Assessing the Accuracy of Eskom Geospatial Data: Case study of the 22KV electrical line in the Paynes Farm, Qunu, Eastern Cape.

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Abstract

Surveying data is essential for many industrial resource activities including power line design on the ground. Eskom which is the main power line designer in South Africa relies on such data collected by its engineers and surveyors. The accuracy and consistency of this geospatial data was evaluated in this study using two GNSS receivers with equal exposure to satellite coverage. We collected location measures along a 22KV Eskom power field in Paynes farm, Qunu, Mthatha in Eastern Cape, using Trimble Juno SB handheld GNSS and a Trimble R8 Real Time device. The field survey was completed using the Trilateration method and the new readings were compared to the existing data stored in Eskom database in Mthatha. The major discrepancy observed in the data was found originating from the Eskom original data, pointing out distorted measures within the reticulation. Although both GNSS receivers were identical in brand and data collection parameters, we found significant statistical difference in terms of average error measures. For applications that require high level of accuracy such as power line design on the ground, Trimble R8 Real Time receiver was found suitable. In contrast, for projects requiring an acceptable level of accuracy Trimble Juno SB handheld device was suggested. It was found important that Eskom looks into implementing compulsory training courses on geospatial data collection and capturing, even though this will not prevent the problem with data inconsistency completely, but it will improve the current condition with inconsistent network data

1. Introduction

Global Navigation Satellite Systems devices are increasingly being used for data collection in many applications such electrical reticulation (Hegarty and Chatre, 2008; Lisa and Paul, 2011; Ikokou, 2013). Regardless of application, reliable terrain measurements require that surveying data be collected across a landscape with accuracy and consistency (Wing and Eklund, 2008; Wing and Franck, 2011). Among the sources that impact the position accuracy of a GNSS receiver are ephemeris errors, satellite and receiver lock errors, multi path errors, receiver measurement noise, satellite measurement noise, satellite geometry measures, tropospheric delays and most significantly ionospheric delays (Klobuchar, 1996). A number of recent studies (Wing et al., 2008; Daskin et al., 2009) have examined the accuracy of GNSS receivers for tasks such as road design, electrical line design in forested areas. Eskom South Africa that mounts electrical power lines countrywide relies on accurate ground surveying data at different accuracy levels.

The Eskom Reticulation for instance requires that the accuracy of geospatial data falls within the accuracy of 5m in order for the data to be optimally used by Eskom project planners, engineers, surveyors as well as other external users for decision support. The accuracy of geospatial data is as equally important in Eskom as in any other organization that deals with the mapping of surveying data. If geospatial data is inaccurate and inconsistent then it invites elements of uncertainty. This brings serious concerns since the data does not reflect the true positions of the features on the ground. The inaccuracy of power line locations can also affect certain Departments such as the Department of Transport which rely on Eskom surveying network when designing new road locations (Fosu et al., 2006). In this study we examined the accuracy and reliability of Eskom geospatial data within a subset of its power line reticulation in the Paynes farm located in the area of Qunu in Eastern Cape, South Africa. Two GNSS receivers were selected to quantify the accuracy and reliability of the manually surveyed data.

2. Data and methods

2.1. Data

Qunu is a small rural village in South Africa’s Eastern Cape Province located 32km south-west of Mthata on the road between Butterworth and Mthata. The area covers an extent of 1.65km^2 with a total number of 213 residents. Figure1shows the location of the study area in the Eastern Cape Province.

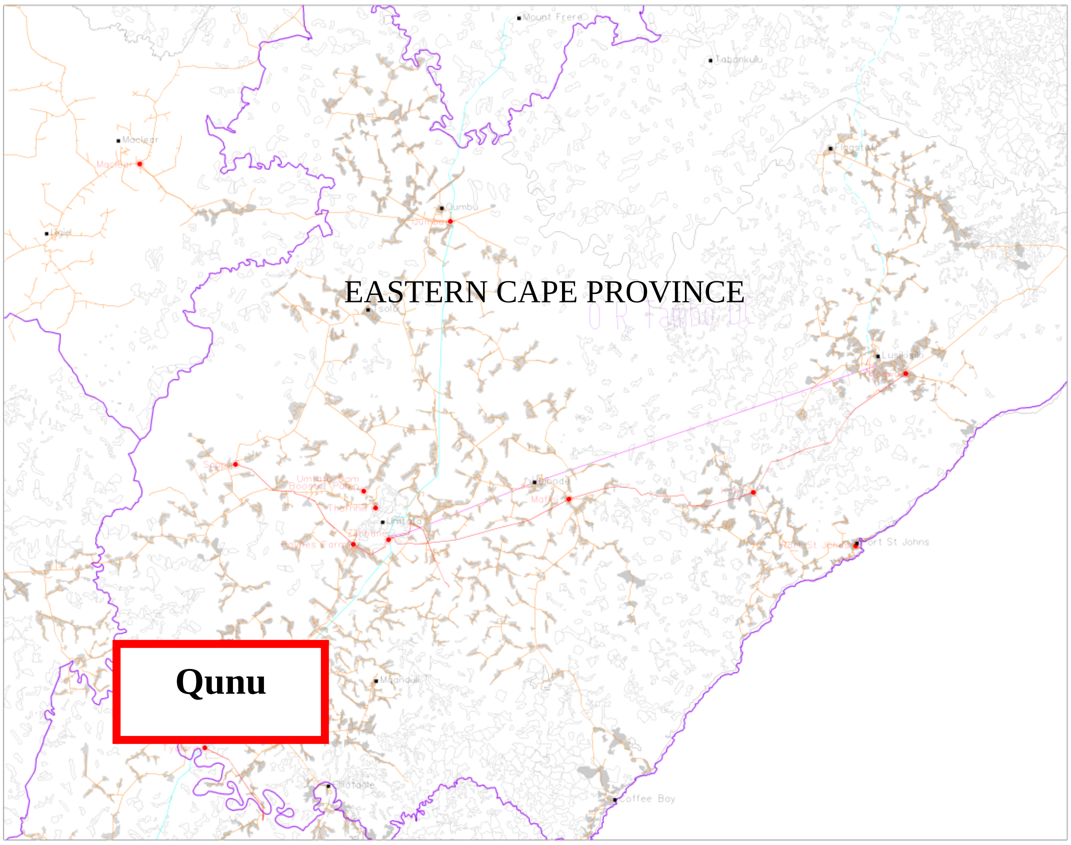

Figure 1: The study site of Paynes farm in Qunu located in the Eastern Cape Province of South Africa.

The GNSS receivers involved in this study include a handheld Trimble Juno SB and Trimble R8 receivers. The Juno Handheld device is highly productive GNSS receiver for field data collection and mobile GIS (Trimble 2013). The Juno Handheld is a fully integrated field computer, providing 2 to 5m positioning accuracy in real time. The device has been specially designed to maximize yield of position in hostile environments such as under forest canopy and up against buildings. The Trimble R8 real time instrument is a multi-channel, multi-frequency GNSS receiver capable of providing surveying professionals with real field benefits (Trimble, 2013). Trimble R8 is designed to deliver high-quality tracking and performance. The instrument's dual frequency provides sub-millimetre phase-centre stability for maximum precision. Moreover, Microsoft excel software was also use to record and analyse the data. Microstation software was used to plot the surveyed points in order to make sure of their real geographic locations before any processing.

2.2. Methods.

The set of geospatial data was collected from the 26 to the 28 of August 2013 in Mthatha and covered a small portion of the Eskom 22KV line in the Paynes farm, Qunu. This Network was selected because of its accessibility and the adjacent Trigonometric beacons and Benchmarks. Data collection parameters for minimum data quality standard comprised a minimum elevation angle of 15^0, a maximum position dilution of precision (PDOP) of 8 and a minimum signal to noise of 39(Wind and Frank, 2011). An external was mounted on a two meters tall pole to provide signal coverage to both GNSS receivers. The Trimble R8 was set up over a benchmark and checked on the closest trigonometric beacon. The Trimble Juno SB had to cover at least 10 cycle slips before saving and storing the point features, which is the recommended Eskom standard. Both instruments were used simultaneously to collect the field data. This sequence of analysis aimed at exposing both receivers to the same number of satellites and other environmental factors that could affect the experiment. All the point positions were captured under point generic and a gross sample of 20 point features was surveyed with each GNSS receiver.

The Trimble Juno Handheld raw data was port-processed using Trimble Pathfinder Office and the Eskom Southern Region base (East London) was used to correct all the files. A compatible geographical coordinate system was used in longitude and latitude to accommodate the plotting of point features using Microstation. We calculated the error measures by determining the difference between each GNSS receiver measures and the corresponding Eskom reference data. The average error was calculated at the bottom of each table, as well as the quantitative error measure expressed in percentage. The error percentage was calculated by working out the cumulative error measure of readings above 5m in a set of 20 readings and comparing it with the total cumulus of error measure in the set.

3. Results and discussion

We calculated average error measures for each point and associated a standard deviation for each set of pints. There was a statistically significant difference between measurement error when comparing Trimble Real R8 Real Time data and the Trimble Handheld Juno measures as shown in Figure1. The least average errors recorded by the Trimble Juno handheld instrument after the survey of the first set of point were 5.977 and 6.06 with a total average error of 2.489m. The values of 6.901 and 10.208m were found as minimal errors from the survey of the second set of point. The instrument produced a least offset of 9.983m on the third set. These measures represent percentage errors of 15%, 18% and 17.084% associated with respective standard deviations of 2.7930, 2.8262 and 2.1258.The Trimble R8 Real time on the other hand produced average error measures of 7.562m and 10.084m, totalling an overall measure of 11.80% of the cumulative error measure. The instrument produced the lowest standard deviation measure with the value of 1.8170. Looking closely at points PYF-QNU_199 and PYF-QNU_225 it seems that the error has been propagated not only through each set of points but also for both GNSS receivers, pointing out inconsistencies within the original Eskom data (Table1).

Table 1: Comparison of errors between Trimble Junohandheld instrument and the Trimble R8 real time receiver.

Trimble Juno Handheld (2-5m Accuracy)				**Trimble R8 Real-time GNSS**
POINT NAME	Juno 1st Set (m)	Juno 2nd Set (m)	Juno 3rd Set (m)	Trimble R8 (m)
PYF-QNU-185	0.983	1.34	0.708	0.346
PYF-QNU-187	1.528	1.265	1.177	0.794
PYF-QNU-188	1.819	1.647	1.172	0.819
PYF-QNU-189	1.976	2.979	0.807	0.838
PYF-QNU-191	0.658	0.559	0.901	1.021
PYF-QNU-193	1.107	1.654	1.338	0.97
PYF-QNU-194	0.494	0.511	1.837	0.693
PYF-QNU-196	4.034	6.901	4.621	4.781
PYF-QNU-198	6.06	2.249	2.45	1.182
PYF-QNU-199	5.977	10.208	9.983	7.562
PYF-QNU-200	0.605	2.712	1.448	0.915
PYF-QNU-202	3.304	1.609	0.527	0.766
PYF-QNU-203	0.757	2.148	2.789	1.551
PYF-QNU-204	0.708	1.553	2.276	0.805
PYF-QNU-214	1.508	0.519	0.425	0.96
PYF-QNU-218	1.129	3.144	5.018	0.713
PYF-QNU-219	0.776	1.531	1.876	1.001
PYF-QNU-222	0.323	2.519	2.183	0.513
PYF-QNU-224	3.911	1.134	2.846	2.842
PYF-QNU-225	12.118	15.735	12.343	10.084
Average	2.489	3.096	2.836	1.958
Standard deviation	2.7930	2.8262	2.1258	1.8170
ERROR (%)	**15%**	**18%**	**17.084%**	**11.80%**

4. Conclusion and recommendation

Most of the average errors from both GNSS receivers were less than 5m in exception of the inconsistency observed at points PYF-QNU_199 and PYF-QNU_225. The Trimble Juno Handheld device had the ability to collect measurements that satisfy Eskom requirements. However, when surveying more than one set of points the instrument is likely to produce some location errors. The Trimble R8 on the other hand collected data with error ranging from 0.346 to 4.781m. Following these it appears that Trimble R8 Real Time is suitable for projects that require high accuracy measurements such as power line network design on the ground. For projects that require less accuracy the Trimble Juno Handheld can provide measurements with acceptable level of accuracy. However, the problem with the distorted network observed in this study still calls for the implementation of spatial data checking procedure. It is important that Eskom also looks into implementing compulsory training courses on geospatial data collection and capturing, even though this will not prevent the problem with data inconsistency completely, but it will improve the current condition with inconsistent network data. Moreover, when post processing data the closest base station should be used at all times by Eskom surveyors. When data is being collected in the field, the surveyor must also be cautious of the PDOP, satellite availability and every point must be stored after a minimum of 10 cycle slips.

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