JNSA, LIDAR and the DoBIH

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The last two years have witnessed an unprecedented amount of hill data analysis by the editorial team of the Database of British and Irish Hills, for which JNSA is primarily responsible. The acronym stands for Joe Nuttall Summit Analysis and refers to a dataset of 30,000 hills sent to us, with perfect timing, at the start of the March 2020 lockdown. Joe created a digital elevation model for the whole of Britain using LIDAR datasets where available and OS Terrain 50 Contour (effectively the 10m contours on OS Maps) elsewhere. He then ran a surface analysis program to find summits with a minimum drop of 20m, reduced to 10m for anything over 600m to identify potential changes in his parents' list. The methodology is similar to that used by Andrew Kirmse and Jonathan de Ferranti in their analysis of the much less accurate SRTM World dataset, whose British data we looked at in 2017. Joe had much the harder task as the LIDAR data came from six sources in a variety of formats and resolutions, and the OS contour data needed to be put through an interpolation routine to produce a grid of heights to fill holes in the LIDAR coverage. The final stage was to match DoBIH hills to the output, defining a match as the closest summit within a radius of 1km.

Four of us (George Gradwell, Dave Marshall, Jim Bloomer & Chris Crocker) have worked intensively on the project, identifying potential reclassifications and relocations from the JNSA output and investigating them in detail. During this period Joe has re-run his analysis several more times to take advantage of further releases of LIDAR data in England and Scotland. Each run produces many new hills to examine.

LIDAR is no stranger to us. The first tranche of English data was published by the Environment Agency in 2015 and Mark Jackson was soon using it to investigate potential Tumps in Cumbria. Data for Wales followed in 2016, but it took a few more years for anything useful to emerge in Scotland. The team performed a steady stream of analyses but it was on an ad hoc basis, often when a new Tump was suggested or to resolve a conflict between GPS submissions, though we did some work on the Humps. JNSA changed all that. Now we were able to draw up a shortlist of hundreds of potential new Tumps and P20s, promotions, deletions and relocations. We have performed around 2500 LIDAR analyses to date.

Joe Nuttall's file identifies summit and col data derived from LIDAR, but that doesn't mean we can reclassify or relocate hills solely on the JNSA output. To understand why, it is helpful to have some knowledge of the technology. LIDAR (**L**ight **D**etection **A**nd **R**anging) is a surveying technique in which the distance to a target is measured by directing a pulse of laser light from an aeroplane and measuring the time taken to bounce back. The output is a digital elevation model giving heights on a uniform horizontal grid. In the data we use, the spacing between points is 50cm, 1m or 2m. The accuracy varies greatly with the terrain, but with the exception of forestry and steep rock, where the error can be in metres, is typically between +/-0.15m and +/-0.5m. This is inferior to measurements obtained with professional GNSS equipment such as the Leica instruments used by Alan Dawson and G&J Surveys, but an order of magnitude better than spot heights on OS maps.

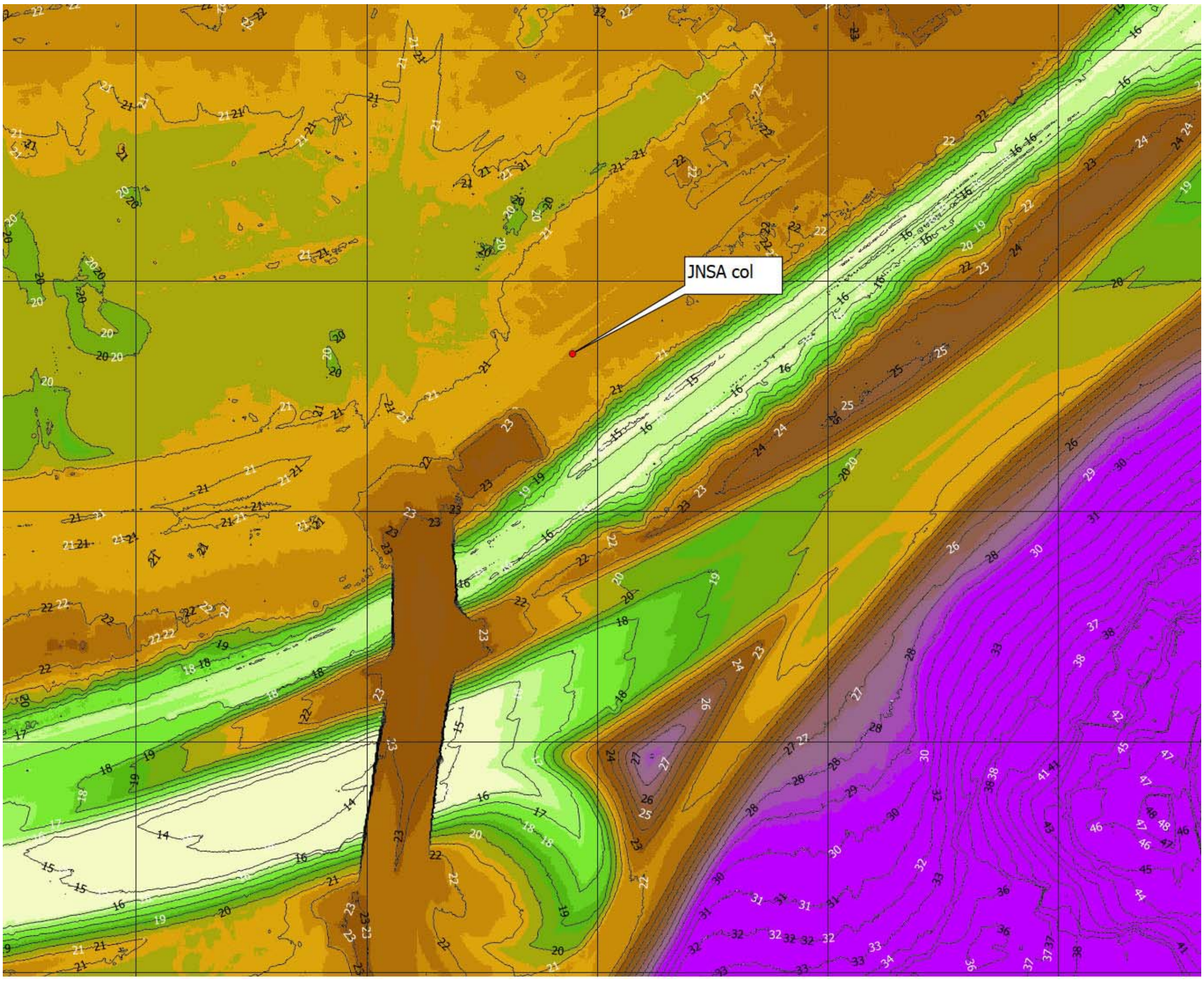
Each LIDAR dataset is supplied in two forms, a digital terrain model (DTM) and a digital surface model (DSM). The DSM is created from the signal returned to the aircraft and includes heights of objects such as buildings, vehicles, and vegetation. The DTM is a 'bare earth' model produced from the DSM by removing such objects. This sounds ideal for researchers, but there are many traps for the unwary. One problem is that the DTM may not remove what you want it to. Rock and boulders are often removed, the algorithm mistaking them for man-made objects; covered reservoirs seldom; cairns and bridges sometimes. Hence we treat the JNSA output as a starting point. We use QGIS or Excel to analyse the downloaded LIDAR tiles. QGIS is quicker, provides a variety of outputs, and is much the best for large areas, but is less good for team working. In upland regions maps may provide adequate context to locations of interest, but on lower ground satellite imagery is invaluable.

The need to interrogate the data in detail is particularly important for lower Tumps. To illustrate this I will conclude by presenting two cases analysed by Dave Marshall and me a few days before composing this article. Duntilland Hill, DoBIH no. 14120, is a popular Tump in Lanarkshire. Mark Jackson put it inside a 290m contour well to the west of Duntilland Quarry in his Tumps listing. Visitors described the summit as the west end of a grassy ridge. The first few JNSA runs gave a higher summit (291.49m) 420m to the south-east, which we disregarded as it appeared to be on quarry spoil. However Joe's latest run, in February 2022, replaced this summit by a 293.5m point inside the quarry. What was going on? Google Earth allows you to view imagery in past years. This showed that the new location was a spoil heap that was not there previously. The original JNSA run had used older data at 1m resolution, whereas the latest run took newly released 50cm data. This "summit" could safely be ignored. However our analysis revealed another summit (291.2m), 0.4m higher than Mark's, which although close to the quarry was by 2021 well vegetated and meets our criteria. So the outcome was a 350m relocation but to neither of the summits identified in the JNSA runs.

Google Earth imagery, December 2006

The new JNSA "summit" in July 2021

Bellahouston Park in Glasgow, DoBIH no. 19656, was a discovery in the original JNSA run. Unsurprisingly, it has been a popular ascent. There are currently 51 logs on the Hill Bagging website, all but three postdating the hill's addition to the Tumps in May 2020. At the time LIDAR was available only for the summit. The original col has been destroyed by a railway cutting. We estimated the drop to the new col, with some difficulty, as at least 30m. The Feb 2022 JNSA run added LIDAR for the col and reduced the drop to 28.5m. As the col location was outside the two cuttings I suspected the program of using an invalid hill-hill traverse, and so it proved. In the elevation profile below, the 50.2m high summit lies to the NW. The surface analysis program has taken the traverse to the next highest hill though a 21.6m low point north of the railway and across a road bridge spanning first the railway and then the M77. Bridges are of course disregarded in our Summits & Cols protocol. The permitted traverse proceeds SW along the railway embankment, crosses the track at its highest point (which is lower than suggested by the map), back along the other side and across the motorway. The col is in trees at the edge of the track. It has a height of about 17.7m, so the status of this attractive little hill is unthreatened.



DTM profile around the JNSA col. Heights are white < green < orange < brown < purple

DTM contours and Bing image showing the correct col

LIDAR surveys have been conducted in Ireland, but little of use to hill list compilers has been made public. Improvements to our Irish data are dependent on surveys by MountainViews. After a dormant period these resumed last year and have produced several reclassifications, though none to the Marilyns.

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