

Survey of the Bwlch of Craig Bron-banog

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The Team:

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1) Introduction

Craig Bron-banog (Hill Number 3358, Section 30C, 1:50000 OS Map 116, 1:25000 OS Map 264S, GR SJ016520) is situated in the centre of the Clocaenog Forest about 5km South East of the southern end of Llyn Brenig. A survey of the summit was carried out in January 2010 and this showed its height to be 501.8m, thus confirming the hill's status as a Dewey. However, in the report we recognised that the drop for the hill, as measured from OS maps, is 99m to 101m depending on the source. The list author, Mark Jackson, gives a drop of 101m and therefore Craig Bron-banog is currently given as a marginal Hump.

The purpose of this survey was to measure accurately the height of the bwlch and thereby the drop to determine the Hump status of Craig Bron-banog.

2) Equipment used and Conditions for Survey

The ground survey to locate the position of the bwlch was carried out using a Leica NA730 Professional Automatic level (X30 telescopic system)/tripod system and a "1m" E-staff extendable to 5m.

Absolute heights were measured using a Leica Geosystems Viva GS15 Professional receiver. This instrument is dual-frequency and multi-channel, which means it is capable of locking on to a maximum of 12 GPS and 8 GLONASS satellites as availability dictates, and receive 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 a stand-alone instrument it is 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 Viva GS15 receiver, there are still sources that create residual errors. To obtain accurate positions and heights, corrections were made to the GNSS (Global Navigation Satellite System) data via imported RINEX data from the Ordnance Survey and this dataset was post-processed using Leica Geo Office 8.3 software.

Conditions for the survey which took place between 11.00hr and 15.00hr GMT were good with a temperature of about 20 degrees Celsius and just a slight breeze.

3) Description of the Bwlch Area

The bwlch of Craig Bron-banog is situated about 1km to the North-West of the hill, deep within the Clocaenog forest, which covers an area of about 35 square km. The map indicates that trees cover the area of the bwlch itself, but aerial photography shows that it has been cleared of trees (Figure 1). This raised our hopes that a survey would be possible, although even recently cleared areas are often littered with brushwood and are consequently difficult to access, let alone survey. Fortunately, wide forest roads surround the critical area and there is ample parking just 700m away to the North-West.

Our first view of the bwlch as we approached did not fill us with confidence. Scattered clumps of small trees were beginning to establish themselves, rising above a carpet of thick heather. Upon leaving the track and heading towards a position that the map indicated was probably the bwlch, we were also confronted with areas of bog and hidden channels filled with water. These hazards combined very effectively with the deep heather to ensure slow and wet progress. We took comfort in the fact that much of the brushwood had been removed or had rotted since the trees had been felled but it still took approximately 15min to reach our destination just 250m away.

Figure 1: Image of the bwlch area of Craig Bron-banog



4) Survey Method

In preparation for the survey we had noted ten-figure grid references from the map for the positions of a 403m spot height and a location for the bwlch estimated from the map. Our first task was to locate these positions on the ground, which we did with the aid of a hand-held GPS that had previously had the grid references entered into it. This enabled us to orientate ourselves in the large expanse in which we found ourselves. Even with the unaided eye we could see that the spot height was not at the critical bwlch, once we reached this position, and our estimated map position for the critical bwlch proved to lie a few tens of metres within the forestry to the South-East.

Three drainage ditches cross the bwlch area and these can just be discerned in Figure 1. They contain stagnant pools, are about 0.75m deep and 1m across and appear from the photograph to link the two streams that flow South-West and North-East from the bwlch. These streams are not in evidence in the area of the bwlch itself.

Having completed our reconnoitre of the area, we next set up the Leica Viva GS15 at a convenient position to collect data, while we carried out a more detailed survey with the level and staff. This position was on a slightly raised piece of ground which was drier and marginally more stable than its surroundings and later measurement with level and staff showed it to be 0.2m higher than the surrounding ground.

The Leica NA730 automatic level was set up on a tripod approximately 20m SE of the Leica Viva GS15. First of all, staff readings were taken in a line running approximately 120m from the SW to 120m to the NE in the valley to valley direction. In both directions the land fell by about 1m over this distance. Next staff readings were taken in a NW to SE (hill to hill) direction starting at the position of the Leica Viva GS15. Before commencing this exercise though, it was noted that the land beyond the Leica Viva GS15 to the NW was rising, with the horizontal line of the level cutting the heather in front of the forestry there; the area was close to the previously visited position of the 403m spot height. This observation showed the land at this point to be higher by about 1m and a subsequent height measurement of the spot height position with a Trimble GeoXH 6000 receiver later confirmed this to be 402.7m. Staff measurements from a position about 10m SE of the Leica Viva GS15 to the edge of the forestry about 50m to the SE showed the ground to be level. Four measurements within the forestry to a further distance of about 50m showed that the ground was then beginning to rise. It should be noted that the general unevenness of the ground over the whole of the bwlch area was approximately 1m or more and this greatly increases the measurement uncertainty of the final height determination. For the purpose of the staff measurements care was taken to place the staff on middle ground rather than select high points or low points in the terrain. A sketch of the survey is shown in Figure 4.

5) Survey Measurement

The 10 figure Grid References for the set-up position of the Leica Viva GS15 were recorded as:-

Garmin Oregon 450 SJ 01169 52965 Accuracy 4m Height = 412m

The Leica Viva GS15 was set up in the general area of the bwlch, as described above, and was supported by a “quickset” tripod. The unit was mounted on a 2.000m pole and a photograph of the set-up is shown in the Appendix (Figure 3). GNSS data were collected for 2 hr. The position and height data that were recorded by the Leica Viva GS15 were post-processed with Leica GeoOffice 8.3 using imported OS RINEX data for the nine nearest base stations under 100km distance and the Computed model for tropospheric correction. The result is given in the table below:-

System	Easting	error(1SD)	Northing	error(1SD)	Height(m)	error(1SD)
GS15	301167.971	0.002	352960.813	0.002	401.653	0.004

Staff reading for GPS set up position = 0.80m

Average staff reading for bwlch area = 1.05m

Therefore the Leica Viva GS15 was set up $1.05 - 0.80 = 0.25$ m higher than the average height of the bwlch

The height of the bwlch is $401.65 - 0.25 = 401.40$ m

6) Summary of Operating and Process Conditions

	GS15
Data Collection bwlch (min)	120
Number of Base Stations used in Processing for all points	9
Epoch Time (sec)	15
Tropospheric Model	Computed
Cut off Angle (degs)	15

7) Discussion of Results

Given the unevenness and vegetated nature of the terrain it is impossible to locate an accurate position for the bwlch. The best that can be achieved is to narrow this down to an area just to the SE of the set-up position of the Leica Viva GS15. This area extends approximately for 15m either side of this point and for a distance of approximately 50m to the SE to the edge of the trees. The approximate coordinates for this rectangle are SJ 01157 52950, SJ 01177 52970, SJ 01194 52900, SJ 01214 52919 (Appendix: Figure 2); these are calculated from the grid reference for the set-up position of the Leica Viva GS15. Within this rectangle the staff measurements were all consistent to within 0.1m. Within the forest to the SE (hill to hill direction) staff measurements clearly show the ground rising while to the SW and NE (valley to valley direction) the ground is clearly falling (Appendix: Figure 3).

The height of the bwlch as measured by the Leica Viva GS15 is 401.40m which gives a drop figure for Craig Bron-banog of $501.86 - 401.40 = 100.46\text{m}$. From our work with level and staff we estimated the general unevenness of the ground to be ± 1 to 1.5m (highest points of mounds to lowest points in troughs). Taking the higher figure we estimate an uncertainty of $\pm 0.8\text{m}$ in the bwlch height measurement. Note that the measurement uncertainty associated with the GNSS measurement itself is $\pm 0.06\text{m}$ and so is irrelevant in this situation which is dominated by the uneven and vegetated nature of the terrain.

The height of the bwlch of Craig Bron-banog is $401.4 \pm 0.8\text{m}$ and the drop is $100.5 \pm 0.8\text{m}$

8) Summary and Conclusions

The height of the **bwlch** of **Craig Bron-banog** is $401.4 \pm 0.8\text{m}$ and is within a rectangle bounded by the grid references SJ 01157 52950, SJ 01177 52970, SJ 01194 52900, SJ 01214 52919.

The **drop** for **Craig Bron-banog** is $100.5 \pm 0.8\text{m}$. The probability is greater that the drop is 100m or above and therefore Craig Bron-banog should retain its status as a Hump.

John Barnard, Graham Jackson and Myrddyn Phillips, 3 November 2014.

Appendix

Figure 2: 1:25k map of bwlch area with approximate position of bwlch shown by red rectangle

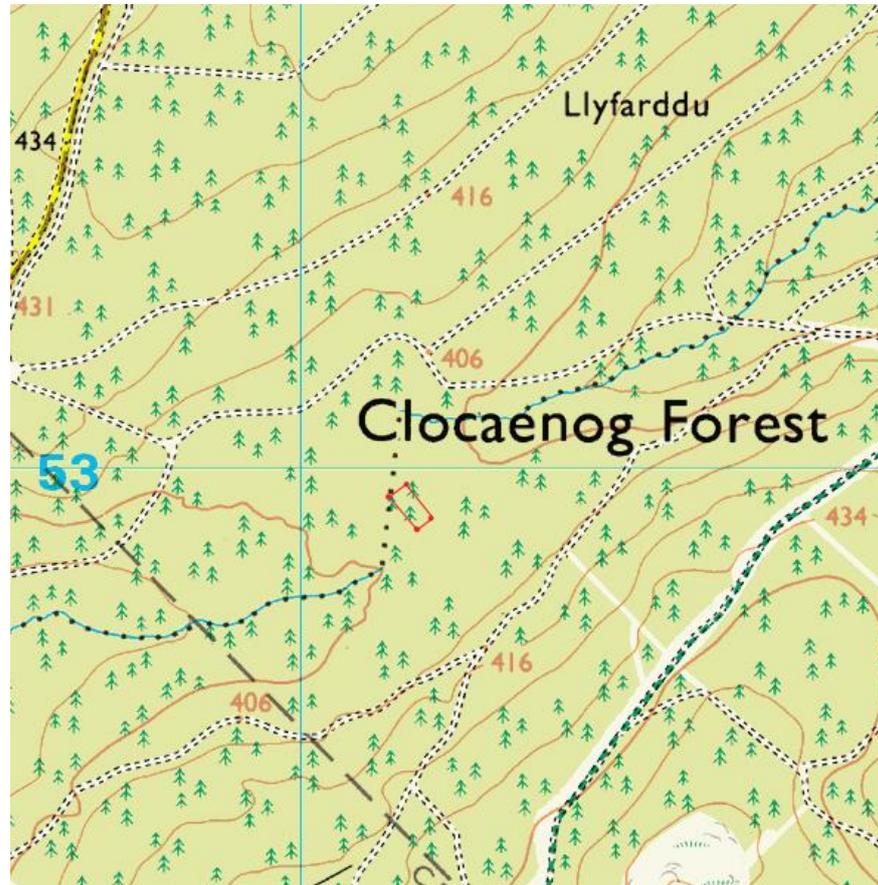


Figure 3: View to NW with the Leica Viva GS15 set up in bwlch area



Figure 4: Sketch of survey (not to scale)

