Survey of Table Mountain

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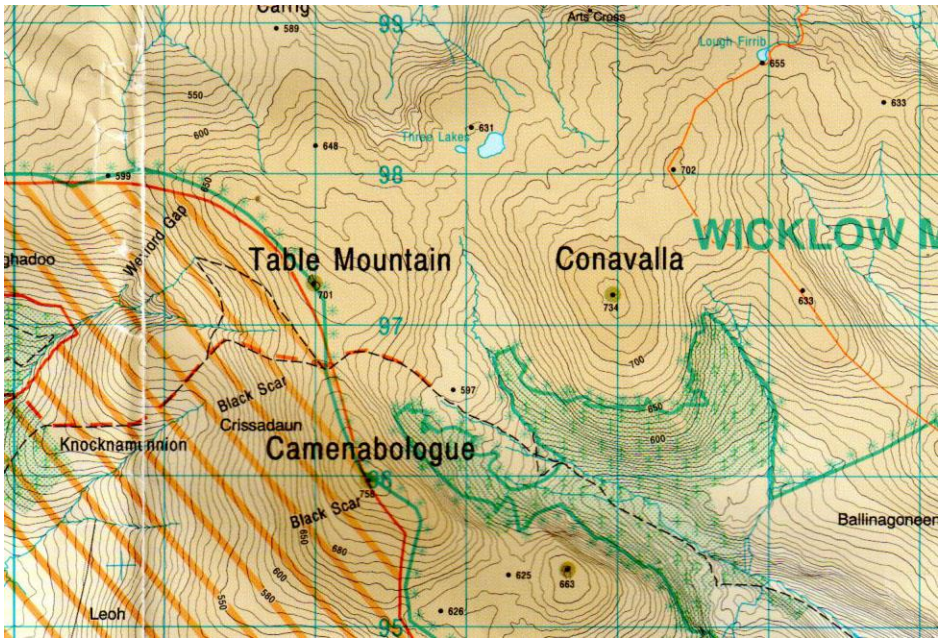
1) Introduction

Table Mountain (Hill Number 20572, Section 55A, OSi 1:50000 Map 56, Grid Ref. T019972) is listed as a Vandeleur-Lynam (a hill of height 600m or greater with 15m or more of drop) in the Database of British and Irish Hills (DoBIH). From map contours the col appears to be very broad, it being approximately 250m in the hill to hill direction and about 250m in the valley to valley direction. An estimate of its height from the map is 684m while there is a 701m spot height on the summit, thus giving an estimated drop of 17m. To check this John Fitzgerald of Mountainviews surveyed the hill using a Trimble GeoXH 6000 GNSS



receiver and obtained a col height of 685.9m and a summit height of 701.7m thereby giving a drop of 15.8m. However, given the broad nature of the col and a summit area that contains three vegetated areas vying for summit status, it was deemed prudent that Mountainviews and DoBIH would carry out a joint survey of the mountain. Consequently, the purpose of the survey was to measure accurately the drop for Table Mountain and thereby resolve its classification.

2) Equipment used and Conditions for Survey

A Leica NA730 Professional Automatic level (X30 telescopic system)/tripod system and a "1m" **E**-staff extendable to 5m were used to determine the positions of the col and summit and to measure drop.

Absolute heights were measured using a Leica Viva GS15, a Trimble GeoXH 6000 and a Trimble 2008 GNSS (Global Navigation Satellite System) receivers. These receivers are dual-frequency, multi-channel instruments, which means they are capable of locking on to a maximum of 12 GPS and 8 GLONASS satellites as availability dictates, and receiving two signals (at different frequencies) from each of these satellites. The latter feature reduces inaccuracies that result from atmospheric degradation of the satellite signals. As stand-alone instruments they are capable of giving position and height to an accuracy of about two metres and five metres respectively. Note that small hand-held GPS receivers used for general navigation can only receive up to 12 GPS satellites and each at a single frequency and therefore these instruments have a poorer positional accuracy of +/-5metres and a height accuracy of no better than +/-10 metres. Some recently produced hand held GPS Garmin receivers can also receive signals from GLONASS satellites which greatly improve the speed at which these units can achieve a satellite "fix". Despite the on-board features of the GS15, GeoXH 6000 and 2008 receivers, there are still sources that create residual errors. To obtain accurate positions and heights, corrections were made to the GNSS data via imported RINEX data from Ordnance Survey Ireland which were post-processed using Leica GeoOffice 8.3 and Trimble GPS Pathfinder Office respectively. Repeated measurements with a GeoXH 6000 instrument made on the same point gives a height precision of +/-0.2-0.3m; height precision for the GS15 using the same method is +/-0.05m.

Conditions for the survey, which took place between 12.00hr and 17.00hr BST, were favourable. The weather was overcast with sunny intervals and the cloud base was at or above 900m. The wind was light and visibility good.

3) The Survey

3.1) Character of Hill

Table Mountain lies in the Wicklow Mountains about 5km North of Lugnaquillia, which at 925m is the highest mountain in the group. Our chosen route began at the large car park adjacent to the hotel near Drumgoff Bridge (T107119). From here we were taken by a four-wheel drive vehicle to the end of the road in Glenmalur, where there is a small Youth Hostel. The vehicle was able to proceed from the Youth Hostel up a deteriorating track for about another kilometre until storm damage to the track halted our progress. Having received this excellent start which saved a few kilometres of walking we now continued on foot. Glenmalur is steep-sided and lined with forestry for much of its length, although some felling had taken place on the North-East side of the valley. It was in this area that a small herd of wild goats watched our progress from a high vantage point in the crags above us. Gradually, as the track climbs, forestry gives way to rough moorland until at about 690m it passes just South of the col that separates Table Mountain from its higher neighbour Camenabologue. At this point there is a fine view of the col area which comprises tussock grass in the vicinity of the track. This then gives way to a bare area of small rocks embedded in gravel and at the foot of Table Mountain this terrain in turn gives way to peat hags which guard the South side of Table Mountain all the way to the summit. The view to the South is dominated by Lugnaquillia just 7km away and indeed the ridge over Camenabologue offers a route to it along the edge of the military artillery range.

3.2) Summary of Survey Method

Upon arrival at the col it was quickly realised that a significant amount of time would be required to determine its exact position. While fairly well defined in the valley to valley direction the profile of the col in the hill to hill direction appeared to be very flat for a distance of about 250m. A strategy was required to find its exact position. The summit also

posed a problem as several prominences and small ridges were present, each of which could be the highest point of the hill. Both the Leica GS15 and the Trimble receivers were used to collect data at the col and the summit and in addition a line survey was conducted between the two points.

3.3) The Col

The first task was the laying out of four parallel lines of flags about 10m apart in the hill to hill direction. The Leica NA730 level was then set up at a convenient position and readings taken for each flag. The lowest flag in each row then traced out the approximate line of the col in the valley to valley direction. Once this task was completed a grid of flags was next laid out with rows either side of this valley to valley line with flags about 5m apart. The highest flags in each row then gave the hill to hill line of the col and the lowest of the flags in this line gave the position of the col itself. Further investigation with level and staff in the immediate area of this flag confirmed the col position.

Next the tripod was set-up over the col position and the Leica Viva GS15 was then fixed to it with a clamp and tribrach (the "short tripod" configuration). The height of the receiver above the ground was then measured with the integral tape. The vertical offset from measuring point to the ground was 0.581m (see photograph in Appendix) plus 0.255m for the tribrach/hook system. GNSS data were collected for 70min with an epoch time of 15 seconds.

Finally, the Trimble GeoXH 6000 and 2008 were placed on the col and data were then collected for 5 minutes once the receiver accuracy measurement had reached 0.1m.

The data for the Leica Viva GS15 were processed in Leica GeoOffice 8.3 using the eight nearest base stations and the data from the Trimble receivers were processed in Trimble GPS Pathfinder Office using the five nearest base stations. The results are given in the table below:-

System	Easting	error(1SD)	Northing	error(1SD)	Height(m)	error(1SD)
GS15	302063.651	0.002	196907.128	0.002	685.598	0.007
Trimble GeoXH 6000	Not given	Not given	Not given	Not given	685.637	Not given
Trimble 2008	Not given	Not given	Not given	Not given	685.54	Not given

The height of the col is 685.6m.

3.4) The Summit

The summit area of Table Mountain is quite complex. An undulating ridge runs on the West edge of the summit area and there are at least two points along it that vie for summit position. Just to the East the ground drops about 5m in height into a flat gully which then rises to a small plateau. There are several positions in this flat area that also vie for summit position. Thick heather and tussock grass make naked eye estimates difficult. The Leica NA730 level was set up at a convenient position from which all candidate summit locations could be seen and the staff measurements were taken to determine the highest point. This was a position on the undulating ridge a few tens of metres away from a small cairn. Care was taken while

carrying out this work to ensure that the staff was placed on ground and not on vegetation; vegetation was removed for staff placements as required.

Next the tripod was set up over the summit position and the Leica Viva GS15 fixed to it with a clamp and tribrach (the "short tripod" configuration). The height of the receiver above the ground was then measured with the integral tape. The vertical offset from measuring point to the ground was 0.420m (see photograph in Appendix) plus 0.255m for the tribrach/hook system. GNSS data were collected for 60min with an epoch time of 15 seconds.

The Trimble GeoXH 6000 and 2008 were also used to determine the summit height prior to this. GNSS data were collected for 5 minutes once the receiver accuracy measurement had reached 0.1m.

The data for the Leica Viva GS15 were processed in Leica GeoOffice 8.3 using the nine nearest base stations and the Trimble GeoXH 6000 and 2008 data were processed in Trimble GPS Pathfinder Office using the five nearest base stations. The results are given in the table below:-

System	Easting	error(1SD)	Northing	error(1SD)	Height(m)	error(1SD)
GS15	301959.145	0.002	197292.063	0.003	700.951	0.005
Trimble GeoXH 6000	Not given	Not given	Not given	Not given	700.999	Not given
Trimble 2008	Not given	Not given	Not given	Not given	700.92	Not given

The height of Table Mountain = 701.0m

The drop as determined by the difference between col and summit heights is:

Leica Viva GS15: 700.95 – 685.60 = 15.35m

Trimble GeoXH 6000: 700.999 – 685.637 = 15.36m

Trimble 2008: 700.92 – 685.54 = 15.38m

4) Line Survey

While the Leica Viva GS15 was collecting data at the col, a line survey was conducted from col to summit and then back to the col. As mentioned in Section 3.1 the ground on the South face of the hill is a network of peat hags. Consequently, a scouting exercise was undertaken first which did enable us to locate a suitable route for the survey; this circumnavigated the worst areas of peat hags.

Next the line survey from the col to the summit was carried out. The Leica NA730 level was set up on the tripod at a convenient position near to the col and staff readings were taken with the staff set up on the col position. Once this set of readings had been taken (Backsights BS) the staff was then moved to an uphill position, but the level not moved apart from a rotation through 180 degrees, to take another set of readings (Foresights FS). The line survey route then continued towards the summit. This process of alternately moving the staff and level

was repeated until the final reading was taken with the staff on the summit position. Readings were taken from the horizontal and also the lower and upper stadia lines of the level to provide a check on any staff misreadings and to improve accuracy. If in any set of three readings the average was greater than 1mm different from the horizontal reading, then that set was re-measured. This happened on two or three legs of the survey and was due to the soft nature of the waterlogged ground. The line survey readings are given in the Appendix 2. Once completed the line survey was then repeated, this time going from the summit to the col and using exactly the same method as just described. The line survey readings are given in Appendix 2.

The drop measured by the line survey is 15.34m with a closing error of 3.5cm.

5) Summary of Operating Conditions

	GS15	GeoXH 6000
Data Collection col (min)	71	5
Data collection summit (min)	70	5
Number of Base Stations used in Processing for all points	8	5
Epoch Time (sec)	15	1
Tropospheric Model	Computed	Unknown
Cut off Angle (degs)	15	15

6) Discussion of Results

For the GNSS results from the Leica Viva GS15, a one hour data collection time gives results with a measurement uncertainty of +/-0.06m. This measurement uncertainty applies to both the col and summit measurement. In addition the measurement uncertainty in height associated with the location of the col is +/-0.05m as determined by the staff measurements. The summit position was also found to within +/-0.05m of height.

Therefore the overall measurement uncertainty associated with measurement of both col and summit is: [Square root $(0.06^2 + 0.05^2)$] = 0.08m

Similarly, the overall measurement uncertainty for the GNSS determination of drop from the Leica Viva GS15 is +/-0.1m [square root $(0.06^2 + 0.06^2 + 0.05^2 + 0.05^2)$]. The drop is therefore 700.95 - 685.60 = 15.35+/-0.10m as determined by the Leica Viva GS15.

The uncertainties described above for the locations of the summit and col also apply to the line survey which in addition gave a closing error of 0.035m. For each set of readings taken from the staff we would estimate an uncertainty of +/-0.001m. Also on the two line surveys there are imbalances in the total foresight and backsight readings of about 153m and 192m respectively. As the NA730 is calibrated to height tolerance within 0.003m over a distance of 30m, the uncertainty associated with the complete set of measurements in each line survey is +/-0.02m [square root $(7x0.001^2 + 0.02^2)$]. Therefore the overall uncertainty in the drop measurement from the line survey is estimated to be +/-0.02m [square root $(0.02^2 + 0.01^2$

$+0.005^2$)] and is consistent with the closing error. All measurement uncertainties are to 99.8% confidence (3 standard deviations). As may be seen the measurement error for the line survey is less than that for the GNSS measurements and therefore is the one adopted. Nevertheless the GNSS data add to the confidence in the result.

7) Summary and Conclusions

The **summit** of **Table Mountain** is at grid reference * T 01960 97293 and is ground on a small ridge on the West side of the summit. It is now marked by a small cairn. Its height is **701.0+/-0.08m**.

The **col** of **Table Mountain** is at * T 02063 96907 and is unfeatured ground in an area of embedded rocks and gravel. Its height is **685.6+/-0.08m.**

The **drop** for **Table Mountain** is **15.3+/-0.1m** and consequently **Table Mountain** remains a **Vandeleur-Lynam**.

- NB: Summit grid reference adjusted for Garmin receivers is quoted in the summary.

24 November 2015

Appendix

Figure 1: Offset reading for the col

Figure 2: Offset reading for summit

Figure 3: Leica Viva GS15 set up on summit

Appendix 2

	Horizontal Line		Lower Stadia Line		Upper Stadia Line				
Point Number	Backsight BS	Foresight FS	Backsight BS	Foresight FS	Backsight BS	Foresight FS	Mean BS	Mean FS	Height Difference
	metres	metres	metres	metres	metres	metres	metres	metres	metres
Col to Summit: JB Level and data recording CC Staff									
1	3.115	0.634	2.860	0.411	3.368	0.859	**3.114**	**0.635**	
2	4.046	0.591	3.805	0.482	4.290	0.698	**4.047**	**0.590**	
3	4.595	0.661	4.300	0.549	4.892	0.774	**4.596**	**0.661**	
4	2.462	0.550	2.114	0.400	2.812	0.697	**2.463**	**0.549**	
5	3.904	0.335	3.403	0.054	4.406	0.616	**3.904**	**0.335**	
						SUM =	**18.124**	**2.770**	**15.354**
Summit to Col: JB Level and data recording CC Staff									
1	0.335	4.494	0.054	4.090	0.616	4.900	**0.335**	**4.495**	
2	1.124	4.493	1.053	4.258	1.195	4.730	**1.124**	**4.494**	
3	0.720	4.391	0.634	4.086	0.807	4.697	**0.720**	**4.391**	
4	0.813	4.000	0.732	3.639	0.896	4.365	**0.814**	**4.001**	
5	1.724	2.656	1.630	2.387	1.819	2.924	**1.724**	**2.656**	
						SUM =	**4.717**	**20.037**	**-15.319**