The Effect of Building Heights on GPS Accuracy

Matamyo Simwanda (Doctoral Program in Geo-Environmental Sciences – Research Student)

1. Motivation

The ability of GPS receivers to record location, movement and actual time has made them an attractive tool. People are now using GPSs for not only professional purposes but also for recreation. This has seen the market flooded with several low cost GPS receivers that are easily accessible. It is therefore interesting to investigate the point location accuracy of measurements recorded by these low-cost GPSs.

2. Introduction

GPS receivers are generally classified into three categories (Survey, Mapping and Consumer grade) based on their accuracy and functional capabilities which has a direct effect on their costs. Survey and Map grade receivers have very high requirements for quality and consistence that are most of the times unnecessary for the general population. They are also too expensive.

Despite the modest functionality and estimated accuracies, consumer-grade GPS receivers are very cheap and therefore more accessible for many potential users. Currently, these GPSs are used around the cities where there are several buildings with different heights. The height of buildings, among others, has been identified as one of the factors that affect the accuracy of GPS receivers. Therefore, this study investigated the Effect of Building Heights on GPS Accuracy.

3. Study Area

The study area was University of Tsukuba campus (Figure 1). A total 6 buildings with different heights were selected (Figure 1). The points to collect GPS measurements were selected based on the varying heights and the number buildings surrounding that collection area (Table 1and Figure 1). One control point (an open space) was also selected to compare to the other location points.

4. Methodology

A consumer-grade Garmin eTrex 10 GPS was used to collect data. GPS points were collected at three distances from each building: 1m, 5m and 10m. In cases were points were collected between two or three buildings and the distance did not exceed 10m, points were collected 1m from each building and the middle point between the buildings (Table 1).

Table 1: Summary GPS Data

Data Collection Points	Description	Height	Mean Distance between		
			1m	5m	10m
1	One Buiding	5m	5.1	3.6	2.5
2	Two Buildings	5m and 10m	N/A	4.3	N/A
3	Three Buildings	15m	12.7	11.7	N/A
4	Two Buildings	25m	9.3	6.7	7.4
5	Three Buildings	30m	7.4	3.8	1.1
6	One Building	40m	5.6	1.8	2.5
7	**Open Space**	**0m**	**0**	**0**	**0.3**
Average			**8.0**	**5.3**	**3.4**

The GPS Data was analyzed using ArcGIS 10.2 software. A 1m buffer was created around each point on the ground from which data was collected. Mean Distances (MDs) between the nearest edge of the buffer and the recorded GPS point was then measured (figure 1).

5. Results and Discussion

The accuracy of the Garmin eTrex 10 GPS has been reported to be less than 15m generally and less than 3m with Differential Global Positioning System (DGPS) reception. DGPS was not applied in this study.

The results show that building heights have a significant influence on the GPS accuracy. The taller buildings have more influence on the accuracy than short ones. The number of buildings also affects the accuracy. The longest MDs between ground and GPS points were found from points surrounded by more than one building. The MDs for points taken 1m from the buildings ranged from 5.1m to 12.7m. The MDs from points taken 5m away (or middle point between buildings) ranged from 1.8m to 11.7m. Better accuracies were recorded from points taken 10 m from the buildings (1.1 m to 7.4m) (Figure 2). Some outlying points were also observed in the data with MDs as long as 50m. However these could be results from collection error by the researcher and other factors. All the GPS points recorded in open space fell within the 1m buffer showing that consumer grade GPS receivers can be very accurate without interfering factors like buildings (figure 1).

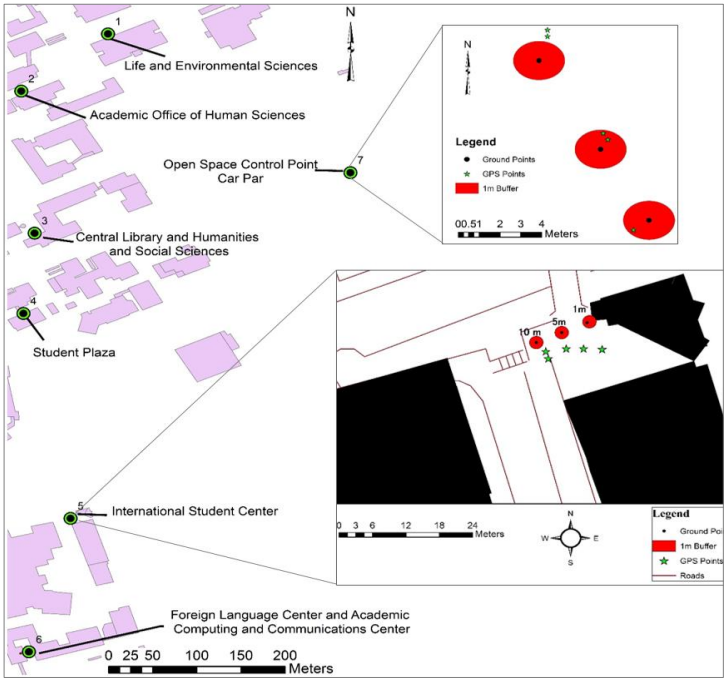

Figure 1: Data Collection points and Sample Ground and GPS points

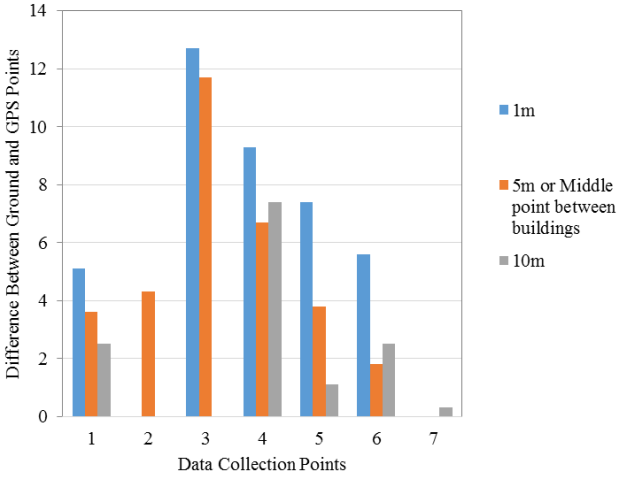

Figure 2: MDs between Ground and GPS Points

The study confirms the accuracy reported by the manufacturer (<15m).For general purposes (e.g. recreation) these accuracies are acceptable. However, for applications where accuracy is more critical, more sophisticated GPSs can provide better results.