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A COMPARISON OF DATA FROM DGPS AND GPSS OBSERVATIONS

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ABSTRACT: *The advent of the global positioning systems both the handheld (HGPS) and dual frequency (DGPS) equipment has made data collection and processing easier and with better accuracy. The integration of GPS and remote sensing data with geographic information systems has also received wide applications. In this paper, we present data collected using two HGPSs and a DGPS equipment with the aim of processing, analyzing and comparing the data using statistical approach. The results show a significant difference between the data collected using the equipment.*

1.0 Introduction

Traditionally, Surveyors measure angles with theodolites such as T1, T2, and distances are determined using steel Tape, linen tape, tacheometry, or electronic distance measurement (EDM). The advent of satellite positioning systems has provided the surveyor

with a modern technology to perform survey works. GPS, for example real time kinematic (RTK) GPS (Fig. 1), provides surveyors with an efficient tool to carryout their survey activities. This system is used either as handheld, mounted on platform such as on Vehicle or aircraft for precise positioning (Craig, 2008).



<http://maic.jmu.edu/sic/glossary.htm#Projection>

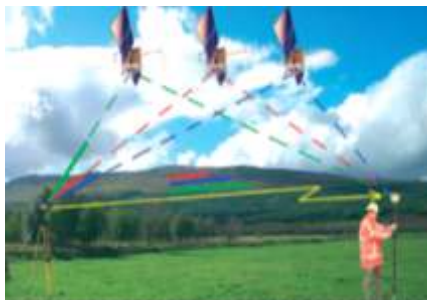


Fig 1: Principle of dGPS (adapted from Huiibert-Jan Lekkerker, 2006)

Most recently the use of GPS has received wide applications for positioning in forested areas (Yoshimura and Hesagawa, 2003), to develop digital elevation model (Yao and Clark, 2000), deformation control networks (Betti et al. 1999), Bridge monitoring (Ashkenazi, et al. 1996, Meng, 2002), Deformation monitoring (Erol, 1999, Ince, and Sahin. 2000, Hartinger, 2002) and its combination with Geographic information system (GIS) tools has become even more popular. For instance, in the monitoring of Olive tree movement (Ramos, et al. 2007), Precision farming (Nemenyi, et al. 2003). In a research conducted by Emily et al. (2003) compared single frequency receivers to dual frequency and reported a promising result in resolving integer ambiguities within a very short time. Serr (2006) compared the precision and accuracy of five current global positioning system (GPS) receivers, namely; Trimble. ProXR, Trimble GeoXT without WAAS, Trimble GeoXT with WAAS, Trimble GeoExplorer II, and an HP/Pharos receiver. To the compare receivers, they conducted a field study using fifteen survey markers in Idaho. The points were observed on ten different dates the results show that the GeoXT is

perfect for submeter accuracy while the Pharos receiver is a viable alternative when the required accuracy is ± 10 meters or more. However, in this work only the accuracy and precision of the receivers were of interest. The rest of the paper is organized into three major sections; firstly, the materials and methodology are discussed. Secondly; the results and discussion are presented and finally; a short conclusion is reached on the outcome of the paper.

2.0 Materials and Methodology

2.1 Materials

Three stations were available for the field observations. Two handheld GPSs (GPS 72H Garmin and GPS Map 76 CSX Garmin), and a dual frequency GPS and accessories. The computer facilities included a laptop Aspire Acer compatible with 1.86GHz, 3MB, 1GB memory and 320GD HDD. The soft wares used were SPSS version 17, the built-in Microsoft excel and Minitab version 14.3.

2.2 Methodology

The objective of this study is to compare the readings obtained using the dual frequency and the handheld Global Positioning

Systems (GPSs) from a Survey station under an open sky. In this study, a brief literature search on GPS was conducted. Thereafter, fifty sets of field observations were carried out using the dGPS and two handheld GPSs in a static

mode (Data acquisition). Here the readings were taking within few minutes of epoch. After this, the data were processed using the Minitab, Excel and SPSS softwares (Fig.2).

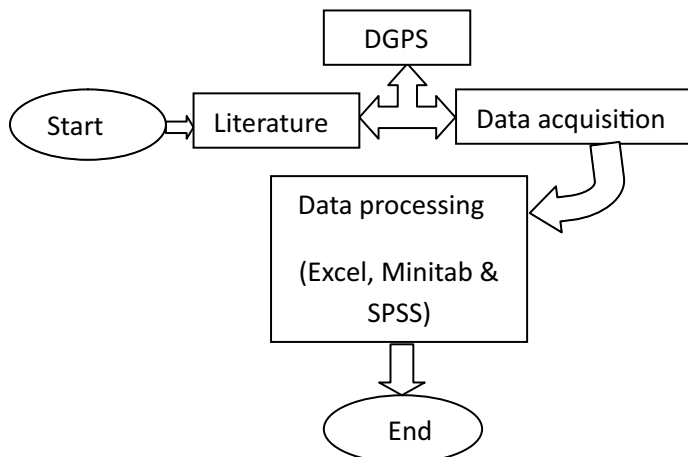


Fig 2: Methodology flow chart

3.0 Results and Discussion

The data collected from dGPS and GPSs observations on the ground stations were then calculated and compared (Fig 3a and 3b). Furthermore, the results were analyzed using analysis of variance (ANOVA). The differences in means were considered significant at $p < 0.05$. Analyses were performed using SPSS version 17, Minitab version 14.3, and the built-in Microsoft excel. From the analysis of variance, the value of the F-statistics (259487.7) is far greater than the critical value of the F

Statistic, F_{crit} (3.94). Which shows that there is a significant difference (at the = 0.05 level of significance) between the means of the readings appearing in Appendix 1. The analyses were subjected to correlation, and the correlation matrix in Table.1 HGPS (N1) and HGPS (N2) are correlated, but there exist no correlation between the HGPS 1 and 2 and the DGPS data. The contrast test carried out shows that the hypothesized difference between the mean of HGPSs and the mean of the DGPS data was tested with planned comparison

and found to be significantly different $F(1,144)= 6660.95$, $p<.001$, $\eta^2_{\text{partial}}=0.82$. The contrast between the mean data between HDPS 2 and the mean data of DGPS $F(1,144) = 12.31$,

$p<.001$, $\eta^2_{\text{partial}}=0.08$ was also significant. The Levene test of homogeneity of variance of 0.000 indicates a significant difference between the means of the data compared.

Table 1. Correlation Matrix

	<i>Easting1</i>	<i>Easting2</i>	<i>Easting3</i>
DGPS Easting1	1		
HGPS Easting2	0.3804	1	
HGPS Easting3	0.23166	0.21864	1

	<i>North1</i>	<i>North2</i>	<i>North3</i>
DGPS Northing1	1		
HGPS Northing2	-0.07164	1	
HGPS Northing3	-0.16763	-0.04152	1

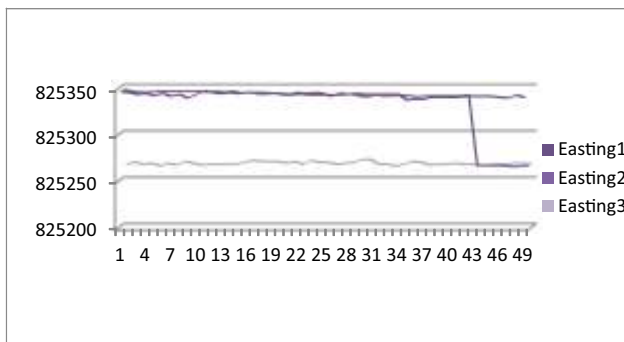


Fig. 3a Easting coordinates for three GPSs compared

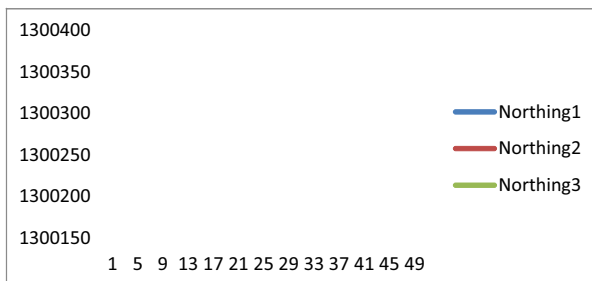


Fig. 3b Northing coordinates for the three GPSs compared

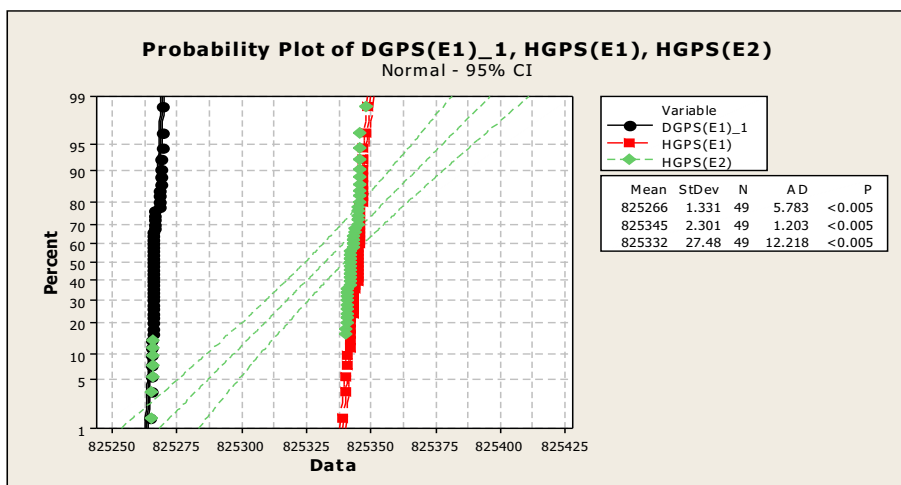


Fig 4a: Probability graph (Easting)

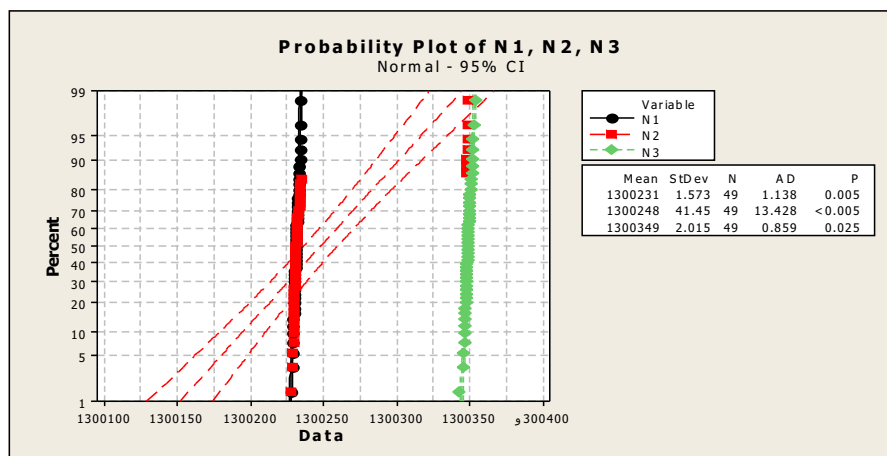


Fig 4b: Probability graph (Northing)

The data points E1 and E2 (Fig.4a) representing the easting and N1 and N2 (Fig.3b) representing northing for (HGPS 1 and HGPS 2) approximately follow the same line (red and green), the p-value is same with 0.05 and the Anderson-Darling

statistics is low. Therefore, the normal distribution fit the data well. The mean Easting for (HGPS1) is 825266, the standard deviation is 1.331. It appears that majority of the easting data fell below 825350. The probability plot for northing (Fig.4b) for N1

and N2 also follow the same line (red and black) with p-value of 0.05 and Anderson-Darling statistics of 1.138. The results show that the data collected using the two handheld GPSs (HGPS 1 and 2) were not different, but there exist a significant difference compared to data obtained using the dual frequency GPS (DGPS). The limitations of this study were that only fifty sets of observations for each GPS were considered and that the study only compared the observed data and not the precision or accuracy of the instrument). This study does, however, carry out a comparison between three various GPS receivers under the same study conditions.

4.0 Conclusions

This paper, is an insight to the use of the GPS technology and analyses of data collected using the handheld GPSs and the dual frequency GPS. It was observed from the analyses and the result obtained in this study that the data collected using the handheld GPS and the dual frequency GPSs differ. However, few possibilities might have warranted this difference, observer's error, weather, or the precision and accuracy of the instruments. It is therefore the belief of this study

that the results obtained from the various GPS receiver types will assist the user to select appropriate GPS receiver for use or to purchase for surveying and mapping purposes.

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Appendix

APPENDIX 1 ANALYSIS OF VARIANCE TO COMPARE THREE MEASURING INSTRUMENTS: HGPS (N1), HGPS (N2) AND DGPS (N1)

Independent Samples Test										
		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
MEASUREMENT	Equal variances assumed	41.950	.000	-2.865	96	.005	-16.97959	5.92594	-28.742	-5.216
	Equal variances not assumed			-2.865	48.138	.006	-16.97959	5.92594	-28.89	-5.065

Descriptives MEASUREMENT								
	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
HGPS(N1)	49	1300231.1633	1.57251	.22464	1300230.7116	1300231.6149	1300228	1300234
HGPS(N2)	49	1300248.1429	41.45178	5.92168	1300236.2365	1300260.0492	1300228	1300349
DGPS(N1)	49	1300347.3820	.27883	.03983	1300347.3019	1300347.4621	1300347	1300348
Total	147	1300275.5627	56.66385	4.67356	1300266.3261	1300284.7993	1300228	1300349

Test of Homogeneity of Variances MEASUREMENT				
Levene Statistic	df1	df2	Sig.	
43.569	2	144	.000	

ANOVA MEASUREMENT							
			Sum of Squares	df	Mean Square	F	Sig.
Between Groups	(Combined)		386177.159	2	193088.579	336.626	.000
	Linear Term	Contrast	330916.344	1	330916.344	576.911	.000
		Deviation	55260.815	1	55260.815	96.340	.000
Within Groups			82598.426	144	573.600		
Total			468775.584	146			

Contrast Coefficients			
Contrast	INSTRUMENT		
	HGPS(N1)	HGPS(N2)	DGPS(N1)
1	-1	-1	2
2	-1	1	0

Contrast Tests							
		Contrast	Value of Contrast	Std. Error	t	df	Sig. (2-tailed)
MEASUREMENT	Assume equal variances	1	215.4578	8.38074	25.709	144	.000
		2	16.9796	4.83862	3.509	144	.001
	Does not assume equal variances	1	215.4578	5.92648	36.355	48.156	.000
		2	16.9796	5.92594	2.865	48.138	.006