to see the degree of linear correlation between the two variables. The coefficient of determination is the square of the correlation between expected scores in a data set and real scores. It can also be expressed as the square of the correlation between the X and Y scores, X can be expressed as an independent variable and Y as a dependent variable. Regardless of the notation, an R square of 0 means that the dependent variable cannot be estimated using the argument. On the contrary, if it equals 1, it means that the argument always waits for the employee of a variable.

4.2.6 Percentage Root Mean Square Error

% RMSE is an RMSE-related error scale value based on the Zmax of the Z component to numerically understand the scale at which each DEM is above or below the Z component level estimate. Lower RMSE values (from ASTER and SRTM) indicate that the Z component has a better value compared to DEM ALOS data (reference).

$$\text{RMSE}= \frac{\sqrt{\sum_i^n (Zalos - Zcomputed)2}}{n} \text{ x } \frac{100}{\sum_i^n Zalos} \qquad (5)$$

4.2 Datum Conversion

To carry out a consistent comparison of the LiDAR and GPS searches with DETM SRTM, ASTER, ALOS and TDX, all measurements must refer to the same horizontal coordinate system and the same vertical data. Since no reliable local data is available, all data with vertical data EGM2008 (Pavlis et al., 2012; Zhang et al., 2019) n meter units were converted into the coordinate system WGS84 UTM Zone 37N using the national geodata tool.

Exchange rates (NGA) ,

(http://earth-info.nga.mil/GandG/wgs84/gravitymod/egm2008/egm08_wgs84.html, Accessed December 10, 2019) and the ArcGIS projection tool. For DEM SRTM, ASTER and ALOS, the horizontal and vertical coordinates of each cell in the grid, which refer to WGS84 and EGM96, were initially displayed as text files. The heights were then converted to ellipsoidal heights related to WGS84 and heights related to EGM2008 using the NGA conversion tool. Finally, the heights of the EGM2008 were converted into a grid in ASCII format in ArcGIS and projected into the UTM coordinate system. The ellipsoid heights of the GPS measurements related to ITRF 2008 were converted to EGM2008 heights using the NGA conversion tool to convert the ellipsoid heights WGS84 to heights EGM2008 because the ellipse heights ITRF2008 and WGS84 matched about 10 cm height.

4.3 Analysis For Vertical (Elevation) Accuracy of DEMs

The vertical accuracy of the AW3D30 is approximative using two reference types, including GCP GLAS and two globalDEM datasets. First, let's compare the heights of the AW3D30 with the heights of the GCP GLAS. The height of the AW3D30 at the GCP position is calculated by double linear interpolation, since a DEM value usually corresponds with the height in the middle of the pixel and rarely the position of the GCPs. At each point, the difference was calculated by subtracting the GCP height from the height of the AW3D30. Second, the AW3D30 was evaluated relative to the pixel pixel difference, aligned with SRTM and ASTER and AW3D30. In order to determine the vertical accuracy of the selected points of ASTERDEM and SRTMDEM in relation to the ALOSDEM data sets, the precision evaluation was carried out using equations (1) - (5) on the vertical component of the SRTM GCP (component Z). ASTER or ALOS (Table 5.1). The results of the selected GCPs observed by RMSE, R-RMSE, MAE, NRMSE and RMSE were followed. Vertical accuracy is obtained to find the difference between the Z component of the points (from ALOS DEM) and the Z component of the points calculated by different SRTM DEM and ASTER DEM to determine the vertical accuracy.

5. RESULTS & DISCUSSION

5.1 Vertical Accuracy of Selected points ($ASTER_{DEM}$ and $SRTM_{DEM}$ with respect to $ALOS_{DEM}$)

The vertical accuracy of each selected ALOS point, SRTM to ALOS, was estimated sequentially using the methods described in the methodology (equations 1-5) in relation to the vertical ASTER component, SRTM GCP (component Z). and ALOS (Table 5.1). The% of selected OSG results observed by RMSE, R-RMSE, MAE, NRMSE and RMSE were monitored. Vertical accuracy is obtained by finding the difference between the Z-point component (of ALOS DEM) and the Z-point component calculated by different SRTM DEM and ASTER DEM to determine vertical accuracy.

5.2 Vertical Accuracy Analysis (ASTER DEM and SRTM DEM with respect to ALOSDEM)

All points selected from ASTER and SRTM DEMs with respect to ALOS DEM ensures the accurate the vertical analysis. The vertical accuracy of 20 points analysed according to RMSE, R-RMSE, MAE, N-RMSE and RMSE%. The results from comparing ASTER and SRTM are showed that RMSE of 20 points is 11,56m (R-RMSE= 0,018, MAE= 14,75 , N-RMSE= 0,013 , RMSE %= 0,066) respectively (Table 5.2). On the other hand analyzed the vertical accuracy of ALOS-30m with respect to SRTM-90m for 20 points showed that RMSE is 6,98m (R-RMSE=0,409 , MAE= 5,75 , N-RMSE= 0,007 , RMSE%= 0,039) with respectively (Table 5.2). Apart from this, analyzed the vertical accuracy of ALOS-30m in respect of ASTER-30m for RMSE of 20 points found as 16,03m (R-RMSE= 0,018 MAE= 13,40 , N-RMSE= 0,018 , RMSE %= 0,09) respectively (Table 5.2). For the whole part of the table it is obvious that ALOSDEM datasets are vertically accurate with respect to SRTM DEM than ASTER DEM, within the resolution of comparing of 30m.

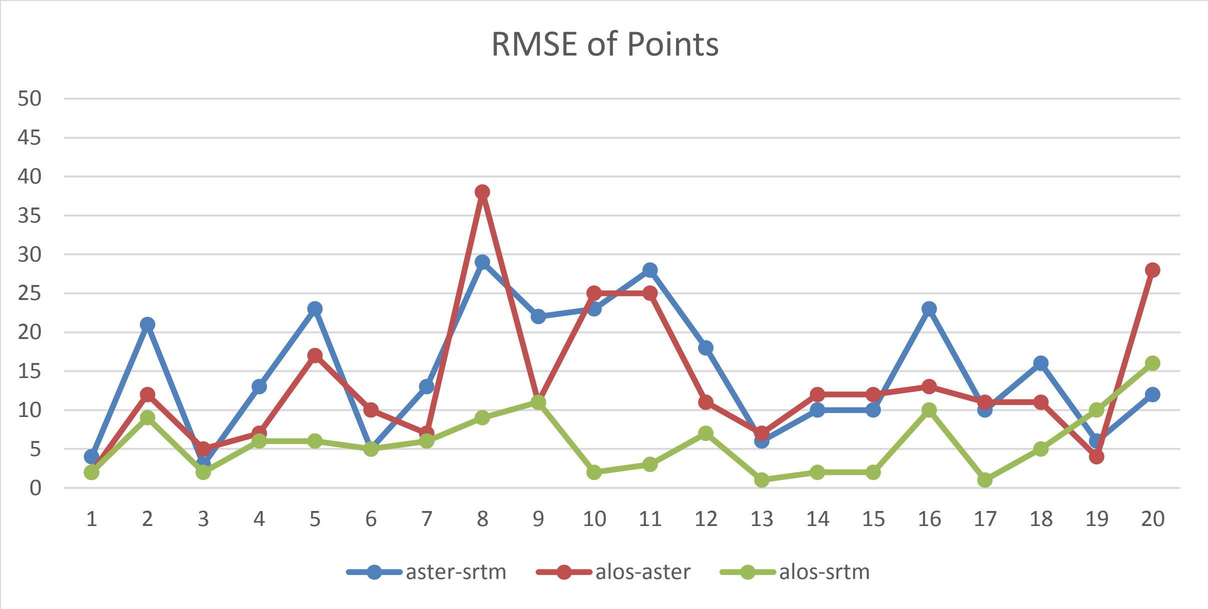

Figure 5.1 Comparison of RMSE in vertical accuracy for ASTER and SRTM with respect to ALOS DEM

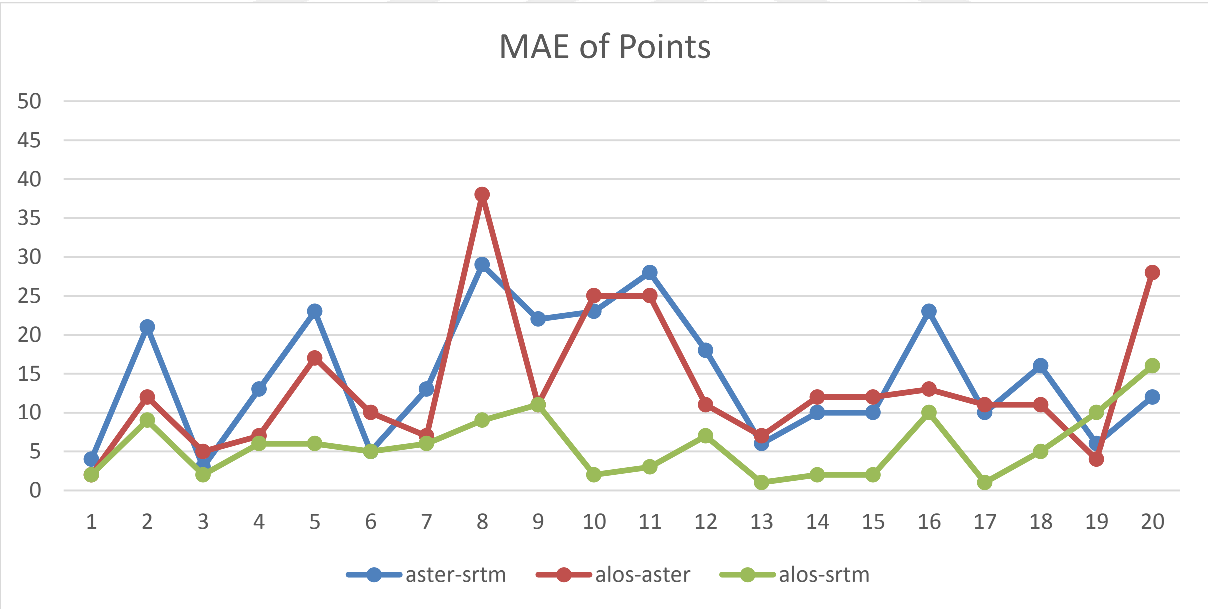

Figure 5.2 MAE in vertical accuracy for ASTER and SRTM with respect to ALOS DEM

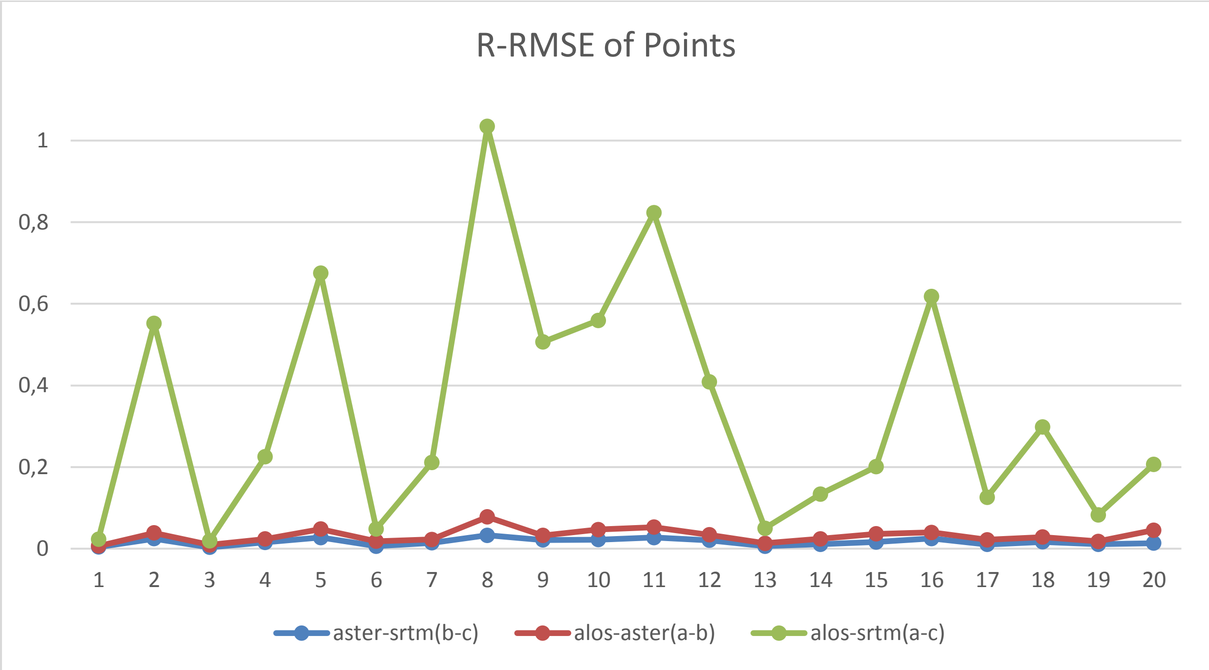

Figure 5.3 R-RMSE in vertical accuracy for ASTER and SRTM with respect to ALOS DEM

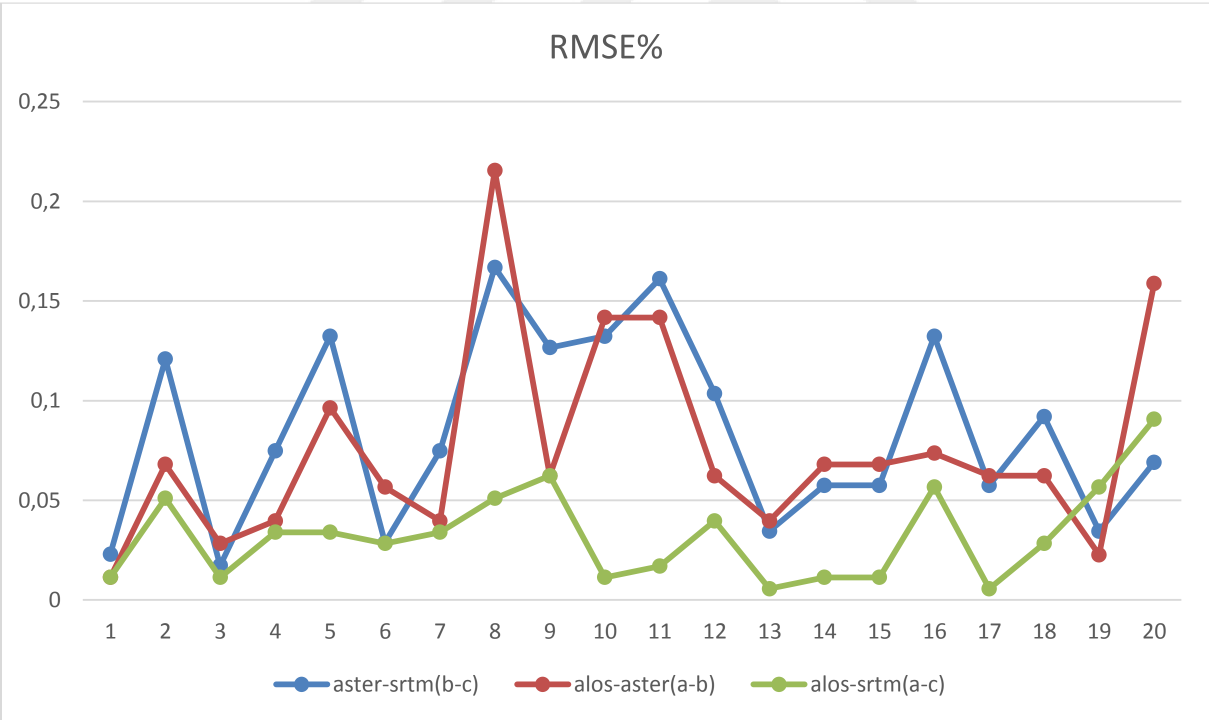

Figure 5.4 RMSE% in vertical accuracy for ASTER and SRTM with respect to ALOS DEM

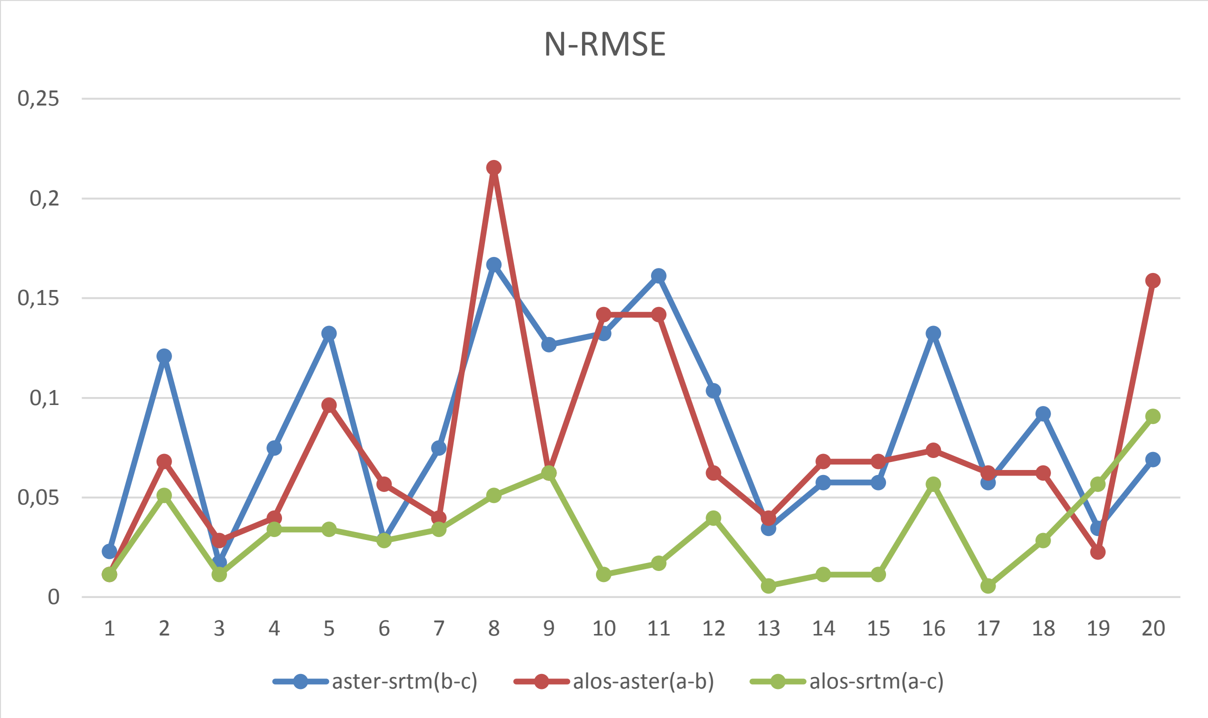

Figure 5.5 N-RMSE in vertical accuracy for ASTER and SRTM with respect to ALOS DEM

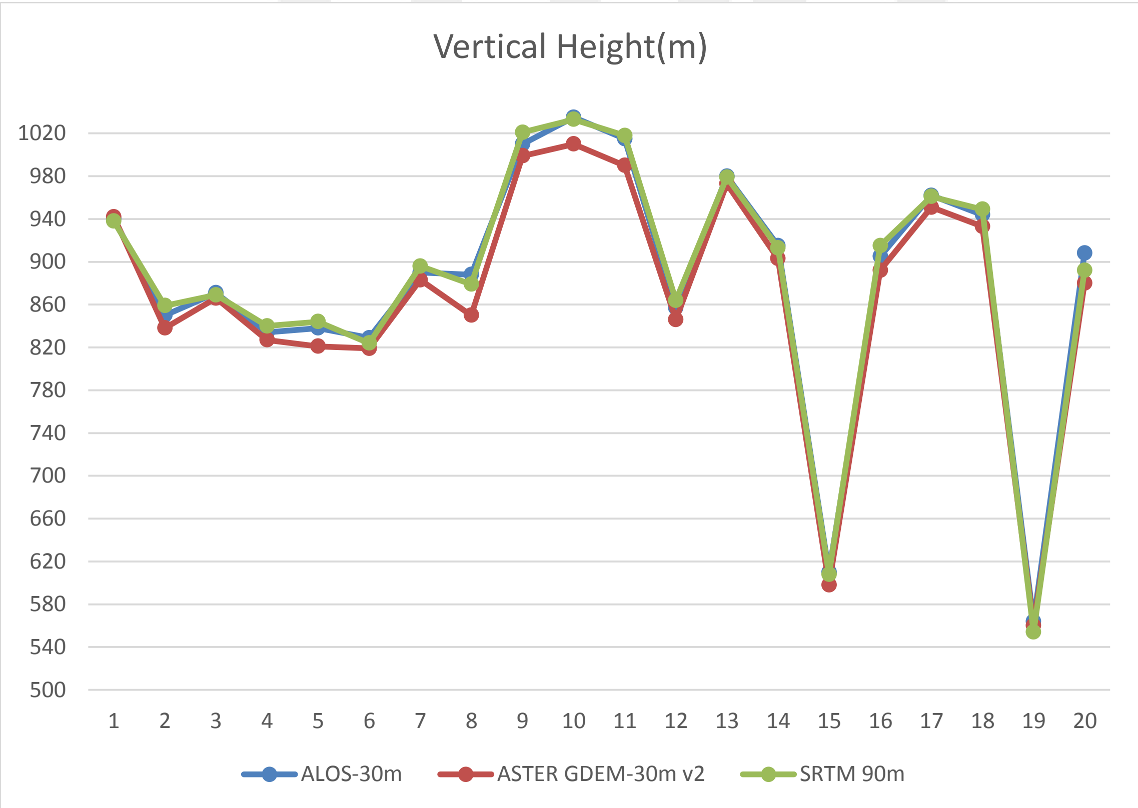

Figure 5.6 Vertical heights (m) of points in ASTER and SRTM and ALOS DEM.

The vertical accuracy of ALOS (AW3D30) is estimated on the basis of two DEMs with ASTER or SRTM. RMSE, R-RMSE, MAE, N-RMSE and RMSE% of 20 points each, introduced by the figure (5.1-5.6). All figures show that the DEM SRTM data records with respect to DEM ALOS are vertically accurate compared to DEM ASTER within the resolution of 3 arcseconds (90 m). Twenty statistical GCP tests such as RMSE, R-RMSE, MAE, N-RMSE and RMSE% values (vertical high and low) can be explained based on the scanning technology or the sensor mapping. All graphics showed that the SRTM data sets are somewhat better correlated than the ASTER GDEM data sets. Since a DEM value generally corresponds to the height of the center of the pixel and rarely to the position of the GCPs, the height of the AW3D30 in the GSO position is calculated by knowing the interpolation (Li and Zhao, 2018). At each point, the difference was calculated by subtracting the GCP height from the AW3D30 height. Second, the AW3D30 was evaluated relatively by pixel differentiation with SRTM1 and GDEM2 aligned with AWTMD30. These differences are errors measured in the AW3D30. All results are related to RMSE, R-RMSE, MAE, N-RMSE and% RMSE. For five examples, seven types of land use have been identified: arable land, forest, meadows, bodies of water, artificial surfaces, bare soil and permanent snow and ice. Since the DEM products record measurements of the surface height during satellite transmission, we assume that the ground cover in the study area has changed significantly during the periods of image acquisition.

Ground control points 12, 13 and 14 in the open forest and in the mountain parts 9, 10, 11 of the region and microwave sensors are more useful for mapping forest areas, since microwaves easily penetrate the forest roof in relation to RMSE and R-RMSE (Figure 5.1 and 5.3) from SRTM and ASTER the same model. Ground control points 19 and 20, which fall into the village area, have a lower RMSE than ASTER compared to the SRTM because the ASTER sensor can easily estimate small vertical deviations on ground surfaces. For ground control points in flat areas, 16.17 and 18 have a lower RMSE than ASTER's SRTM. For ground control points in urban areas 1, 2, 3, 4, 5, 6, 7 and 8, the SRTM and ASTER values are actually very similar. The topography of open forests, mountainous and undulating terrain is always different from the flat areas. Particularly in areas such as open forests, mountainous and undulating terrain, the vertical accuracy depends on the precision of the DEM generation and on the mapping method for the relief shift factor.

Table 5.1 Geodetic networks map locations in Turkey

GPS and Leveling	LATITUDE	LONGITUDE	GCP	GPS	ALOS-30m	ASTER GDEM-30m v2	SRTM 90m	Location
Burç kavşağı GPS	37,02415	37,30597	1	948	940	942	938	city
Leveling 1 (no:004)	37,05972	37,35056	2	845	850	838	859	city
Leveling 10 (no:007)	37,04917	37,33028	3	865	871	866	869	city
Leveling 11 (no:012)	37,39611	37,07472	4	831	834	827	840	city
Leveling 5 (no:015)	37,09139	37,43667	5	835	843	784	844	city
Leveling 6 (no:014)	36,99361	37,33722	6	820	829	819	824	city
Leveling 7 (no:040)	37,08861	37,34861	7	889	890	883	896	city
Leveling 15 (no: 009)	37,035	37,31806	8	887	888	850	879	city
Leveling 3 (no:036)	37,11722	37,32444	9	997	1010	999	1021	hilly part
Leveling 8 (no:035)	37,12611	37,30611	10	1028	1035	1010	1033	hilly part
Nurdağı Sakçagözü GPS	37,19046	36,97193	11	1023	1015	873	1018	hilly part
Leveling 12 (no:011)	37,00861	37,31111	12	854	857	846	864	open forest
Leveling 13 (no:026)	37,2114	37,2611	13	973	980	973	979	open forest
Leveling 2 (no: 019)	37,11111	37,48111	14	912	915	903	913	open forest
Narlı GPS	37,41722	37,16111	15	619	610	598	608	plain area
Leveling 14 (no:038)	37,09389	37,34333	16	910	905	892	915	plain area
Leveling 9 (no:043)	37,17611	37,23583	17	959	962	951	961	plain area
Leveling 4 (no:045)	37,16417	37,26278	18	948	944	933	949	plain area
İslahiye Fevzipaşa GPS	37,08756	36,64326	19	560	564	560	554	village
Kızılhisar GPS	36,99222	37,31563	20	918	908	852	892	village

All points are indicated in meters of twenty points from ALOS, ASTER and SRTM. Areas are varied as city, hilly part, open forest, village and plain area.

Table 5.2 Statistical test for calculating vertical accuracy of DEM with respect to each other

Tests	ALOS-30m w.r.f ASTER-30m	ALOS-30m w.r.f SRTM-90m	ASTER-30m w.r.f SRTM-90m
RMSE	16,03	6,98	11,56
R-RMSE	0,0182	0,4097	0,0185
MAE	13,40	5,75	14,75
N-RMSE	0,018	0,007	0,013
RMSE %	0,090	0,039	0,066

All points selected from ASTER and SRTM DEMs with respect to ALOS DEM ensures the accurate the vertical analysis. The vertical accuracy of 20 points analysed according to RMSE, R-RMSE, MAE, N-RMSE and RMSE%. The results from comparing ASTER and SRTM are showed that RMSE of 20 points is 11,56m (R-RMSE= 0,018, MAE= 14,75 , N-RMSE= 0,013 , RMSE %= 0,066) respectively (Table 5.2). On the other hand analyzed the vertical accuracy of ALOS-30m with respect to SRTM-90m for 20 points showed that RMSE is 6,98m (R-RMSE=0,409 , MAE= 5,75 , N-RMSE= 0,007 , RMSE%= 0,039) with respectively (Table 5.2). Apart from this, analyzed the vertical accuracy of ALOS-30m in respect of ASTER-30m for RMSE of 20 points found as 16,03m (R-RMSE= 0,018 MAE= 13,40 , N-RMSE= 0,018 , RMSE %= 0,09) respectively (Table 5.2). For the whole part of the table it is obvious that ALOSDEM datasets are vertically accurate with respect to SRTM DEM than ASTER DEM, within the resolution of comparing of 30m.

In addition, the results of measuring the vertical accuracy AW3D30 are crucial for understanding good vertical accuracy in relation to the DEM SRTM and ASTER data sets. In addition, study studies showed that ASTER DEM provides more accurate altitude readings than DEM-SRTM data based on GPS heights, like similar studies in a previous study. However, according to some studies, the accuracy of SRTM is better than that of ASTER. The reasons may be the accuracy of DEM ASTER and SRTM, depending on the region you are interested in and the type of terrain.

An important finding of this study is that the three DEMs exaggerate the true height of the land regardless of the terrain type. Regarding vertical accuracy, it is very clear that the AW3D30 has exceeded SRTM-30m and especially ASTER GDEM2 due to lower average errors and RMSE values compared to the last DEM.

Compared to ASTERGDEM, the 10.51 m RMSE calculated for the AW3D30 is higher than the expected vertical accuracy of ALOS World 3D, which is 5 m (RMSE).The average errors calculated are slightly higher than the calculated errors of Takaku et al. (2014), and Santillan and Santillan (2016), Takaku et al. and according to 274 GCP, the average error is 4.36 m and the RMSE is 5.68.

Although the AW3D30m has an RMSE of 5 m, the calculated average error and the RMSE show that the ground level of this DEM provides a more precise definition than the SRTM-30m and ASTER GDEM2. Therefore, the accuracy of ASTER-30m better than the RMSE of SRTM-90m.

ASTER GDEM2 results increase the number of publications reporting the weakness of this DEM. The high mean error, SD and RMSE calculated in this study may indicate the presence of and artifacts in DEM, which may have been detected by the GCPs used in the analysis. The results of the analysis of the effects of land cover on the accuracy of the DEM level were inconsistent with the results of the DEM accuracy assessment studies focusing specifically on SRTM and ASTER GDEM2. Gesch et al. (2012) found a clear correlation between ground cover types and the accuracy of ASTER GDEM and SRTM-30m, i.e. height errors increased when the ground cover completely changed vegetatively from non-vegetatively. In his study, a positive trend was found in the forest dominated GCP regions. In addition, the RMSE ASTER GDEM2 and SRTM-30m values were almost the same as the ground clearance, which increased as the floor level measured the height (Gesch et al., 2012). In this study, these results are not accidental. Although there is evidence that land cover types affect the accuracy of DEM, there is no absolute relationship between the two. However, this does not mean that the relatively rough ground cover map used to group the limitations of the GCP study and the GCP and SRTM-90m rationales may not be available for DEMs in Gaziantep Province.Of the three, the AW3D30 showed the actual terrain heights most accurately, since this DEM has the lowest RMSE. ASTERGDEMV2-30m and SRTM-90m follow. The superiority of the AW3D30 over the other two DEMs was also constant with different types of land cover.

7. CONCLUSIONS

The purpose of this document, the GCP AW3D30 distribution is to examine the impact of vertical accuracy of SRTM and aster'n in the city of Gaziantep in Turkey. The study area of Gaziantep is 36o 28 'and 38o 01' east longitude and 36o 38 'and 37o 32' north latitude. Of a total area of 6222 km 2 1% corresponds to Turkey. The undulating and rough terrain dominates the city. For the evaluation, 20 GSIOs were chosen for different types of land cover. This document also analyzes a comparative evaluation of the vertical accuracy of ASM and SRTM DEMs compared to ALOS-3D with ArcGIS of several DEM datasets. Field research in the study area focuses on investigating vertical accuracy in GCPs selected from SRTM, ASTER and AW3D30 DEM. All the points selected between DEM ASTER and SRTM compared to DEM ALOS guarantee the accuracy of vertical analysis. The vertical accuracy of 20 points was analyzed according to RMSE, R-RMSE, MAE, N-RMSE and % RMSE. The results of the comparison between ASTER and SRTM show that the 20-point RMSE is 11.56 m (R-RMSE = 0.018, MAE = 14.75, N-RMSE = 0.013, RMSE% = 0.066) (Table 5.2). On the other hand, the analysis of the vertical accuracy of ALOS-30m for 20 points in relation to SRTM-90m showed that RMSE was 6.98 m (R-RMSE = 0.409, MAE = 5.75, N-RMSE = 0.007, RMSE%) = 0.039) (Table 5.2). In addition to that, he analyzed the vertical accuracy of ALOS-30m against AMS-30m for 20 RMSE points which is 16.03m (R-RMSE = 0.018 MAE = 13.40, N-RMSE = 0.018, RMSE% = 0), 09) (Table 5.2). For the entire table, it is clear that ALOSDEM data records for DEM SRTM are vertically accurate compared to DEM ASTER with a comparison resolution of 30 m. The results show that vertical accuracy can be improved for all drawn points. Highly recommended for applications that require high vertical precision DEM. We compare the vertical accuracy of the ALOS AW3D30 with the ASTER and SRTM data sets for different types of land cover, such as plains, open forests, urban areas and mountainous areas. The types of land cover and slopes contribute to changes in the accuracy of the sample and the latter will have a greater impact than before. The analysis shows that the ALOS AW3D30 offers the best accuracy when analyzing the vertical accuracy of the ground control points, then SRTM and, therefore, DEM ASTER GDEM2. However, the vertical accuracy of SRTM is better than that of ASTER. The reasons for this may be that the accuracy of ASTER and SRTM DEM depends on the region and the type of terrain that interests.

REFERENCES

Caglar, K. Becek, C. Mekik & M. Ozendi (2018). *On the vertical accuracy of the ALOS world 3D-30m digital elevation model,* **1**, Turkey.

Darshik Gajjar, Kishan Darji, Dhruvesh Patel, Cristina Prieto, and Dawei Han (2017). *A Comparative Study of Delineated Watersheds through ASTER, SRTM and ALOS for evaluating morphological changes in Hathmati Basin*, **1**, Gujarat, India.

Deng, Mel Rodgers, Surui Xie, Timothy Dixon, Sylvain Charbonnier, Elisabeth Gallant, Cristian Velez, Milton Ordonez, Rocco Malservisi, Nicholas Voss, Jacob Richardson (2019). *High-resolution DEM generation from spaceborne and terrestrial remote sensing data for improved volcano hazard assessment — A case study at Nevado del Ruiz, Colombia*,**1,** Colombia.

Gajalakshmi K. and Anantharama V. (2015). *Comparative Study of Cartosat-DEM and SRTM-DEM on Elevation Data and Terrain Elements*,**1**, India.

Gayla A. Evansa, Bhaskar Ramachandranb, Zheng Zhangb, G. Bryan Baileya, and Philip Cheng (2008). *An Accuracy Assessment of Cartosat-1 Stereo Image Data-Derived Digital Elevation Models: A Case Study of the Drum Mountains*,**1,** Utah, USA.

Gökmen (2018). *Turkey Sample On Alos and Srtm C-Band AW3D30 Incompatıbılıty Analysis of Global Surface Models,***4**, Turkey.

Grohman C. H. (2018). *Evaluation of TanDEM-X DEMs on selected Brazilian sites:comparison with SRTM, ASTER GDEM and ALOS AW3D30,* **13**, Sao Paulo, Brazil, 2-19.

Gürbüz (2019). *Multispectral mapping of evaporite minerals using ASTER data: A methodological comparison from central Turkey*,**1**, Turkey.

Hewson,Cristian Rossi, Fernando Rodriguez Gonzalez, Thomas Fritz, Nestor Yague-Martinez, Michael Eineder (2012). *Tandem-X Calibrated Raw Dem Generation,* **1**, Germany.

Elisante Mshiu, Chris Hecker, Harald van der Werff, Frank van Ruitenbeek, Dinand Alkema, Freek van der Meer (2019). *Application of Day And Night Time Aster Satellite İmagery For Geothermal And Mineral Mapping İn East Africa* ,**1**, Netherlands.

Ismail Elkhrachy (2016). *Vertical accuracy assessment for SRTM and ASTER Digital Elevation Models: A case study of Najran city*, **1**, Saudi Arabia.

İl *(2018). SRTM and ASTER Numerical Height Models of Gravimetrıc Geoit Contribution to Determination,* **5**, Turkey.

J. R. Santillan, M. Makinano-Santillan (2016). *Vertıcal Accuracy Assessment of 30-M Resolutıon ALOS, ASTER, And SRTM Global Dems over Northeastern Mindanao,* **1**,Philippines.

Jojene R. Santillan, Meriam Makinano-Santillan, Ronald M. Makinano (2016). *Vertical Accuracy Assessment of ALOS World 3d – 30m Digital Elevation Model over Northeastern Midanao,* **1**, Philippines.

Julia Neelmeijer, Mahdi Motagh, Bodo Bookhagen (2017). *High-resolution digital elevation models from single-pass TanDEM-X interferometry over mountainous regions: A case study of Inylchek Glacier, Central Asia,* **1**, Germany.

Karabulut (2016). *Comparative Geomorphometric Analysis of Draınage Basins Based on Aster GDEM and SRTM Data,* **4**, Turkey.

Keqi Zhang, Daniel Gann, Michael Ross, Quin Robertson, Juan Sarmiento, Sheyla Santana, Jamie Rhome, Cody Fritz (2018). *Accuracy assessment of ASTER, SRTM, ALOS, and TDX DEMs for Hispaniola and implications for mapping vulnerability to coastal flooding,* **1,** Miami, USA.

Komal Choudhary, Mukesh Singh Boori (2018). *An approach to delineate groundwater potential zones in Orenburg,* **1**, Russia.

Liyew Birhanu, Binyam Tesfaw Hailu, Tamrat Bekele, Sebsebe Demissew (2019). *Land use/land cover change along elevation and slope gradient in highlands of Ethiopia,***1**, Ethiopia.

Sabri Hussein, Mohamed Abdelkareem, Raafat Hussein, Mohamed Askalany (2019). *Using remote sensing data for predicting potential areas to flash flood hazards and water resources,* **1**, Eygpt.

Li and Zhao (2018). *Evaluation of the Newly Released Worldwide AW3D30 DEM over Typical Landforms of China Using Two Global DEMs and ICESat/GLAS Data* ,**1**, Turkey.

Moradasa Maria del Rosario Gonzalez , Willem Viveenb, *Evaluation of ASTER GDEM2, SRTMv3.0, ALOS AW3D30 and Tandem-X Dems For the Peruvian Andes Against Highly Accurate GNSS Ground Control Points and Geomorphological-Hydrological Metrics,* **1**, Spain.

Öztürk (2015). *Egm2008 Model's SRTM Numerical Integrity Model Investigation of Contribution: A Case Study,* **3**, Turkey.

Rajasekhar, G.SudarsanaRaju, R.SiddiRaju, M. Ramachandra ,B.Pradeep Kumar (2018). *Data on comparative studies of lineaments extraction from ASTER DEM, SRTM, and Cartosat for Jilledubanderu River basin, Anantapur district, A.P, India by using remote sensing and GIS* ,**1**, India.

Rossi, Hewson, Fernando Rodriguez Gonzalez, Thomas Fritz, Nestor Yague-Martinez, Michael Eineder (2012). *Tandem-X Calibrated Raw Dem Generation,* **1**, Germany.

Elisante Mshiu, Chris Hecker, Harald van der Werff, Frank van Ruitenbeek, Dinand Alkema, Freek van der Meer (2019). *Application Of Day And Night Time Aster Satellite İmagery for Geothermal And Mineral Mapping in East Africa* ,**1**, Netherlands.

Saygılı (2008). *Investigation of Accuracy of Digital Elevation Models Obtained from SRTM (Shuttle Radar Topography Mision) Data,* **10,** İstanbul, Turkey.

Shangmin Zhao, Weiming Cheng, Shifang Zhang (2018). *Hydrologic application comparison among typical open global DEM data based on remote sensing images,* **1**, China.

Tadono T, Nagai H, Ishida H, Oda F, Naito S, Minakawa K and Iwamoto H (2016). Generation of the 30 M-Mesh Global Digital Surface Model by ALOS PRISM, *The International Archives of the Photogrammetry, Remote Sensing and Spatial Information Sciences*, **1**, Czech Republic.

Vassilaki, Athanassios A. Stamos (2019). *TanDEM-X DEM: Comparative performance review employing LIDAR data and DSMs,* **1**, Greece.