INTRODUCTION

The Plynlimon experimental/research catchments were set up in the late 1960s by the Institute of Hydrology (IH), a component body of the Natural Environment Research Council (NERC), which later become part of the Centre for Ecology & Hydrology (CEH). The main aim of this project was to elucidate the impact of land use on catchment water availability as well as the influence of upland land use both on flooding and on low flows lower down the river system.

The Plynlimon catchments, adjacent to one another, contained the headwaters of the River Severn and the River Wye in the uplands of mid-Wales. They were selected to represent the two major land uses of upland Wales, which are coniferous forestry and sheep-grazed grassland respectively, while being as similar as practically possible in all other environmental respects.

Both catchments were intensively instrumented, and detailed hydrological and climatic records are available from the late 1960s. According to Brandt *et al*[1] (2004) the initial aim of the project was to compare evaporation losses from the Wye (moorland) and the Severn (mostly conifers). This required high quality long-term measurements of climatic parameters, streamflow and soil moisture. Surveys of the spatial distribution of the main physical characteristics (such as topography and soils) and land use were also undertaken. The combined datasets include a variety of thematic maps compiled during some of those surveys.

Further information about Plynlimon Experimental Catchments projects can be on CEH Website: http://www.ceh.ac.uk/sci_programmes/Plynlimon.html and http://cehsciencenews.blogspot.co.uk/2012/08/plynlimon-catchments-open-air-lab-21.html.html

The Plynlimon Spatial datasets comprise the following layers:

- Catchment and subcatchments boundaries
- River network
- Spot heights
- Wye catchment contour lines
- Severn catchment contour lines
- Soil Parental Materials
- Vegetation map

It also comprises the following grid:

- Plynlimon hydrologically corrected elevation grid

[1] Brandt, C., Robinson, M., Finch, J.W. (2004) *Anatomy of a catchment: the relation of physical attributes of the Plynlimon catchments to variation in hydrology and water status*. Hydrol. Earth Syst. Sci., 8, 345-354

SOURCE MAPS

At the start of the project, large scale topographic maps were produced from a specially commissioned aerial photography survey, known as the Hunting survey (see appendix for further information). The topographic maps also included spot heights, the main stream channels, main forest drains and tracks and fence lines.

In late 1990s the topographic and hydrographyc data contained in those maps was digitised into a number of spatial layers that could be displayed and analysed within a GIS. Those layers included elevation (from which a hidrologically corrected digital terrain model was derived), catchment boundaries and river network.

Various field surveys took place during the initial years of the project to map various physical characteristics of the catchments such us soil, geology, vegetation and land use types. Some of these datasets are not available as they contain information owned by other organisations and some further has been lost. An exception is the Soil Hydrology Study carried out by JP Bell in 1969 which, along with IH report No 8 (a revised edition was published in 2005; full reference in page 3), produced the map of distribution of soil parental materials in the Plynlimon catchments. This map was also digitised in late 1990s

TOPOGRAPHY

As mentioned above, topographic maps of each catchment on a scale of 1:5000, with a contour interval of 2.5m, were derived from the aerial photographs through photogrammetric techniques. A topographic map of both catchments on a scale of 1:10000 and the same contour interval of 2.5m was also compiled. The full references are:

> Natural Environmental Research Council. *Plynlimon Catchment Areas – Severn Catchment*. Sheet No. 1. Scale 1:5000. Wallingford, Berkshire. Institute of Hydrology, Natural Environmental Research Council, 1968.
>
> Natural Environmental Research Council. *Plynlimon Catchment Areas – Wye Catchment*. Sheet No. 2. Scale 1:5000. Wallingford, Berkshire. Institute of Hydrology, Natural Environmental Research Council, 1968.

A 1:10000 scale topographic map of both catchments, also with contours at 2.5m, was produced from photogrammetric reduction of the 1:5000 maps:

> Natural Environmental Research Council. *Plynlimon Catchment Areas*. Sheet No. 1. Scale 1:10000. Wallingford, Berkshire. Institute of Hydrology, Natural Environmental Research Council, 1968.

Details on the aerial photography survey can be found in appendix A.

HYDROGRAPHY

The main stream channels and forest drains are also featured on the large scale topographic maps derived from the aerial photography survey carried out in 1967-68.

The boundary of the two main catchments was digitised from the topographic maps. The subcatchment boundaries must have been derived from the elevation information in the topographic maps. These boundaries appeared drawn in numerous maps and reports generated by

the project prior to the digital capture of the spatial data; however they are not outlined in the topographic maps.

SOILS

The soil hydrology of Plynlimon aka Bell's soil map shows the distribution of soil parent materials in the Severn and Wye catchments. This map was compiled during the Soil Hydrology Study conducted by JP Bell in 1968-1969. The aim of that study was to provide some preliminary understanding of the soil hydrological processes that influence runoff. The findings were issued at that time as Institute of Hydrology (IH) Report No. 8, in a limited edition intended for internal used. The full reference to this report is:

> Bell, J.P. 1969. The Soil Hydrology of the Plynlimon Catchments. Institute of Hydrology Report No. 8, Institute of Hydrology, Wallingford, UK, 50 pp.

A copy of the revised and updated version of this report, published in 2005 by the CEH, is provided alongside this document. It can also be downloaded from CEH website on:

http://www.ceh.ac.uk/products/publications/SoilhydrologyofthePlynlimoncatchments.html

DIGITISING OF HARD COPY MAPS

All shape files listed above apart from the Severn catchment contour lines were digitised at CEH. They were captured on a CALCOMP digitising table connected to a PC. In order to register the map, GCP (ground control points) were fed into the computer before capturing the elevation points and contour lines at 10 and 20 m intervals from the 1:5000 topographic maps cited above. Once captured, the information was saved and converted into Arcinfo coverage files.

The Severn catchment contour lines dataset was captured, also from the 1:5000 scale topographic map, at Edinburgh University however there is no record on the process and/or technology used. The contours, at 10 m intervals, were captured as a succession of points at irregular intervals rather than lines. The points have recently been converted into lines; the process is described on page 6 of this document.

CREATION OF HYDROLOGICALLY CORRECTED ELEVATION GRID

The following datasets were used to derive the Plynlimon hydrologically corrected DTM:

- 1: 5,000 contour maps (based on photogrammetric derived topography),
- spot heights,
- stream maps (also photogrammetric derived topography) and
- catchment boundaries.

After importing all the data into Arcinfo (by digital capture as described above) a TIN was created which was then used to derive a hydrologically corrected grid based DTM. A flow diagram describing the steps involved in its production is shown in fig. 1.

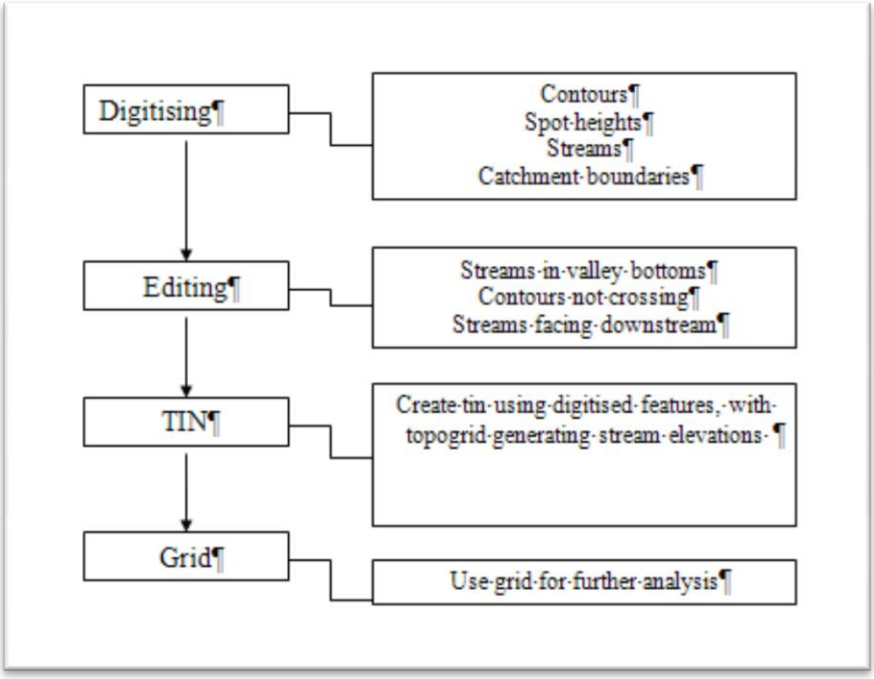


Figure 1. Flow diagram showing steps in Plynlimon DEM production

Plynlimon DEM

File name: Plyn_DEM

Format: GRID

Cell size: 15 metres

Pixel type: floating point

Coordinate system: British National Grid

Description: hidrologically-corrected digital terrain model of Plynlimon catchments.

LAYER ATTRIBUTES

DIGITISITED

Catchment and subcatchments boundaries

Shapefile name: PlynlimonCatchments.shp

Coordinate system: British National Grid

Description: Upland catchments at the headwaters of rivers Upper Hafren (Severn) and Upper Gwy (Wye). The subcatchments within those catchments are also defined; these are defined as the areas drained by each major tributary to Severn and Wye rivers.

Attributes:

- *Catchment* – Name of the river catchments
- *Subcatch* – Name of the river subcatchments

River network

Shapefile name: PlynlimonRiverNetwork.shp

Coordinate system: British National Grid

Description: Plymlimon river network.

Attributes:

- *FNODE_* - ID of the FROM node of a line segment. This attribute defines the origin of a segment which is always up stream in relation to its end, defined by TNODE_
- *TNODE_* - ID of the TO node of a line segment. This attribute defines the end of a line segment which is always downstream in relation to its origin, defined by FNODE_.
- *LENGTH* – Length of the line segment
- *Catchment* – Name of the river catchment the stream belongs to
- *Type* – Type of stream; they have been classified as natural and artificial (i.e. man made) streams.

Spot heights

Shapefile name: PlynlimonSpotHeight.shp

Coordinate system: British National Grid

Description: Spot heights from Plynlimon catchments.

Attributes:

- *HEIGHTS*: Elevation, in metres.

Wye catchment contour lines

Shapefile name: Plynlimon_WyeElevationContours.shp

Coordinate system: British National Grid

Description: Elevation contour lines at 10 and 20 meters intervals within Wye catchment

Attributes:

- *HEIGHTS*: Contour elevation, in metres

Soil Parental Materials

Shapefile name: Plynlimon_SoilParentalMaterials

Coordinate system: British National Grid

Description: Distribution of soil parent materials in the Severn and Wye catchments. For further information see Bell, J.P. 1969. The Soil Hydrology of the Plynlimon Catchments. Institute of Hydrology Report No. 8, Institute of Hydrology, Wallingford, UK, 50 pp.

Attributes:

- SOIL – Soil type code
- Descript –Soil type description

Vegetation map

An updated vegetation map of the Plynlimon catchments has been produced in early 2014 by photo interpretation of 2009 aerial photography of the area and subsequent ground truthing (2013).

Background

In order to assist in identifying soil survey vegetation boundaries for the SoilTrEC project a broad vegetation class map was required. The CEH Land Cover Map 2000 (LCM 2000) was considered as a base because it is the standard used in many of the CEH models and didn't cause IPR conflicts which would have existed with LCM2007. A soil carbon survey, top 30cm, was conducted in 2012 as part of the SoilTrEC project and this vegetation map is to be used in a geostatistical analysis of those data. The basic LCM2000 was updated because it only contained acid grass land and forest. The update allowed us to better incorporate heath, bracken, and areas of improved grassland, which will all impact soil properties.

Method

A draft vegetation map was created by interpreting a number of broad classes from a print out of the 2009 Next Perspectives Aerial Photography[2] of the Plynlimon catchments.

The classes were as follows:

- Conifer plantation
- New Plantation
- Felled Plantation
- Rough Acid Grass
- Bracken
- Open Dwarf Shrub Heath
- Improved Grassland
- Inland Bare Ground
- Deciduous Woodland
- Inland Water

Using the digital version of the aerial photographs as backdrop, the draft vegetation map was digitised on screen using ArcGIS 10.1. A map of the draft vegetation digital line work, overlaid on the aerial photographs was then produced. This map was then used in field observations to check and refine the mapping. Field observations were carried out by driving around the network of tracks in the catchments. Any differences between the draft vegetation map and field observations were noted on the map. Differences between the draft map and the field observations were due mainly to the date the photographs were taken 2009 and the date of the field observations (November / December 2013). For example areas mapped as felled plantation from the aerial photographs were

[2] NextPerspectives. Plynlimon Catchments (air photo). 1:10,000. Photos SN7982-SN7990, SN8082-SN8091, SN8182-SN8790, SN8282-SN8290, SN8382-SN8390, SN8482-SN8490, SN8582-SN8590, SN8682-SN8690. Leicester, 2009.

observed as new plantation. There were also some differences due to areas of shade in the aerial photographs making interpretation difficult.

The final digital version of the vegetation map was created by editing the digital draft vegetation map in ArcGIS 10.1 with the digital aerial photographs as a backdrop. In addition, any obvious features on the aerial photographs not previously mapped were digitised; typically these included water features and areas of inland bare ground. Polygons were then classified into one of the classes shown above. Further refinements of the classes were then made so that they matched the LCM2000 classes. The defined vegetation classes correspond with the classes defined in CEH Land Cover Map 2000[3] (LCM 2000). Rough acid grassland was reclassified as Acid grassland. Conifer plantation, new plantation and felled plantation were reclassified as coniferous woodland. To accommodate the variations of the coniferous plantation category an additional column was created in the shape file (Variants). This allows the user to have the flexibility of using these polygons either as coniferous woodland as classified by LCM 2000 or as felled or new plantation.

Shapefile name: Plynlimon_VegetationMap2013

Coordinate system: British National Grid

Description: Vegetation map of the Plynlimon catchments.

Attributes:

- id– Vegetation class code
- VegClass –Vegetation class description
- Varients – Vegetation class variant (or subclass) description

DERIVED LAYERS

Severn catchment contour lines

The Severn catchment elevation contour lines have been derived from a point feature shapefile created at Edinburgh University. The succession of points was converted into lines in ArcGIS 10 using the *Point to Line* tool. The resultant line feature shapefile needed editing to remove artefacts resulting from the transformation; then the line segments were merged into full contour lines. The resulting shapefile was clipped to the Severn catchment boundary.

Shapefile name: Plynlimon_SevernElevationContours.shp

Coordinate system: British National Grid

Description: Elevation contour lines at 10 meters intervals within Severn catchment

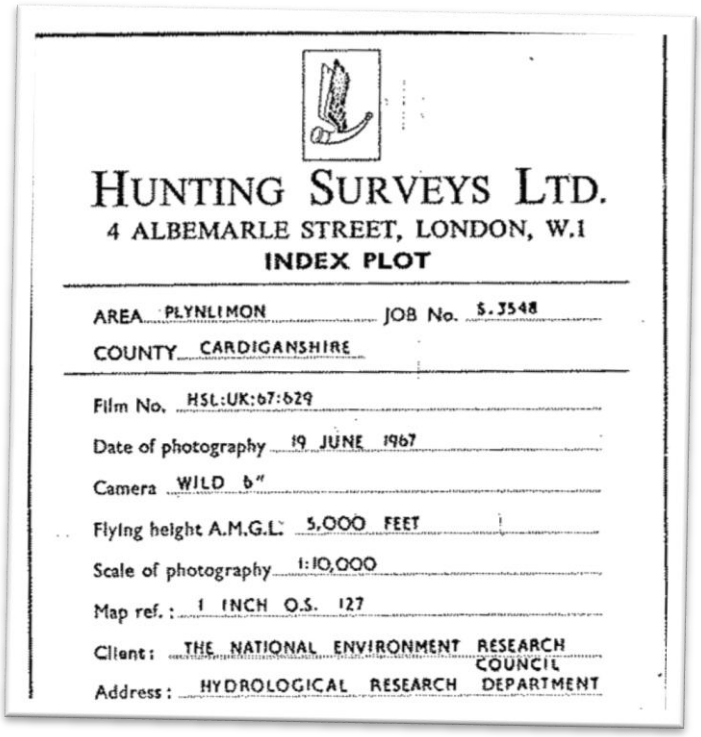
Attributes:

- *HEIGHTS*: Contour elevation, in metres

[3]For further information on LCM2000 see http://www.ceh.ac.uk/landcovermap2000.html.

APPENDIX A HUNTING SURVEY

The aerial photographic survey from which the topographic maps were derived was undertaken by HUNTING SURVEY Ltd in June 1967. This survey was commissioned by NERC. Figure A.1 shows an inset of a working document where the technical specifications of the aerial photograph survey are detailed. The film negatives are lost however copies of the printed frames have been recently digitised and rectified by CEH in an attempt to preserve this data. The footprints of each frame are shown in figure A.2.



HUNTING SURVEYS LTD.
4 ALBEMARLE STREET, LONDON, W.1
INDEX PLOT

AREA PLYNLIMON JOB No. S.3548
COUNTY CARDIGANSHIRE

Film No. HSL:UK:67:629
Date of photography 19 JUNE 1967
Camera WILD 6"
Flying height A.M.G.L. 5,000 FEET
Scale of photography 1:10,000
Map ref.: 1 INCH O.S. 127
Client: THE NATIONAL ENVIRONMENT RESEARCH COUNCIL
Address: HYDROLOGICAL RESEARCH DEPARTMENT

Figure A.1. Inset from a work document showing the technical specifications of the aerial photograph survey done in 1967 by Hunting Survery Ltd.

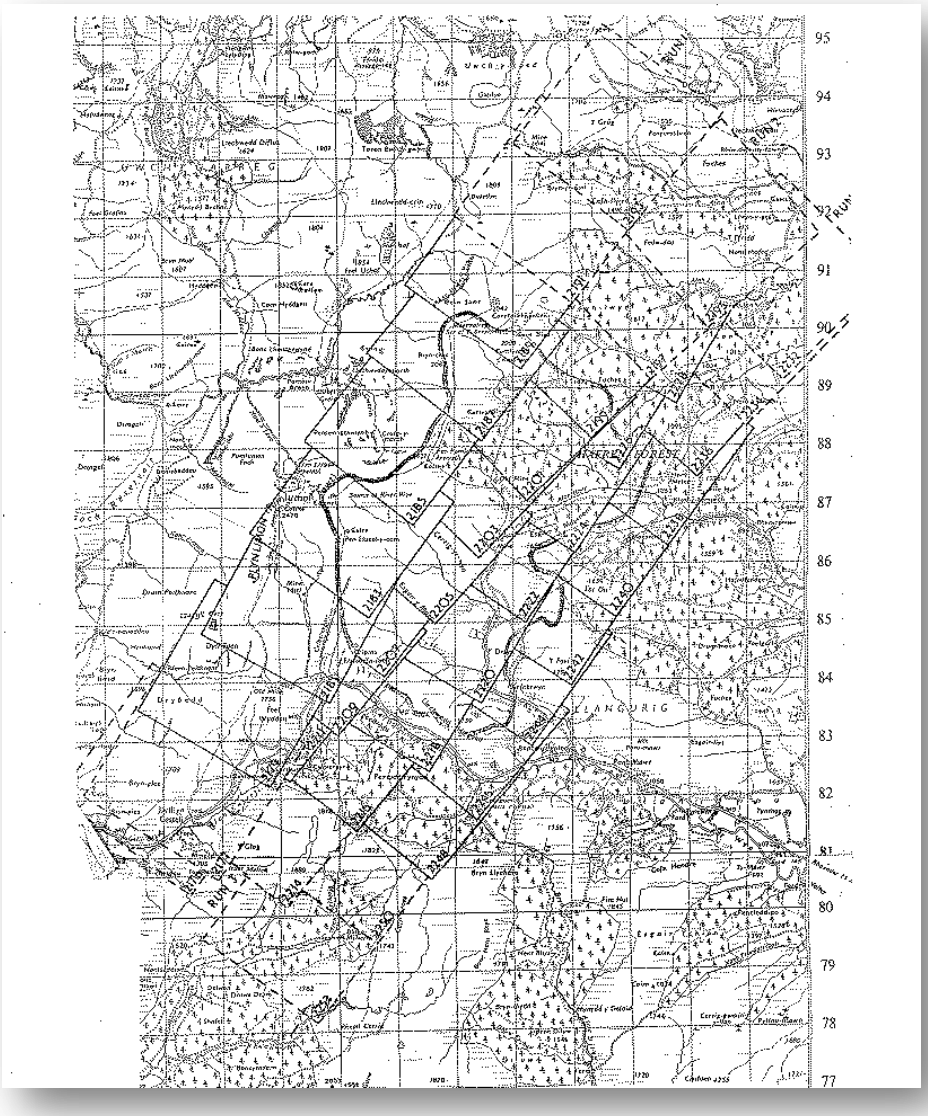


Figure A.2. Footprint of all aerial photograph frames capture on the Hunting Survey in June 1967.