GoogleEarth for precision agriculture (Aswan, Egypt)

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Abstract: Google Earth is a virtual globe, map and geographical information software. It maps the Earth by the superimposition of images obtained from satellite imagery, aerial photography and GIS 3D globe. GoogleEarth® has become recently the ultimate source of spatial data and information for private and public decision-support systems. GoogleEarth is a strong tool for precision agriculture. It could be used for farm planning, field mapping, soil sampling, crop scouting, crop health monitoring, variable rate applications, and yield mapping. Also, Google Earth presents a base layer of an aerial photographic image that is geo-located. Different layers of information could be used with this base layer such as soil maps, mineral deposits and crop productivity. This research paper presents a small-scale accuracy assessment study of GoogleEarth's derived elevations. The elevation profile for a 600 m path delivered by GoogleEarth was compared to combined dual frequency GPS/GLONASS Precise Point Positioning (PPP) elevation profile as a reference. The results show that the average error and RMSE of the GoogleEarth-elevation profile is 1.13 m and 2.54 m respectively.

Keywords: GoogleEarth, precision agriculture

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1 Introduction

Agriculture plays a major role in economies of both developed and undeveloped countries. Agriculture represents a substantial trading industry as well as a pillar for national security for world nations. The production of food in a cost-effective manner is the goal of every regional agricultural agency. A farmer needs to be informed to be efficient, and that includes having the knowledge and information products to forge a viable strategy for farming operations. Precision Agriculture is an agriculture management concept based on observing, measuring and responding to inter and intra-field variability in crops. The goal of precision agriculture research is to define a decision support system (DSS) for whole farm management with the goal of optimizing returns on inputs while preserving resources. Satellite and airborne images are used as mapping tools to;

- Crop type classification
- Crop condition assessment
- Crop yield estimation
- Mapping of soil characteristics
- Mapping of soil management practices
- Compliance monitoring (farming practices)

The GoogleEarth® service is the most well-known and used internet service that provides free-of-charge access to the global collection of geo-referenced satellite imagery (Google, 2017). The service has many tools that allow users to not only extract spatial data but also to add their own content to the imagery, such as photographs and notes. GoogleEarth now hosts high-resolution (0.5-meter) imagery allows human observers to readily discriminate between major natural land cover classes and to discern components of the human built environment, including individual houses, industrial facilities, and roads (McInnes et al., 2011; Naji et al., 2013).

There are domestic and international commercial satellite imagery companies that provide high-resolution imagery that can be found in software tools like Google Earth and Bing Maps. Examples of these commercial companies and their employed satellites are:

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-US based Digital Globe is currently operating three satellites: QuickBird, WorldView -1 and WorldView-2. (Digital Globe, 2017)

-US based GeoEye is currently operating three satellites: GeoEye-1, IKONOS and OrbView-2. (GeoEye, 2017)

-French based Spot Image is currently operating two satellites: SPOT 4 and SPOT 5. (SPOT, 2017)

-German based RapidEye is currently operating five satellites: RapidEye 1-5. (RapidEye, 2017)

-Netherlands Antilles based ImageSat is currently operating two satellites: EROS A and EROS B. (ImageSat, 2017)

However, it must be noted that GoogleEarth provides this service with a disclaimer that warns users about the quality of the data. Despite this warning, many individuals still refer to GoogleEarth® as a reliable and accurate data source. While inaccuracies in the GoogleEarth data are not expected to cause harm or damage in many cases, it can potentially cause problems if it is used for navigation purposes, or in technical tasks requiring high accuracy such as surveying and mapping applications. It worths referring to previous studies that assessed the positional accuracy of GoogleEarth such as (Potere, 2008; Kazimierz Becek et al., 2011; Naji et al., 2013).

Potere (2008) tested the Google Earth positional accuracy of 436 control points located in 109 cities worldwide. The study concluded that those control points had a positional accuracy of 39.7 meters RMSE (error magnitude range from 0.4 to 171.6 meters). The accuracy of control points in more-developed countries is 24.1 meters RMSE, which is significantly more accurate than the control points in developing countries such as KSA (44.4 meters RMSE).

Kazimierz Becek et al. (2011) tested the Google Earth positional accuracy of more than 1900 control points located in five continents worldwide. The study concluded that the error could reach 1.5 km in some cases. Naji et al. (2013) tested the Google Earth positional accuracy of 16 control points located in Khartoum state, Sudan. This was carried out by comparing Google Earth measured coordinates of control points with Global Positional System (GPS). Root Mean Square Errors (RMSE) for horizontal and height coordinates were found to be 1.59m and 1.7m respectively. Farah and Algarni (2014) tested the hz and vl. Accuracy of GoogleEarth imagery in a semi-rural area in Riyadh, KSA. The results show that the RMSE of the GoogleEarth imagery is 2.18 m and 1.51 m for the horizontal and height coordinates respectively.

The production of elevation profiles for highways, roads and other civil engineering projects is a high demand job especially in planning stages. GoogleEarth is offering the production of this job at no cost. However, the vertical accuracy offered by GoogleEarth is variable based on the location, so the assessment of such accuracy is essential to decide whether or not to depend on GoogleEarth elevation profiles.

This research presents an accuracy assessment study of the elevation profile provided by GoogleEarth in Aswan; a city sited in south Egypt (24.0889° N, 32.8997° E). The elevation profile for a 606 m path was determined using kinematic-PPP using mixed dual-frequency GPS/GLONASS observations (Zumberge et. al., 1997). The elevation profile was extracted also for the same path using GoogleEarth. The elevations from GoogleEarth were compared to the elevations from kinematic-PPP as a reference.

2 Test Study

The objective of this study is to determine the vertical positioning accuracy for GoogleEarth. The elevation profile was prepared for a 606 m path in College of Engineering, Aswan University (Figure 1) kinematic-PPP using mixed dual-frequency GPS/GLONASS observations. Mixed dual-frequency GPS/GLONASS observations were collected for the tested track using Leica Viva GS15 receiver with 1 sec recording interval, 10^{o} mask angle (Leica Viva, 2017). Table 1 demonstrates the average number of visible satellites as well as the average DOP values for the tested track. The different sets of observations were processed and the PPP solutions were estimated through Canadian Spatial Reference System (CSRS) Precise Point Positioning (PPP) service (CSRS-PPP, 2017). Table 2 presents Kinematic-PPP average accuracy using mixed dual-frequency GPS/GLONASS observations (24/1/2017). Figure 2 presents he Elevation Profile for the tested path as shown in GoogleEarth software. Figure 3 presents the Elevation Profile for the tested path extracted from GoogleEarth software.

Figure 1 The location of the tested path (red color) in Aswan, Egypt (GoogleEarth, 2017)

Table 1 The average DOP values and no. of visible satellites for tested station

Test	HDOP	VDOP	PDOP	Average no. of visible satellites
Kinematic (24/1/2017)	0.619	1.191	1.342	16

Table 2 Kinematic-PPP average accuracy using mixed dual frequency GPS/GLONASS observations (24/1/2017).

Sigma (95%) Latitude, m	Sigma (95%) Longitude, m	Sigma (95%) Ellipsoidal height, m
0.044	0.083	0.120

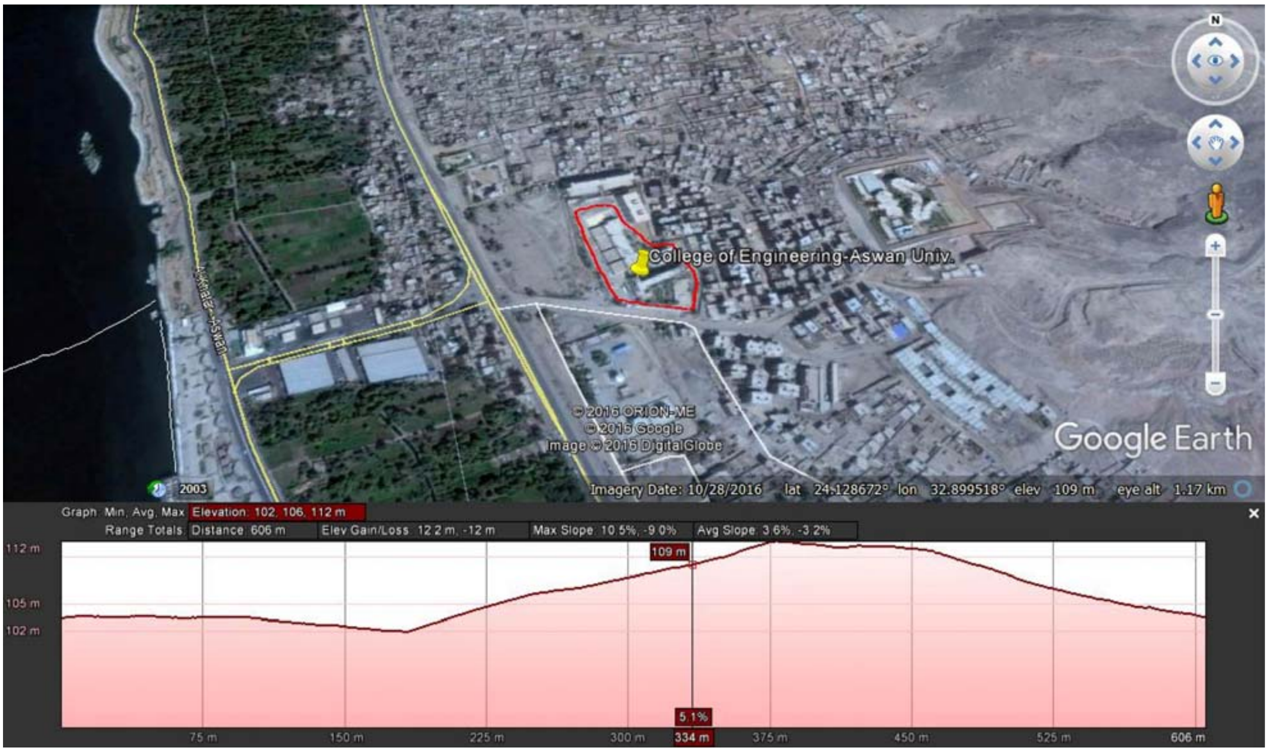

Figure 2 The Elevation Profile for the tested path as shown in GoogleEarth software

Figure 3 The Elevation Profile for the tested path extracted from GoogleEarth software

3 Results, Analysis and Discussion

Figure 4 presents the elevation profiles for the tested path extracted from GoogleEarth and the truth (kinematic-PPP). Figure 5 presents the elevation difference for the tested path. Table 3 presents statistical analysis for the tested path elevation profile. Table 4 presents statistical analysis for the assessment of the vertical accuracy of GoogleEarth study.

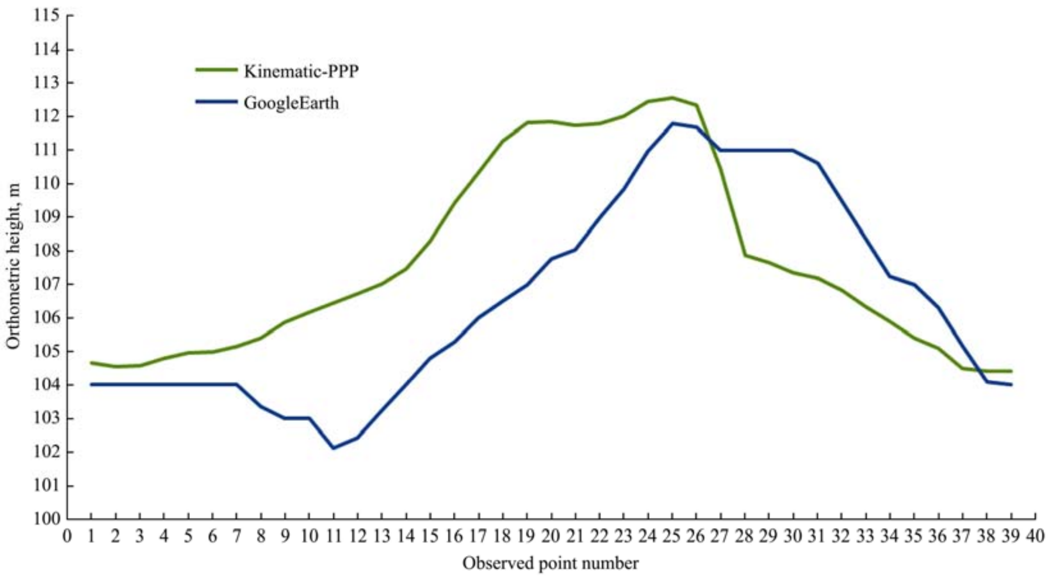

Figure 4 Elevation profile from GoogleEarth and Kinematic-PPP dual frequency mixed GPS/GLONASS observations (24/1/2017)

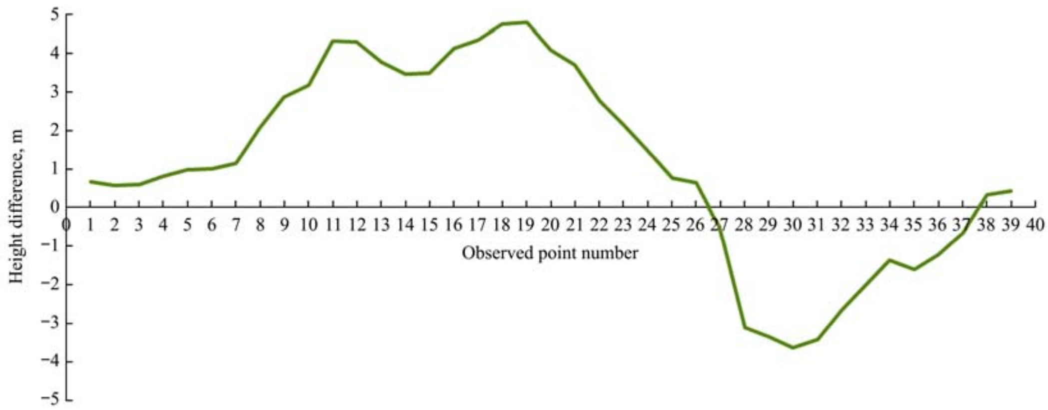

Figure 5 Profile height difference from Kinematic-PPP dual frequency mixed GPS/GLONASS observations (24/1/2017) and GoogleEarth

Table 3 Statistical analysis for the tested path elevation profile

Elevation profile Source	Maximum orthometric height, m	Minimum orthometric height, m	Average orthometric height, m
Kinematic-PPP	112.564	104.426	107.649
GoogleEarth	112.000	102.000	106.000

Table 4 Statistical analysis for the assessment of the vertical accuracy of GoogleEarth study

Maximum orthometric height Shift, m	Minimum orthometric height Shift, m	Average orthometric height Shift, m	Root Mean Square Error (RMSE) of orthometric height Shift, m
4.817	-3.643	1.131	2.540

4 Conclusions

This research presents an assessment small-scale study of the vertical positional accuracy of GoogleEarth in Aswan, south Egypt, where the performance of GoogleEarth was compared with Kinematic-PPP (using dual frequency mixed GPS/GLONASS observations). The GoogleEarth vertical Error was in the range of (–3.64 m to 4.82 m) with a mean value of 1.13 m and RMSE of 2.54 m. Those findings are valid in the place of study and should not be applicable elsewhere. Other studies are needed prior to conclude certain accuracy elsewhere. GoogleEarth provides different vertical accuracies for different locations (Farah and Algarni, 2014; Nagi et al., 2013). GoogleEarth's vertical accuracy is better in rural areas comparing with urban areas (this could be concluded by comparing the results of this study with other studies by Naji et al. (2013), Farah and Algarni (2014) where they did their studies in semi-rural areas while this study was done in an urban area). GoogleEarth provides a vertical accuracy suitable for precision agriculture applications.

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