

Appraisal of Land use Survey using Total Station and Handheld GPS

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Abstract - A handheld GPS (Global Positioning System) is a device that uses to conduct a survey with less manpower and less time. Mostly total station is used in land use survey with higher accuracy. Hence this study is going to verify the capability of the handheld GPS to replace instead of the Total Station in land use survey. The aim of the study was to evaluate the land use survey results with handheld GPS and total station. GPS (Leica GS 15) instrument was fixed at a Base station named NSG 01 and data collection was done using handheld GPS (Leica Zeno 20) instrument with different modes such as Satellite-Based Augmentation System (SBAS) off and SBAS on. Further the collected data were processed with the Differential GPS (DGPS) and without DGPS approaches using Leica infinity and QGIS software and four plans were prepared. Then the area was calculated for each land use category. Results were compared using the error percentages each land use. Further it was compared using correlation analysis. Finally, the most accurate results were given by the handheld GPS in SBAS on mode. Its error level was 0.46% and it is very low compare with other modes. SBAS on mode Correlation Coefficient was 0.99995 and it was the closest value to 1. So, the SBAS on mode is the best method to improve the accuracy of land use surveys where there is scarcity of manpower and time instead of total station.

Keywords: Handheld GPS, Total station, Land Use Survey and SBAS

I. INTRODUCTION

The Global Positioning System (GPS) is a satellite navigation system which was developed by the United States Department of Defense (DOD) in the early 1970's. Continuous, instantaneous positioning and timing information was provided by the system GPS under any weather conditions, anywhere in the world. GPS could be worked as a one-way broadcasting system where the signals were transmitted, that could be picked up by a receiver (GPS unit). The GPS signals could be picked up by any number of receivers. GPS positioning accuracy could be varied greatly and satellite and receiver clock inaccuracy, ephemeris error, signal delay due to atmospheric refraction, reflection of signal known as multi-path errors, receiver noise, and satellite geometry relative to the receiver could be impacted on it (El-rabbany, 2002; Kamruzzaman *et al.*, 2014; Shoval & Isaacson, 2006). Conventional terrestrial survey method, such as Total Station, was used in land surveying with great efficiency, which was reduced field survey and permitted to accelerate data acquisition with the highest accuracy. An Electronic Distance Measurement (EDM), an electronic digital theodolite, and a computer were combined by Total Station (TS) in one unit. Horizontal and vertical angles, and distances were measured by the

device automatically, and the results in real time were transmitted to a built-in computer (Chekole, 2014).

A hand-held GPS is a device that uses the worldwide Positioning System, combining sophisticated geographic technology with a transportable, easy device for everyday use. Introduced during the late 1990s, the hand held GPS had several functions, consisting navigation assistance and land-survey data (Schwieger, 2003).

Land use was related mainly to the use of which the land in a certain region at a certain time is put. Generally land use survey was done for the purpose of land use planning. Land use survey is for the preparation of land use maps and is the basic planning survey. Land use could be classified as residential, commercial, manufacturing, and public semi-public, recreational, transport and communications, etc. (Madana, 2002)

Global Navigation Satellite System (GNSS) has become as an important tool in land use study. Using GNSS, it is possible to conduct survey with less manpower and less time. In land use survey, generally total station was used for the field work. So there should be a control network either it should be established. If Hand-Held GPS is used, a control network would not be necessary. This could be used for land use survey. The research problem is the capability of the Hand-Held GPS replace for the Total Station in Land use survey. The aim of the study was to compare the land use survey results conducted by both Handheld GPS and Total Station.

II. METHODOLOGY

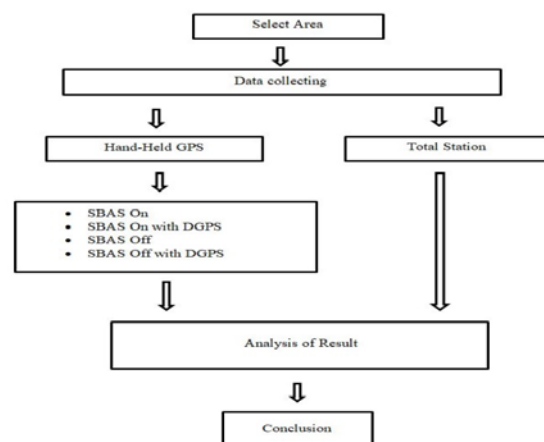


Fig. 1 Methodology Chart

According to the methodology shown in figure 1, area was select and collected data by using Hand-held GPS and Total Station. Then results were compared by using Hand-held GPS different methods. Finally results were analyzed and attained to a conclusion.

Leica GS 15 and Leica Zeno 20 were used to do the field task. The used Hand-held GPS was Leica Zeno 20 as shown in Figure 2. Leica GS 15 instrument used to do DGPS and it is shown in Figure 3.



Fig. 2 Leica Zeno 20



Fig. 3 Leica GS 15

Leica GS 15 instrument was fixed at Base station and collected the data by using Leica Zeno 20 instrument. Here 15 second login interval was used. The study area was inside of Sabaragamuwa University. This area is situated in Imbulpe divisional secretariat, Ratnapura district in Sabaragamuwa Province. Relevant study area is shown in Figure 4.

Handheld GPS observations coordinates need to be created. The coordinates were downloaded to MDB file format, later those were imported to the Leica infinity GNSS processing software. In the processing procedure of the Leica infinity, it is necessary to set the parameters, and coordinates

parameters were set to SLD99 coordinates system. So Raw data of SBAS off mode was processed by Leica infinity software and converted it into SLD99 coordinates system. Then the data was exported into CSV file.

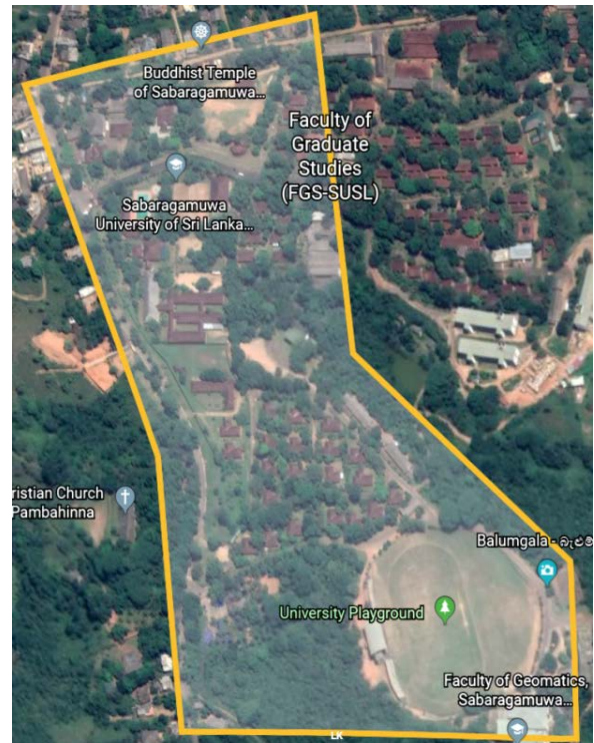


Fig. 4 Sabaragamuwa University Area

After that coordinates of the study area were processed through the DGPS Method. DGPS method has to define the base station. The base station should be converted to control point from the navigated point. Then the coordinates of the base station was inputted and the base station was set to reference station. Then SBAS off raw data was added into Leica infinity software and it was marked as a Rover. The data was started to process and exported into the CSV file. Also SBAS off raw data was processed by above method and exported into CSV file.

QGIS functions as geographic information system (GIS) software, allowing users to analyze and edit spatial information, in addition to composing and exporting graphical maps. Usually QGIS software is used to GIS works. But it can transform the coordinate systems. So QGIS software was used to transform the WGS-84 coordinate system into SLD-99 coordinate system by using collected shape files in SBAS on mode.

Four CSV files were prepared in four methods and added into AutoCAD Civil 3D 2018. After adding those CSV files, four plans were prepared. Then area was calculated as Water, Steps, Buildings, Roads, Ground and Open Area in four plans. That calculated area was inserted in the Microsoft Excel 2010.

II. RESULTS

The results were compared using Error percentages and Correlation Analysis. First results were compared between the error percentages in areas of the different methods in Hand Held GPS and Total Station in Land Use Category. When considering Table II; which represents land use category and the different methods of Hand Held GPS; minimum errors were contained by SBAS ON mode and maximum errors were contained by SBAS OFF mode. The errors of other two methods were held in the middle of SBAS OFF mode and SBAS ON mode. When the area increases, the error percentage was decreased and when the area decreases, the error percentage was increased. As an overall the minimum error percentage was recorded in the land use, Garden.

When considering the error percentage of Parcel area differences in Hand-held GPS different methods with respect to the actual area in Building, Steps, Water, Roads, Play Ground and Garden. From the results Building Land Use is shown in Figure 5, Steps Land Use is shown in Figure 6, Water Land Use is shown in Figure 7, Road Land Use is shown in Figure 8, Play Ground Land Use is shown in Figure 9, and Garden Land Use is shown in Figure 10.

According to above Figures, minimum error was occurred in SBAS On mode and maximum error was occurred in SBAS Off mode. The other two methods' errors have in the middle of SBAS OFF mode and SBAS ON mode.

Then Correlation Analysis was done using the areas of Hand Held GPS different methods. Results were analyzed by using Variation of Correlation Coefficient and P-Value in Hand-held GPS different methods in all land use Category. It is shown in Table I. According to the Table I, the Correlation Coefficient maximum in the SBAS ON mode was 0.99995 and the Correlation Coefficient minimum in SBAS OFF mode was 0.99975. When considering the other two methods, the

Correlation Coefficient was between 0.99975 and 0.99995. Then Hypothesis test was done using P-Value.

Hypothesis test;

H_0 ; There is not positive Correlation

H_1 ; There is positive Correlation

Test statistic;
P-Value < R-Value (We have to reject H_0)

A. SBAS off Method

0.000 < 0.05 (95% confidence level of P-Value)

H_0 was rejected. So there was a positive Correlation. The Correlation Coefficient between Hand-held GPS SBAS off mode Area and actual area of all land use value was 0.99975 and also this was higher positive Correlation.

B. SBAS off with DGPS Method

0.000 < 0.05 (95% confidence level of P-Value)

H_0 was rejected. So there was a positive Correlation. The Correlation Coefficient between Hand-held GPS SBAS off mode Area and actual area of all land use value was 0.99978 and also this was higher positive Correlation.

C. SBAS on Method

0.000 < 0.05 (95% confidence level of P-Value)

H_0 was rejected. So there was a positive Correlation. The Correlation Coefficient between Hand-held GPS SBAS off mode Area and actual area of all land use value was 0.99995 and also this was higher positive Correlation.

D. SBAS on with DGPS Method

0.000 < 0.05 (95% confidence level of P-Value)

H_0 was rejected. So there was a positive Correlation. The Correlation Coefficient between Hand-held GPS SBAS off mode Area and actual area of all land use value was 0.99994 and also this was higher positive Correlation.

TABLE I VARIATION OF CORRELATION COEFFICIENT AND P-VALUE IN HAND-HELD GPS DIFFERENT METHODS IN ALL LAND USE CATEGORY

Method	Correlation Coefficient (R-Value)	P-Value
SBAS Off	0.99975	0.000
SBAS Off with DGPS	0.99978	0.000
SBAS On	0.99995	0.000
SBAS On with DGPS	0.99994	0.000

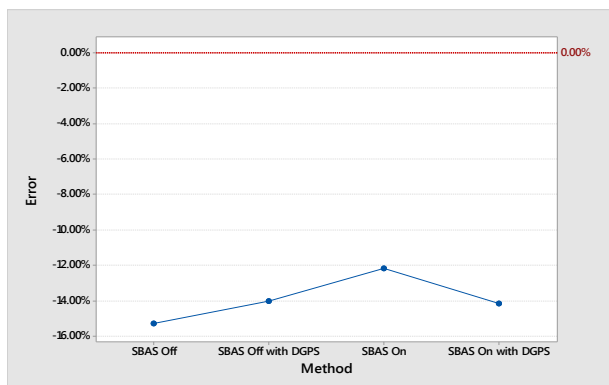


Fig. 5 Accuracy comparison of the Building Land use

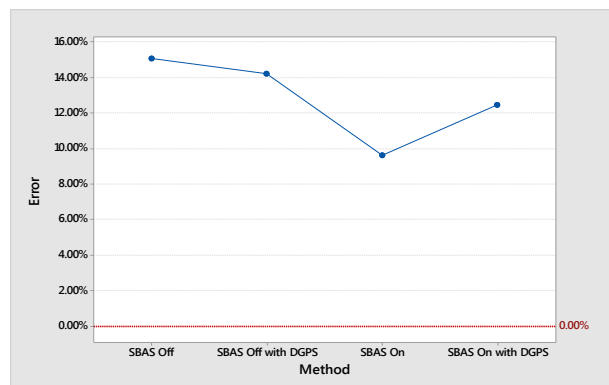


Fig. 6 Accuracy comparison of the steps Land use

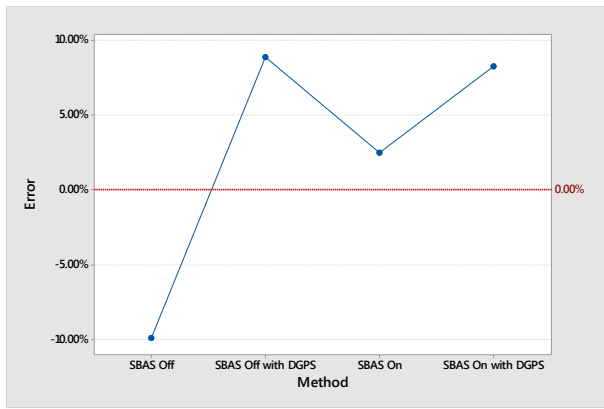


Fig. 7 Accuracy comparison of the Water Land use

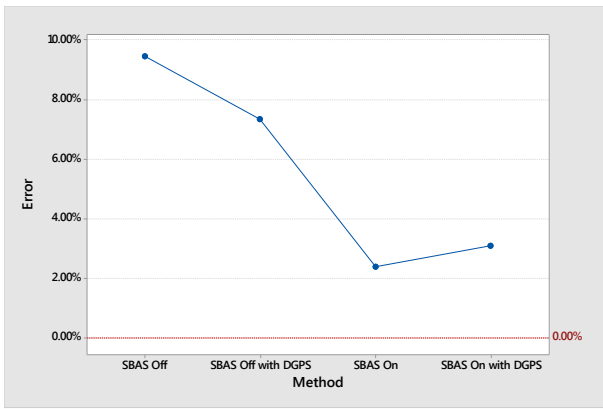


Fig. 8 Accuracy comparison of the Road Land use

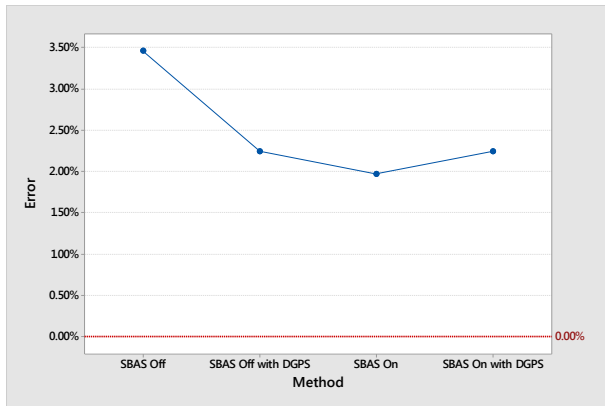


Fig. 9 Accuracy comparison of the Playground Land use

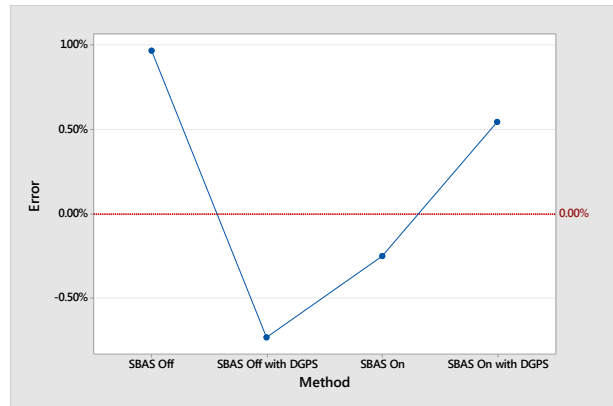


Fig. 10 Accuracy comparison of the Garden Land use

TABLE II SUMMARY OF CALCULATED ERRORS IN HAND HELD GPS AND TOTAL STATION OF LAND AREA

Land Use Category	Hand-held GPS SBAS OFF		Hand-held GPS SBAS OFF with DGPS		Hand-held GPS SBAS On		Hand-held GPS SBAS On with DGPS		Land Area (in m ²) by Total Station
	Land Area (in m ²)	Error (%)	Land Area (in m ²)	Error (%)	Land Area (in m ²)	Error (%)	Land Area (in m ²)	Error (%)	
Buildings	3072.186	15.26	3038.858	14.01	2989.481	12.16	3041.823	14.12	2665.454
Steps	1231.822	15.10	1244.614	14.22	1310.937	9.65	1269.959	12.48	1450.977
Water	482.719	9.87	400.518	8.84	428.329	2.51	403.196	8.23	439.357
Roads	16754.236	9.47	17147.797	7.34	18064.482	2.39	17935.916	3.08	18505.895
Play Ground	27664.663	3.46	28013.650	2.25	28089.765	1.98	28011.104	2.25	28657.052
Garden	82564.965	0.97	83977.725	0.73	83579.803	0.25	82916.527	0.54	83370.069
Total Area	131770.591	2.46	133823.162	0.97	134462.797	0.46	133578.525	1.13	135088.805

IV. DISCUSSION AND CONCLUSION

According to the Table I, most accurate results were given by Handheld GPS in SBAS on mode. Its error level was 0.46% when compared with other methods. Hand-held GPS SBAS on with DGPS mode and SBAS off with DGPS mode had same error, respectively 1.13% and 0.97%. Handheld GPS SBAS off mode error level was 2.46%. Its error level was higher than when compared to other methods. According to the Figure 3 to 8, error level was minimum in SBAS ON mode. Referring the Table II, the value of SBAS ON mode Correlation Coefficient was maximum when it

compared with other methods. SBAS on mode Correlation Coefficient was 0.99995 and it was the closer value for 1.

The importance of the accuracy of the survey depends on the project. Specially, for the project like Traversing (to establish a control network), the high accuracy of the survey results are very important. Final output of the land use survey is to draw a land use map, but there is no high importance of the accuracy. Costing side of applying Total Station method is not economical, though the accuracy level of the Total Station is very high. It needs high manpower and time, because of that financial cost increases.

When comparing Handheld GPS with Total Station, the Handheld GPS is cost effective. It does not need more people and the survey can be done with less time consuming very easily. Other thing is that areas those are difficult to reach can be covered very easily.

The major accuracy of the Handheld GPS is increased with the SBAS on mode. Because when SBAS turned on, Satellite Based Augmentation System is activated. In Sri Lanka, GAGAN Satellite Based Augmentation System is supported and it gives GPS error correction as well as it corrects Range in real time.

Same accuracy was given by both DGPS modes because same raw data was given by SBAS on mode and SBAS off mode and we were able to process only raw data. The .shp files can't be processed.

Low accuracy was given by both DGPS modes when compared to SBAS on mode, because, in SBAS on mode, GPS corrections were done inside the instrument, but when doing DGPS, its accuracy was based on Base Station and post processing method which data was processed. Also code solutions were given by only using post processing methods, because 15 second log intervals were taken to collect Data. At least 15 minutes log intervals were needed to take Phase Fixed solutions. All the satellites placed on that area were cracked when SBAS turned on. But Common satellites related to Base station and Rover station were considered when the DGPS was done. Then less amount of satellites was cracked than Rover station (Handheld GPS), when the DGPS were done. Therefore both DGPS methods may reduce the accuracy. So the SBAS on mode is the best method to improve the accuracy of land use survey out of the other methods.

According to the findings of this research, 0.46% error level and 0.99995 Correlation Coefficient was given by Handheld GPS in SBAS on mode. Therefore, it is recommended to use handheld GPS in SBAS on mode for the land use survey and prepare a land use map.

Furthermore, it is recommended for the future researchers, to go for area comparison by using Handheld GPS in SBAS on mode and DGPS correction for very broad area in land use survey to get the further confirmation regarding the accuracy of Handheld GPS in SBAS on mode and DGPS mode. And it is proposed to do these types of researches onward using the RTK GPS for huge areas in Land Use Survey.

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