A Study On The Usabılıty Of Dıgıtal Elevatıon Models Obtaıned From Open Sources In The Productıon Of Contours: Comparıson Of Alos And Srtm Dem Data

S.Cabuk [a], A.C. Kiracı, M.Kaya, M.Erdogan, O.Eker, A.Okul
General Command of Mapping, Department of Photogrammetry, Cebeci, Ankara, Türkiye – (serhat.cabuk, alicoskun.kiraci, mustafa.kaya, mustafa.erdogan, oktay.eker, abdullah.okul)@hgk.msb.gov.tr

Keywords : ALOS, SRTM, Digital Elevation Model, Contour

SUMMARY:

Open source digital elevation data is often for geographical applications and map productions because of no cost and easy accessibility. It can be used contour production as well as digital elevation data source. In this study, we discovered about possibility of using contours derived from ALOS (Advanced Land Observing Satellite) 30m, SRTM (Shuttle Radar Topography Mission) 1” (approximately 30m) and 3” (approximately 90m) resolution digital elevation models for 1:50k scale topographic map production. In this context, two different areas with different characteristics are selected. The first area is located in Canakkale that has high elevation differences and mountainous characteristic. The other area is located in Konya that has low elevation differences and plain territory. In the study areas, 200 control points have been identified in the different areas through stereo models created with high resolution aerial photographs. ALOS 30m, SRTM 30m and SRTM 90m resolution DEM data and data derived by applying filters or resampling from DEM data accuracy were analized at these control points. It was evaluated on stereo models by producing contours from each DEM data in terms of how it represented the territory. As a result of comparison, it is determined that the dataset which is the lowest standard deviation and RMS values and best represents the topographic structure of the land is ALOS 30m elevation dataset. The RMS of ALOS 30m data in Konya area is 2.35 m. and SRTM 30m is 2.82 m. In the Canakkale area RMS of ALOS 30m data is 2.54 m. and SRTM 30m is 3.95 m. Therefore, it is found that ALOS 30m DEM data gives more accurate results than SRTM DEMs in the study areas where the data generated and produced contours represent topography better.

A Study On The Usabılıty Of Dıgıtal Elevatıon Models Obtaıned From Open Sources In The Productıon Of Contours: Comparıson Of Alos And Srtm Dem Data

S.Cabuk, A.C. Kiracı, M.Kaya, M.Erdogan, O.Eker, A.Okul

1.INTRODUCTION

Open source digital elevation data is known that it is used for geographical applications and map productions because of the lack of cost and easy accessibility. These data can be used contour production as well as elevation data source.

Open source digital elevation data is often used for geographical applications and map productions because of no cost and easy accessibility. These data can be used contour production as well as elevation data source.

In this study, we discovered about possibility of using contours derived from ALOS (Advanced Land Observing Satellite) 30m, SRTM (Shuttle Radar Topography Mission) 1" (approximately 30m) and 3" (approximately 90m) resolution digital elevation models for 1:50k scale topographic map production. In this context, two different areas with different characteristics areas are selected. The first area is located in Canakkale that has high elevation differences and mountainous characteristic. The other area is located in Konya that has low elevation differences and plain territory.

In the study areas, 200 control points were identified in the different areas through stereo models created from high resolution aerial photographs. ALOS 30m, SRTM 30m and SRTM 90m resolution DEM data and data derived by appliying filters or resampling from DEM data were discovered about accuracy at these control points.

Although numerous studies have been carried out for accuracy assessments of DEMs in different parts of the world using various kinds of reference data and reference DEMs. (Hirt, 2010; Gomez, 2012; Suwandana, 2014; Jing, 2014; Ioannaidis, 2014; Satge, 2015). The quality and accuracy of the DEMs used and their suitability for these applications were not adequately assessed.(J.R.Santillan-M.Santillan, 2016)

2. STUDY AREA, DATA and METHOD

2.1 Study Area

While choosing the study areas, it is especially important to have areas with different characteristics and to use the same DEM data. When we look at these areas, it is chosen that Canakkale area has high and difference of elevation and Konya area is less flat and flat area of elevation. The study areas are worked on 1: 25000 scale borders within the Canakkale area H17c1 and within the Konya area J28c3. Study areas has presented in Figure 1 and Figure 2.

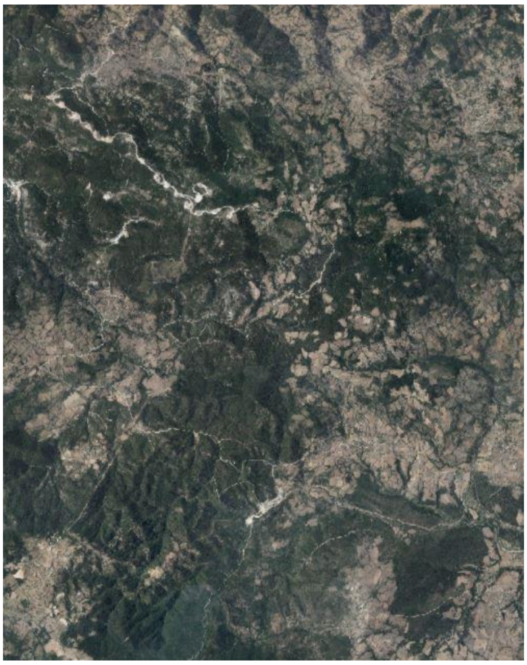

Figure 1. Canakkale - H17c1

Figure 2. Konya - J28c3

2.2 Data

High resolution aerial photographs taken in 2015 for the Canakkale area and 2011 for the Konya area were used in the application areas. Using these aerial photographs, the x, y, z coordinate values of the digitized point features of the 3D have been reached in WGS 84 datum.

100 point feature coordinates are captured from stereo models for each study area. The points in the Canakkale area are captured from different places and especially from the areas which are suitable for comparison, in order to represent topography better in mountainous areas where the elevation differences are increasing and decreasing rapidly. For Konya area, the point features are captured from different and vast plain areas.

In order to compare and make an assesment for digitized point features SRTM 90m, SRTM 30m and ALOS 30m DEM data are used. The cells used are E026N40 in Canakkale area and E032N36 in Konya area. In addition to these data, data by applying filter and resample methods are used to product variety data and make an assessment.

2.2.1 ALOS 30m

ALOS 30m was released in 2015 by the Japan Aerospace Exploration Agency (JAXA), and can be downloaded free of charge. The AW3D-30 is actually a resampling of the 5-meter mesh version of the World 3D Topographic Data, which is considered to be the most precise global-scale elevation data at this time. It was generated using the traditional optical stereo matching technique.

Due to its very recent release, studies assessing the vertical accuracy of ALOS 30m are few or are yet to be reported. Found the same DEM version to have a Root Mean Square Error (RMSE) of almost 4 m based on comparisons with various datasets including airborne LiDAR Digital Surface Model (DSM) and ground control points (GCPs). (J.R.Santillan-M.Santillan, 2016)

ALOS 30m data used in this study are shown in Figure 3 for Canakkale area and Figure 4 for Konya area.

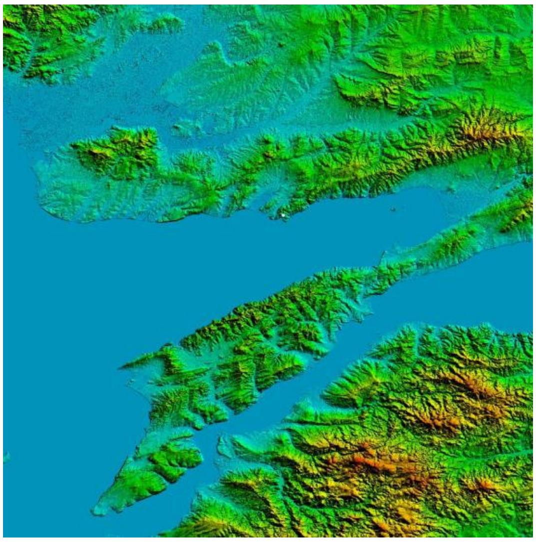

Figure 3. Canakkale ALOS 30m

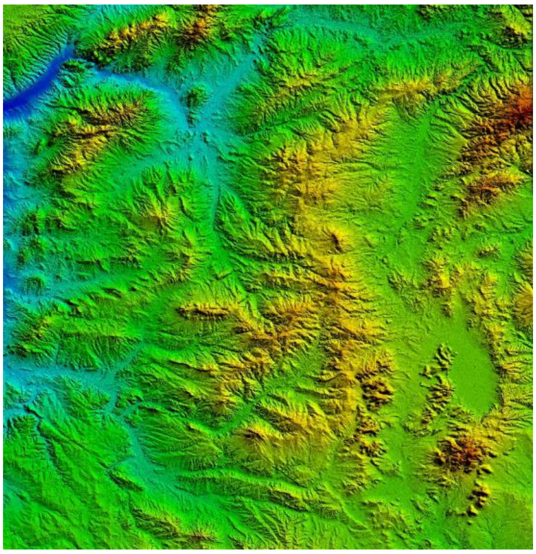

Figure 4. Konya ALOS 30m

2.2.2 SRTM 30m

The SRTM 30m data was developed by improving the SRTM 90m digital elevation data. This new data was improved by interpolating gaps in the SRTM 90m digital elevation data and filling in the data from different sources, resampling the data. The accuracy of the new data generated started to be released as open source in 2014 with an accuracy of approximately 1 " 30 m. The accuracy evaluation studies carried out by the NIMA, USGS and SRTM project team of the SRTM 30m data show that the vertical error will be approximately 5m accuracy. (Kellndorfer, 2004)

The SRTM 30m data used in this study is shown in Figure 5 for the Canakkale area and Figure 6 for the Konya area

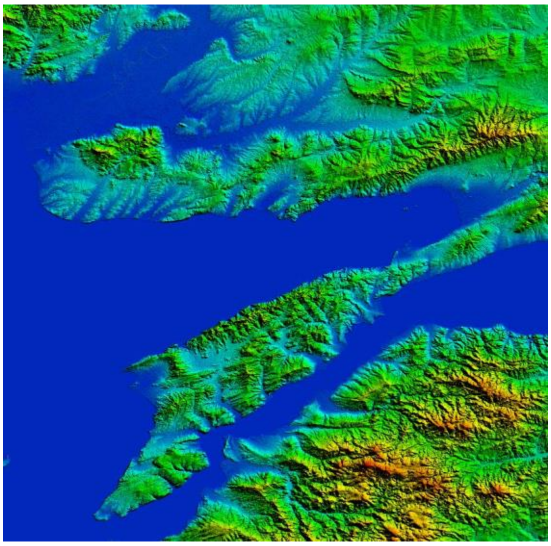

Figure 5. Canakkale SRTM 30m

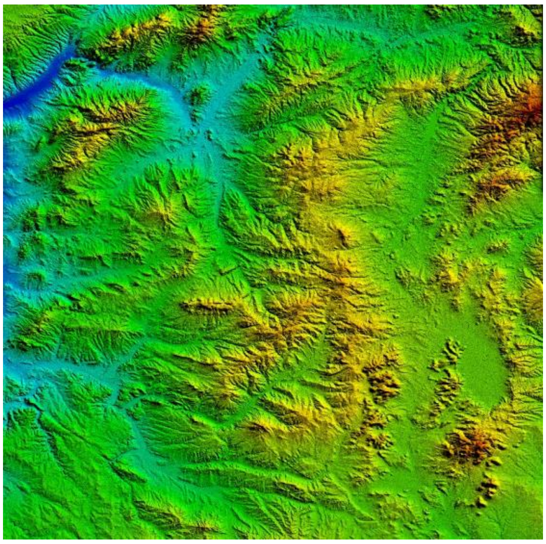

Figure 6. Konya SRTM 30m

2.2.3 SRTM 90m

The SRTM 90m is digital elevation data with an approximate 90m sampling distance, which is available as open source in 2003 and covers areas outside the United States. It is produced in 5x5 degree for easy to download and use. The SRTM data cover the area between north 60 degree latitude and south 60 degree latitude. It has horizontal WGS-84 datum and vertical EGM96 datum with geographical latitude and longitude coordinates. It has been reported that the vertical error of the SYM produced is less than 16m.

The SRTM 90m data used in this study is shown in Figure 7 for the Canakkale area and Figure 8 for the Konya area.

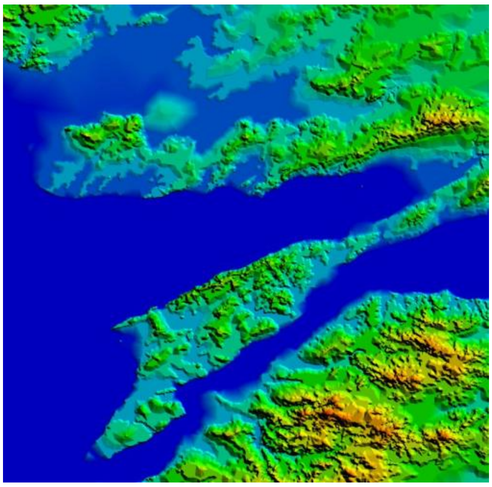

Figure 7. Canakkale SRTM 90m

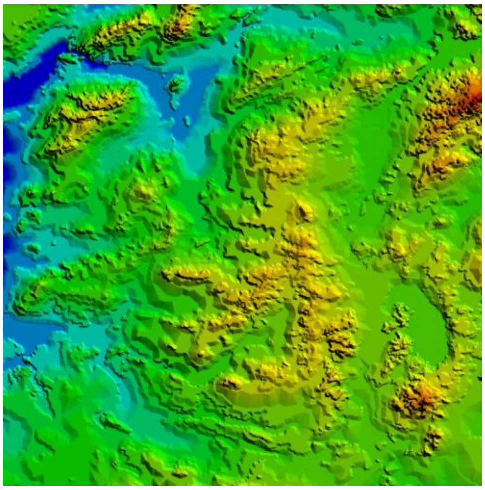

Figure 8. Konya SRTM 90m

2.3 Method

Besides use of elevation data, DEM data can be used for contour production. Because of ease of access open source DEM data is effective as secondary data in. Therefore these data can be used when the primary data source is absent or in urgent cases for production of contours and elevation data.

In order to be able to compare the point data captured from the stereo models, it is necessary to obtain different elevation data at the same point. Therefore, there are different elevation data and DEM data. As a result, it is estimated that comparison can be made between the obtained data.

3. APPLICATION

In order to realize 3D digitize application ArcMap 10.2.2 integrated wtih DAT/EM Summit Feature Collection software was used. High precision point features used as reference point in the territory are captured with the software. Totally 200 points are derived;. 100 of these are located in the Canakkale area, 80 point features stand on the ground and 20 point features are collected from top of the construction in the build-up areas. The remaining 100 points are captured from Konya area with the same specialities.

The most important speciality of these features is that they represent the best way of the ground and digitized widely within the area. Afterwards statistical values are computed.Therefore, the best results are determined by making comparisons between the available data and the DEM data. According to the results of the research, contours were produced using Global Mapper program. It has been observed that how contours produced fit the ground and how it represents territory. The statistical results are compatible with the impression got with the controls made from stereo models. Therefore, results were been supported and checked with extra controls.

3.1 Differences Between Elevation Data

The use of different elevation data on the same point allows us to extract the differences between the elevation and statistical data according to them. The statistical results include total difference, minimum-maximum difference, mean of difference, median, standard deviation and RMS values.

3.1.1 Differences Between Elevation Data - SRTM 90m

The differences between the point features in Canakkale and Konya areas and the SRTM 90m data and statistical information are given in Table 1 below.

	SRTM 90m
Number of Feature	100
Total Difference	211,61 m
Minimum Difference	0,15 m
Maximum Difference	11,33 m
Mean Difference	4,12 m
Median	2,65 m
Standard Deviation	**4,39 m**
RMS	**4,85 m**

	SRTM 90m
Number of Feature	100
Total Difference	236,11 m
Minimum Difference	0,1 m
Maximum Difference	12,91 m
Mean Difference	2,36 m
Median	-1,13 m
Standard Deviation	**3,21 m**
RMS	**3,20 m**

Table 1. Difference Between Data Canakkale-Konya Areas SRTM 90m and Statistical Information

3.1.2 Differences Between Elevation Data - SRTM 30m

Differences between point features in Canakkale and Konya areas and SRTM 30m data and statistical information are given in Table 2 below.

	SRTM 30m
Number of Feature	100
Total Difference	312,2 m
Minimum Difference	0,08 m
Maximum Difference	10,09 m
Mean Difference	3,12 m
Median	0,24 m
Standard Deviation	**3,97 m**
RMS	**3,95 m**

	SRTM 30m
Number of Feature	100
Total Difference	208,03 m
Minimum Difference	0,12 m
Maximum Difference	13,91 m
Mean Difference	2,08 m
Median	-0,88 m
Standard Deviation	**2,82 m**
RMS	**2,82 m**

Table 2. Difference Between Data Canakkale-Konya Areas SRTM 30m and Statistical Information

3.1.3 Differences Between Elevation Data - ALOS 30m

The differences between the point features in Canakkale and Konya areas and the ALOS 30m data and statistical information are given in Table 3 below.

	ALOS 30m
Number of Feature	100
Total Difference	124,22 m
Minimum Difference	0,07 m
Maximum Difference	7,92 m
Mean Difference	1,7608 m
Median	0,855 m
Standard Deviation	**2,23 m**
RMS	**2,54 m**

	ALOS 30m
Number of Feature	100
Total Difference	201,13 m
Minimum Difference	0,14 m
Maximum Difference	9,46 m
Mean Difference	2,01 m
Median	-1,465 m
Standard Deviation	**2,27 m**
RMS	**2,35 m**

Table 3. Difference Between Data Canakkale-Konya Areas ALOS 30m and Statistical Information

Comparisons of the Canakkale and Konya areas are shown in the following tables, respectively, as statistical values will be side by side in order to be compared with each other. The data and statistical data of Canakkale area are given in Table 4.

ÇANAKKALE	SRTM 90m	SRTM 30m	ALOS 30m
Minimum Difference	0,15 m	0,08 m	0,07 m
Maksimum Difference	11,33 m	10,09 m	7,92 m
Mean Difference	4,12 m	3,12 m	1,76 m
Median	2,65 m	0,25 m	0,86 m
Standart Deviation	4,39 m	3,97 m	2,23 m
RMS	4.85 m	3.95 m	2.54 m

Table 4. Difference Between Data Canakkale Area SRTM 90m – SRTM 30m – ALOS 30m and Statistical Information

The data and statistical data of the Konya area are given in Table 5.

KONYA	SRTM 90	SRTM 30	ALOS 30
Minimum Difference	0,10	0,12	0,14
Maksimum Difference	12,91	13,91	9,46
Mean Difference	2,36	2,08	2,01
Median	-1,14	-0,88	-1,47
Standart Deviation	3,21	2,82	2,27
RMS	3.20	2.82	2.35

Table 5. Difference Between Data Konya Area SRTM 90m – SRTM 30m – ALOS 30m and Statistical Information

3.2 Contours

Contours are generated using the elevation data of DEM data. But it is necessary to know which is more accurate and close to reality. Therefore, in this study, two different areas with different characteristics were examined and contours was produced. The produced contours were controlled on stereo models. As a result of these checks, the data and statistical values gathered from the field are consistent and the results of representing the land are examined. However, it was checked how it represents the land by using the river features from the hydrographic layer apart from the control over the stereo models.

3.2.1 Contours Produced From SRTM 90m Data

The river compliance of the contours produced from the SRTM 90m data are shown in Figure 9 and Figure 10.

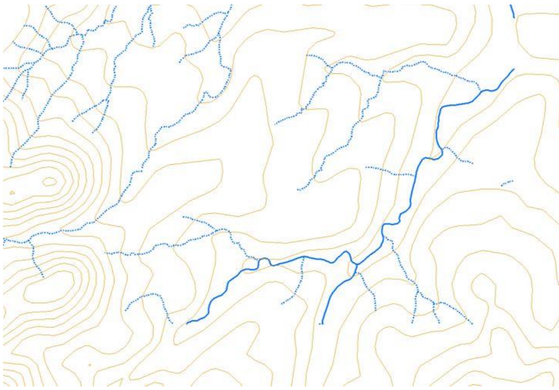

Figure 9. Contours Produced From SRTM 90m in Canakkale Area and River Compliance

Figure 10. Contours Produced From SRTM 90m in Konya Area and River Compliance

3.2.2 Contours Produced From SRTM 30m Data

The river compliance of the contours produced from the SRTM 30m data are shown in Figure 11 and Figure 12.

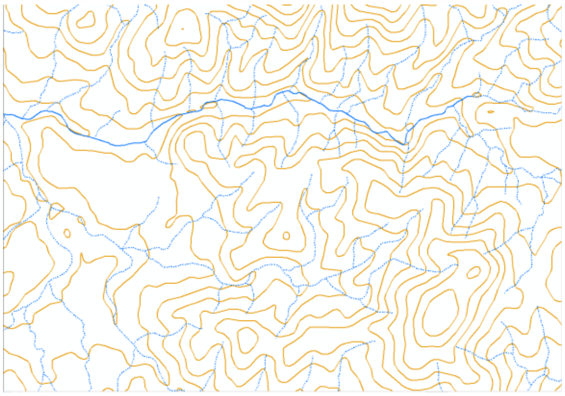

Figure 11. Contours Produced From SRTM 30m in Canakkale Area and River Compliance

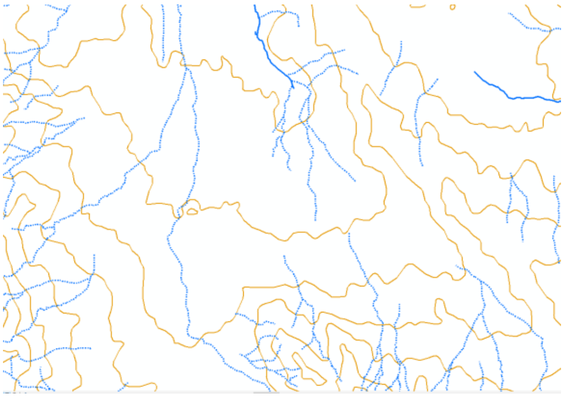

Figure 12. Contours Produced From SRTM 30m in Konya Area and River Compliance

3.2.3 Contours Produced From ALOS 30m Data

The river compliance of the contours produced from the ALOS 30m data are shown in Figure 13 and Figure 14.

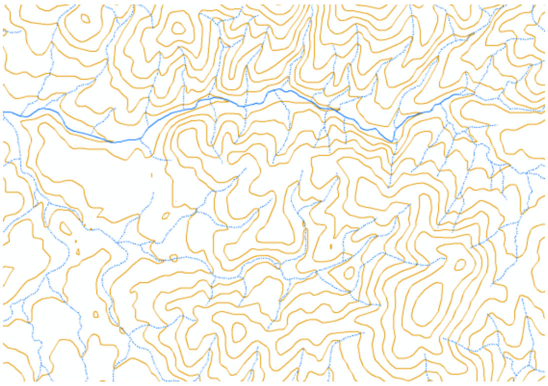

Figure 13. Contours Produced From ALOS 30m in Canakkale Area and River Compliance

Figure 14. Contours Produced From ALOS 30m in Konya Area and River Compliance

While comparing the contours in terms of topographical representation and river compliance, it can be listed as ALOS 30m, SRTM 30m, SRTM 90m respectively. It is seen that SRTM 90m data represent more general topography and the data of ALOS 30m and SRTM 30m show more topographic detail. The ALOS 30m and SRTM 30m data are similar to each other, but also show differences. These differences; ALOS 30m orange and SRTM 30m green are shown in Figure 15.

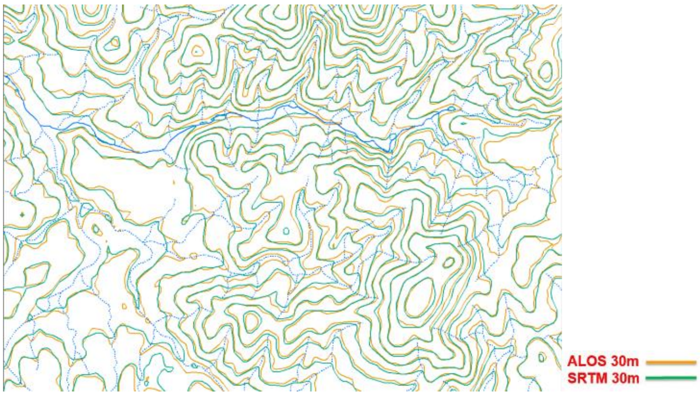

Figure 15. Differences Between Contours Produced From ALOS 30m and SRTM 30m

4. CONTROLS ON STEREO MODEL

Above, statistical result controls of DEM data and vector comparison studies of contours are explained. In addition to these controls, the contours obtained from each DEM data were opened on stereo models, all models were examined and visual inspection was done in terms of land representation. As a result of these checks, the best and most accurate representations of land in topographical sense were ALOS 30m, SRTM 30m and SRTM 90m respectively. During these checks, it was observed that the areas with higher elevation differences were represented more accurately than those with flat areas.

5. RESULTS

The use of open source data in the production of contours is still a research topic. In this study, the reference elevation data and open source elevation data used in Canakkale H17c1 and Konya J28c3 areas were compared and statistical results were obtained. In addition to these comparisons, contours were produced and controls were made to see how generated contours represent the integrity of the land in stereo models. Deciding with the results gathered, it is evaluated that open source data can be used in the production of contours if no data is available as elevation data. As a result of the study, it was determined that ALOS 30m data from open source data gives more accurate results than other SRTM 90m and SRTM 30m data.

SOURCES

Santillan, J.R., Makinano-Santillan, M., 2016. Vertical accuracy asssessment of 30m resolution ALOS,ASTER and SRTM global DEMs over Northeastern Mindanao, Philippines. ISPRS Congress

Gomez, M.F., Lencinas, J.D., Siebert, A., Diaz, G.M., 2012. Accuracy assessment of ASTER and SRTM DEMs: a case study in Andean Patagonia. *GIScience & Remote Sensing*, 49(1), pp.71-91.

Hirt, C., Filmer, M.S., Featherstone, W.E., 2010. Comparison and validation of the recent freely available ASTER-GDEM ver1, SRTM ver4.1 and GEODATA DEM-9S ver3 digital elevation models over Australia. *Australian Journal of Earth Sciences*, 57(3),pp. 337-347.

Ioannidis, C., Xinogalas, E., Solie, S.,2014. Assessment of the global digital elevation models ASTER and SRTM in Greece. *Surver Review*, 46(338),pp. 342-354.

Jing, C., Shortridge, A., Lin, S., Wu, J., 2014. Comparison and validation of SRTM and ASTER GDEM for subtropical landscape in Southeastern China. *International Journal of Digital Earth*, 7(2),pp. 969-992.

Satge, F., Bonnet, M.P., Timouk F., Calmant, S., Pillco, R., Molina, J., Lavado-Casimiro, W., Arsen, A., Cretaux, J.F., Garnier, J., 2015. Accuracy assessment of SRTM v4 and ASTER GDEM v2 over the Antiplano watershed using ICESat/GLAS data. *International Journal of Remote Sensing*, 36(2), pp.465-488.