

Determination of the National Highpoint of Botswana

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Abstract

Botswana has not previously been surveyed with sufficient accuracy to determine the highest peak in the country. The highest two peaks, Otse Hill and Monalanong Hill, have been identified, but it has been uncertain which is highest. For this study, ground surveys were conducted on each of these peaks using an Abney level and a differential GNSS unit to measure the elevation of each hill with sub-meter vertical accuracy. Monalanong Hill was measured to be 1.87m +/- 0.02m taller than Otse hill. Monalanong Hill is the highest hill in Botswana, with elevation 1492.12m +/- 0.01m (orthometric height, EGM2008 geoid, 95% confidence interval). Otse Hill was measured to be 1490.25m +/- 0.01m.

Introduction

The location of the highest peak in Botswana is geographically significant. However, before this study the elevation and location of the highest peak was not known with certainty. Several ground-based and satellite-based measurements have previously been conducted.

In February 2000, the satellite-based Shuttle Range Topography Mission (SRTM) collected elevation data at discrete points around the world, including in Botswana, with 1 arcsecond spacing (approximately 30m) with reported vertical accuracy +/-16m (Farr 2007, Smith 2023). Elevations of locations between measured points have been approximated by different Digital Elevation Models (DEMs). However, the error bounds of elevations of locations between measured points is unknown and can potentially be higher than +/-16m, especially for sharp peaks (Sandip 2013).

Digital elevation models based on SRTM data include Google Earth (Google Earth 2025), Google Terrain (Google Terrain 2025), Topographic-map (Yamazaki 2017), Floodmap (Floodmap 2025), and Gaia (Gaia 2025). All of these models identified the two highest peaks in the country as Otse Hill (location 25.007687 S, 25.715566 E) and Monalanong Hill (location 24.840437 S, 25.665229 E) (Fig 1). All other peaks in Botswana were lower and outside of the error bounds of the elevation of these two peaks. The peaks have the same elevation within the error bounds of the measurements, thus satellite-based measurements are not sufficient to distinguish which peak is highest (Table 1).

Otse Hill has been measured by a trigonometric ground survey in 1999 conducted by the Botswana Department of Surveys and Mapping (Botswana 1999). This measured Otse Hill 1491m, but did not measure Monalanong Hill (Table 1). Thus, based on all existing measurements it was unknown which of the two peaks is highest.

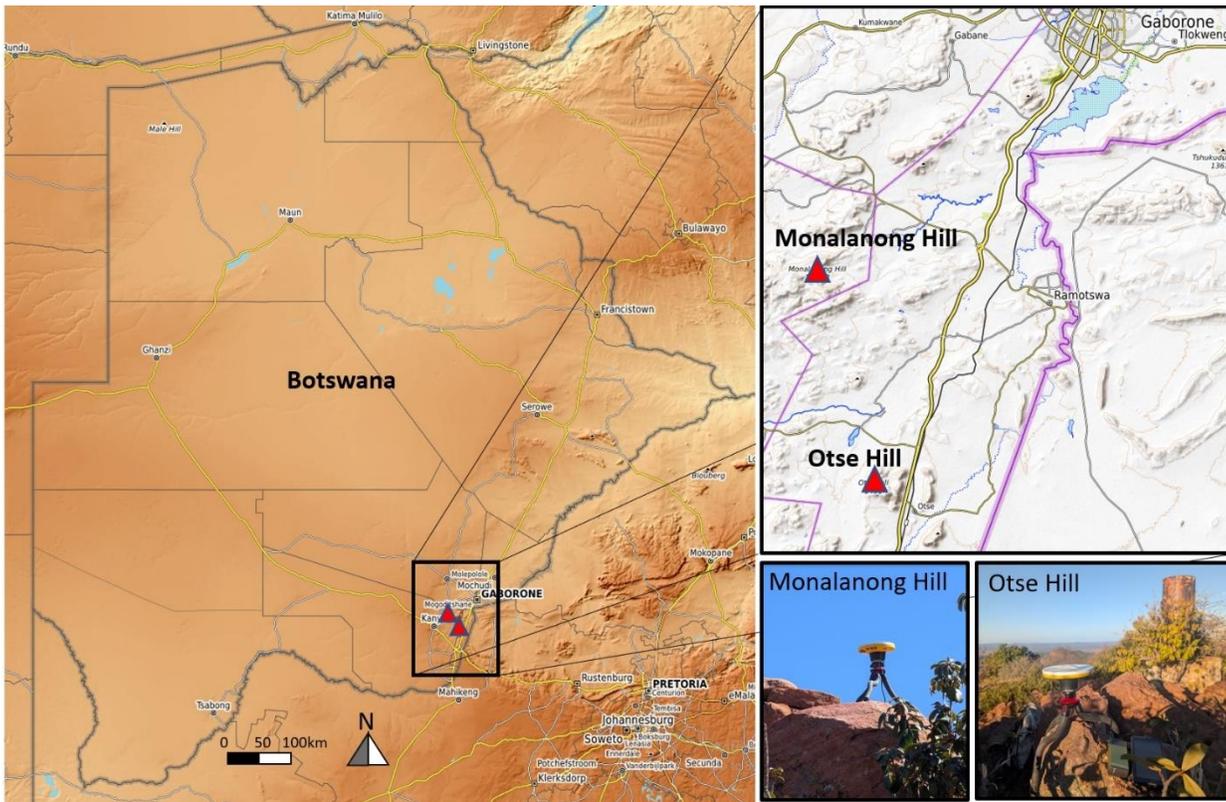


Figure 1. Location of Otse Hill and Monalanong Hill in Botswana. Basemap from opentopo (Opentopo 2025).

Table 1: Elevations (m) for each peak from different sources (EGM96 geoid).

Peak	1:50k DSM Map	Google Earth	Topographic-map	Floodmap	Gaia	Google Terrain
Monalanong	--	1492	1491	1494	1495	1480-1500
Otse	1491	1490	1489	1487	1486	1480-1500

Methodology

We conducted ground surveys using a 10 arcminute 5x Sokkia Abney level and a Trimble DA2 differential GNSS unit capable of sub meter vertical accuracy. On August 7, 2025 we went to the location on Monalanong Hill identified by satellite DEMs as the highest point on the summit plateau. We used the Abney level to identify the highest rock in this vicinity. This was a rock pillar approximately 2m x 1m x 1m sticking up from the plateau (Fig 1).

We mounted the DA2 on a flexible-leg tripod on the highest point and logged data for one hour. We measured the antenna height as 0.16m above the ground.

Later the same day we ascended Otse Hill to the concrete monument at the summit. We used the Abney level to identify the highest rock in the summit vicinity, and mounted the DA2 on the rock on the tripod (Fig 1). The antenna height was 0.08m, and we logged data for one hour.

Results

Elevations are reported as orthometric height using the EGM2008 geoid (Pavlis 2012), because this is the most accurate geoid for this area of Botswana.

We processed data with PRIDE-PPPAR (Geng 2023) and TrimbleRTX (Trimble 2025), accounting for antenna heights. Both gave consistent ellipsoidal heights. The PRIDE-PPPAR method resulted in the smallest errors, and final results will be reported for that method. We then converted ellipsoidal heights to EGM2008 orthometric using the UNAVCO/NSF GAGE tool (UNAVCO 2025).

We first processed kinematic solutions for each location (Fig 2). This showed vertical errors for Monalanong Hill of +/- 1.37cm and for Otse Hill +/-1.05cm (95% confidence interval).

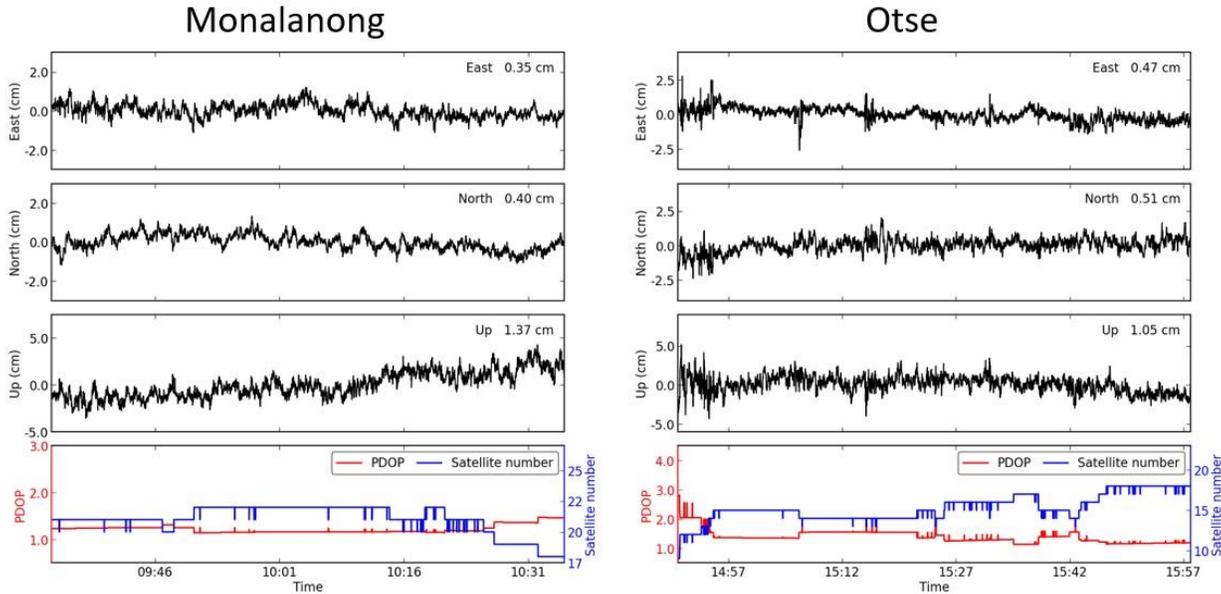


Figure 2: Kinematic solutions for Monalanong Hill and Otse Hill.

We next processed the data to find a static solution for each location (Table 1). Static solutions generally have smaller errors than kinematic solutions, and final results will thus be reported as the static results.

Table 1: Static solution for Monalanong Hill and Otse Hill processed with PRIDE-PPPAR.

Station	Monalanong	Otse
Latitude	-24.8404370	-25.0076873
Longitude	25.6652302	25.7155664
Ellipsoidal Height(m)	1514.658	1513.452
Sigma (vertical, m)	0.00054	0.00071
Orthometric Height (m)	1492.12	1490.25

The sigma values for the elevations from static solutions are less than 1 cm. However, because antenna heights were measured to the nearest cm with a tape measure, we will report 95% error bounds as +/-1cm and round orthometric heights to the nearest cm. This means Monalanong Hill was measured to be 1492.12m +/-0.01m and Otse Hill was measured to be 1490.25m +/-0.01m.

Discussion

Monalanong Hill (location 24.840437 S, 25.665230 E) is the highest point in Botswana, and is 1.87m +/-0.02m taller than Otse Hill. The error bounds on the elevation measurements do not overlap, meaning Monalanong Hill is higher than Otse hill with greater than 95% confidence.

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