ROUGH GUIDES

Specifying and handling terrain data

Introduction

This guide looks at the different types of terrain data you can buy off-the-shelf and what to look for when specifying such data. It also covers the subject of visual impact analysis (Zones of Visual Influence and Impact) as these topics are often touched upon by those who use large DTM datasets as they are often involved with planning applications and need to analyse visual impact.

Specifying, purchasing and using aerial photography

Image resolution

Aerial imagery is often available in a range of resolutions. By resolution we mean the size on the ground of one pixel (or dot) on the image. When we refer to high resolution we mean small pixel size – the best quality.

In the UK it is possible to buy imagery which ranges from 5cm to 10m. More likely, it will be supplied at 25cm resolution and you will then be expected to re-sample it down to a lower resolution to suit the computer resources you have available. Generally speaking, the higher the resolution, the greater will be the computer memory and disk space required to store it and there comes a time when a compromise has to be made to avoid running out of those resources.

The table below compares image resolution with the amount of computer memory (or disk space) required to save or view the image(s).

The amount of disk space required for various resolutions of digital aerial photography (approximate figures in Mb)

Image size (all tiles combined) in square km

Image Resolution	1	2	4	6	8	10	50	100
0.11m	236	473	945	*	*	*	*	*
0.25m	45	91	183	274	366	457	*	*
0.5m	11	22	46	66	92	110	550	*
1.0m	3	6	11	17	22	29	143	286
2.0m	0.7	1.4	2.9	4.2	5.8	7	35	70
4.0m	0.2	0.4	0.8	1.1	1.3	1.8	9	18
5.0m	0.1	0.2	0.5	0.7	0.9	1.1	5.7	11.4
10.0m	0.03	0.05	0.11	0.17	0.23	0.29	1.43	2.9

* = Too large to use practically

DTM resolution

In order to view the aerial photographs in LSS 3D view, you will need a source of DTM data. You may well be wanting to superimpose your own surveys or designs onto the view, but you may still need to acquire DTM data for the area surrounding the specific site in question and at least to cover the area under the images you are about to buy. Please note that to view the images in plan, no DTM is necessary (though you will need at least one point in the survey in order to have access to the 'Configure / DTM Display' menu from where the images are selected).

DTM data is normally of three types and available in two broad data formats. Type 1 is contour data – this is the normal format as provided by the Ordnance Survey in the UK and is provided as contour lines with points supplied at the change in direction of the lines. Because LSS models data itself, contour data is not usually the preferred data type as you can get 'flat spots' in the DTM where contour ridges appear. Type 2 is a better form to ask for and it is regular grid. It should be just as good as contour data, as long as the grid is dense enough to represent the undulations in the terrain surface. If purchasing this type of data from the Ordnance Survey you need to ask for 'DTM' data. Yes, it's confusing, but it allows you to differentiate between contour and gridded data sets. Type 3 is breakline data. This type of data not only contains spot levels (possibly in a grid), but it also defines links where

obvious breaklines appear in the terrain surface. This is the best type of data to choose, but cost and availability may restrict its use.

The first type of data format you will encounter is ascii XYZ data, where the DTM is supplied in a text file containing Eastings, Northings and Elevation. In LSS use 'Input / Convert from XYZ' to convert the data into an LSS loadfile.

The second type of data format is AutoCAD DXF and is the preferred data format for the Ordnance Survey in the UK (but is being replaced by MasterMap format). All you need to do is import the file as you would any other DXF file.

Image types

Digital aerial photographs are broadly of three types

Unrectified

These are simply scanned aerial photos supplied with no adjustment for image distortion due to the wide angle of the camera lens used or the pitch and roll of the aircraft taking the picture. These images have limited use, except for general purpose illustration. They will not match features on maps due to their distortion.

Use with caution.

Georectified

These images are digitally stretched and adjusted so that a distance measured on the image represents quite accurately the distance on the ground. Some would say that this technique is not as accurate or reliable as the next method.

Orthorectified

These images are digitally corrected to fit 3D ground control points and arguably represent the closest match to objects actually on the ground, rather than fitting existing 2D plans. The creators of this type of data claim it to be of the highest quality.

Sources of imagery

There is one main source of off the shelf digital imagery in the UK.

GetMapping.com

100% coverage of England and Wales and the central belt of Scotland. All imagery is either Orthorectified or Georectified and supplied either by email or on CD-ROM in a variety of formats, including 'ECW', 'TIFF' or 'JPEG' and in a variety of resolutions.
Decide before you ring them what resolution you will need as once you have bought it you won't be able to change. 2m resolution may be good enough for a large scale fly-through, but not as useful when it comes to plotting a tiny part of a site and you want the buildings clearly displayed. The coarser the imagery the cheaper they get.
Think about ordering high resolution for the area immediately covering the site you are working on and lower resolution for the surrounding area. Expect to pay as little as £4 or £5 for 5m resolution tiles (minimum order values may apply), but much more for 25cm resolution. DTM data is not included in these prices, but is available from them at the same time from Intermap Technologies (the NextMap Britain Dataset).

Ordnance Survey of Great Britain

As part of their MasterMap 'Image Layer' offering the Ordnance Survey supply Orthorectified aerial imagery. The source of this imagery will be that currently available from GetMapping, UK Perspectives and some from their own operations, is Orthorectified and at 0.25m resolution.
Back in 2003 the Ordnance Survey stated that by the end of 2005 all imagery for Great Britain will be no more than 3 years old. This has proved unachievable as continued bad weather during the limited flying season has prevented their suppliers from completing their photography on time. You will find that imagery of some urban areas is updated more frequently than for remote rural ones.

Sources of DTM data

GetMapping (or their agents)

They will supply you with the new **NEXTMap Britain** dataset, flown and supplied by **InterMap Technologies** from the USA. This data is supplied as either a 5m interval or 10m interval digital terrain model XYZ data file, or as a Digital Surface Model.
Claimed elevation accuracy is ±0.5m in the SE of England and ±1.0m for the remainder of England and Wales. These figures are quoted as RMSE (Root Mean Square Error) values which states that 69% of the data lies within these accuracy values. N.B. All data providers will use RMSE values, so please make sure you appreciate what this means.

Ordnance Survey of Great Britain (or their agents)

For many years the OS have supplied DTM data as either a grid of points or contour lines. Based on the 1:50,000 mapping, **Land-Form Panorama** is supplied either as 10m contours or a 50m grid of points. The stated accuracy of the contours is +-3.0m. Supplied as a 20kmx20km tile.

Of higher resolution is **Land-Form Profile** which is supplied either as 5m contours or a 10m grid of points. The stated accuracy of the contours is +-1.5m. Supplied as a 5kmx5km tile.

Land-Form Profile Plus is a new data set supplied at a 2m grid and according to the Ordnance Survey…

+/- 0.5m RMSE on a 2m grid in selected urban and flood plain areas
+/- 1.0m RMSE on a 5m grid in rural areas
+/- 2.5m RMSE on a 10m grid in mountain and moorland areas
Existing Land-Form PROFILE data infill where no higher accuracy data has been captured.

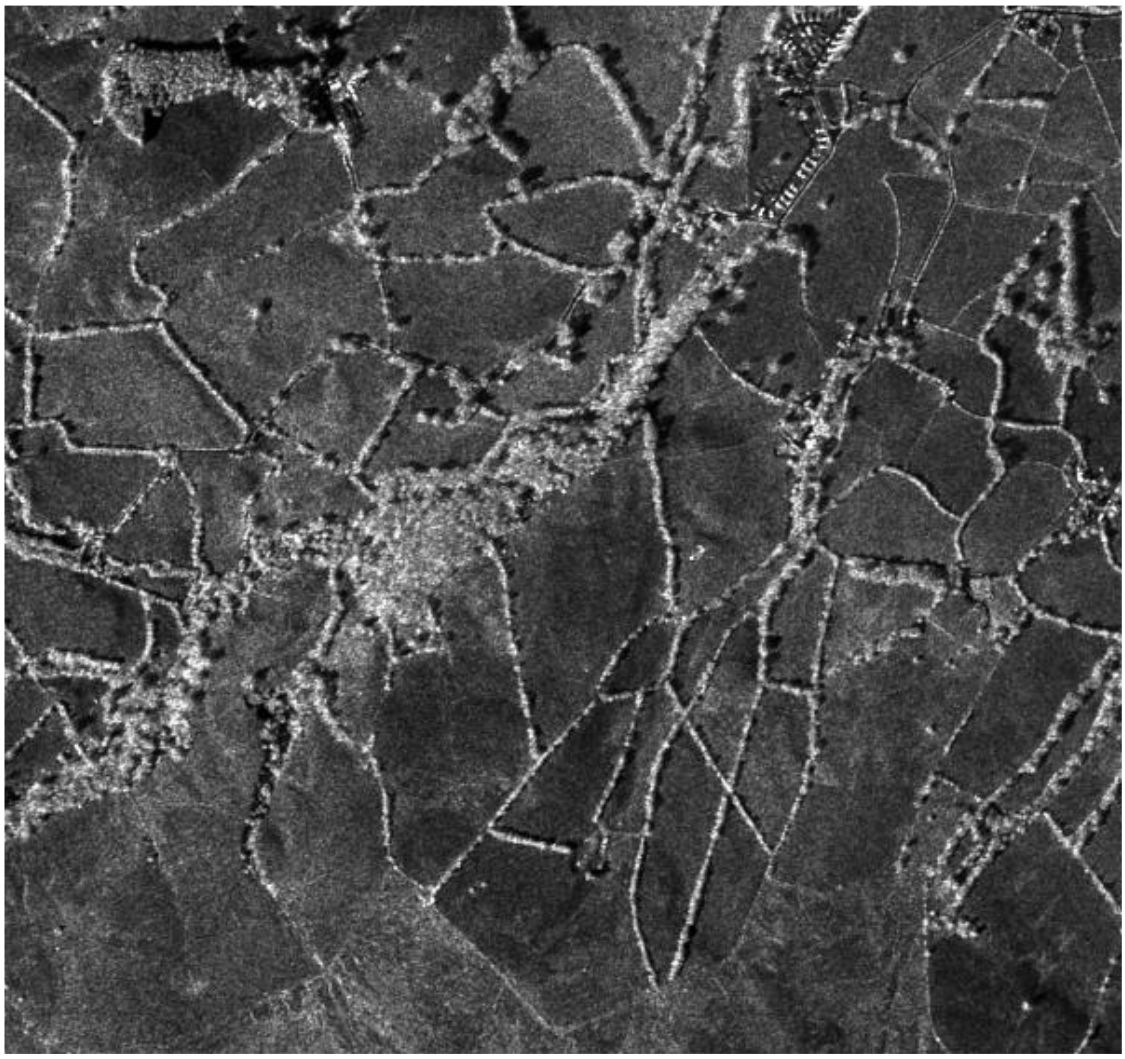
Sources of Digital Elevation Data

While DTM data represents 'bald earth' levels (i.e. to the ground beside trees and buildings), DEM data takes readings to the tops of buildings and trees, and in some cases overhead power lines. While this data is not normally what you may be looking for, it may be worth considering when performing large scale line of sight exercises and ZVI calculations in LSS, but please ask to see a sample of the data before buying some as it isn't ideal for everyone.

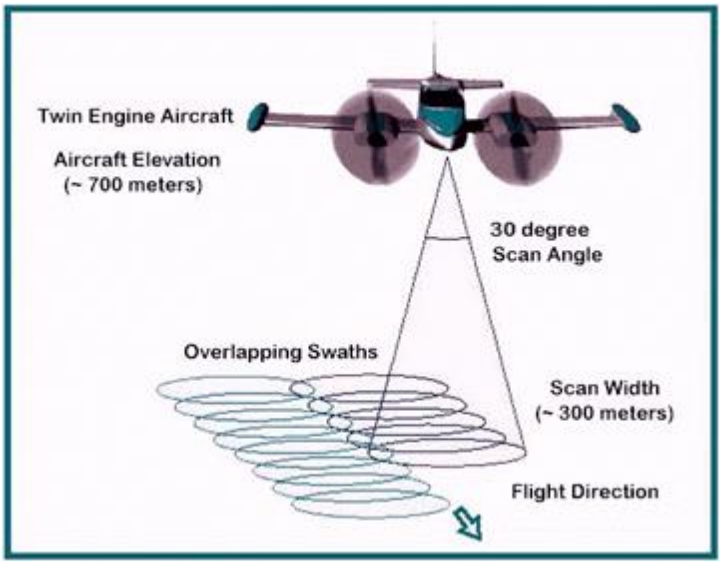
GetMapping are an agent for what is termed the 'NextMap Britain' dataset. This is a UKwide set of DEM or DTM points at a spacing of 5m and with accuracies ranging from +-0.6m to +-1.5m vertical. The company who have undertaken this data collection are 'Intermap Technologies Inc.' based in Colorado USA. Visit their website at

www.globalterrain.com. For technical details. If buying this data from GetMapping you need to specify it in ASCII XYZ file format. It is supplied in 1km tiles and multiples and at the time of writing is up to £80 per 1km tile for the DTM or DEM datasets. Expect this price to fall through time and with bulk quantities. We have seen some of the data and it appears to be good, which is somewhat surprising as the aircraft which took the readings was flying at 24,000ft. The latest news from GetMapping is that they are willing to offer 10m grid versions of this data at substantial discounts on the published prices.

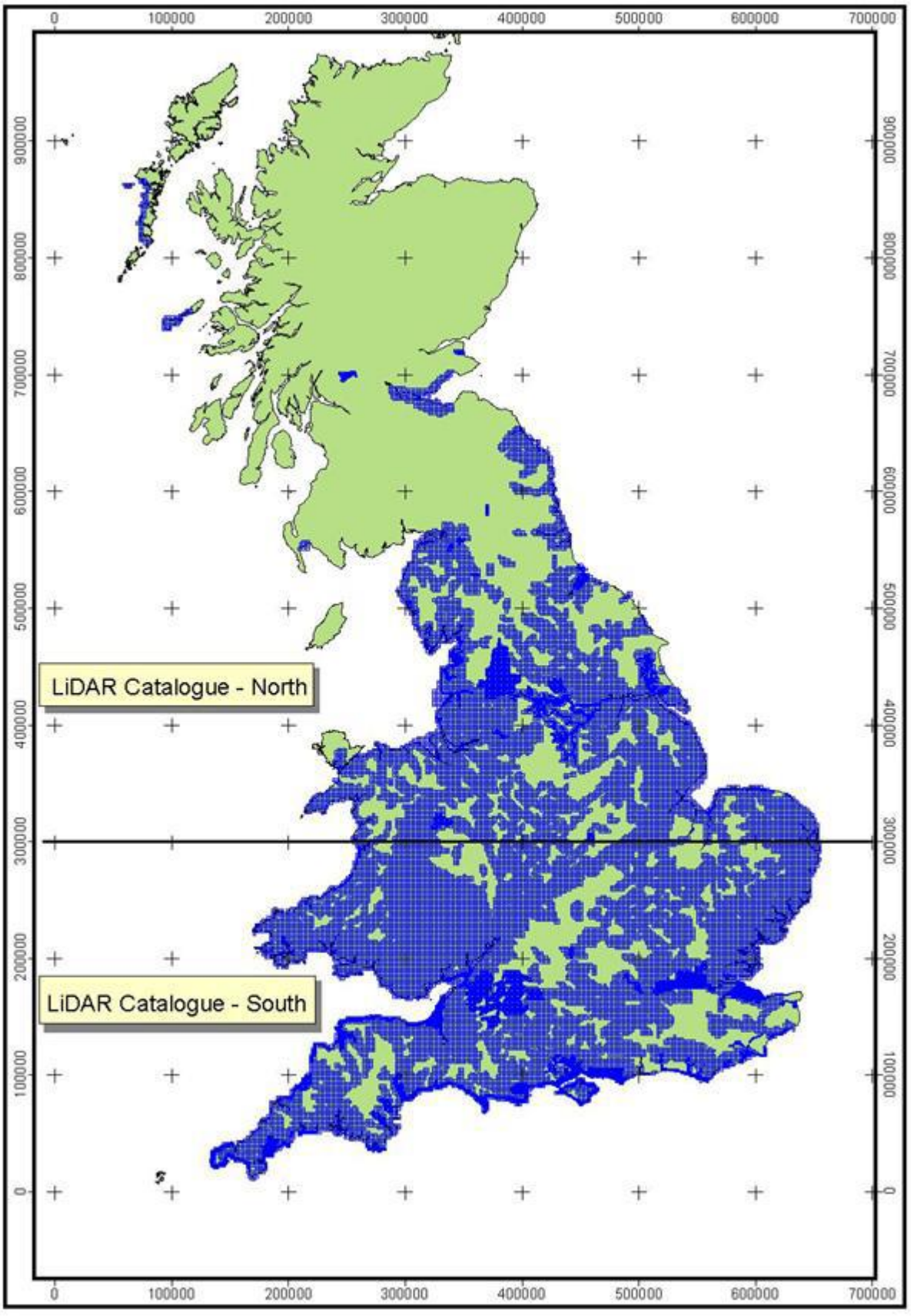
A by-product of this radar elevation data is black and white imagery. It is available at a resolution of 2.5m and the darkness of the pixel represents the reflectivity of the ground surface and not the visible spectrum. Again, we have seen some of this data and you can make out features very clearly. It could prove of interest in specialist sectors.



InfoTerra and the Environment Agency are supplying LIDAR (airborne laser range finding) data. It can be of high density and high accuracy, but the point limit in LSS could be reached quite quickly. As is often the case with remotely sensed data, because it is not capable of determining the most appropriate density of points to suit the terrain being surveyed, a lot of the data is what might be termed overkill. It often also includes a lot of erroneous points, such as high voltage electricity cables, birds in flight etc. A commercial source of this data is not readily accessible as it is often funded by government projects. However, UK Perspectives and several other companies will offer the service if required.



Contact the Environment Agency for an up to date coverage map of LIDAR data availability.
http://www.environment-agency.gov.uk



Handling large datasets

All about high resolution or large spatial datasets

As you may be aware, LSS can handle 4,080,000 points in a single survey. And at this maximum capacity the survey size may exceed 500Mb in size which makes it impractical to use in 3D fly-throughs. Even 1 million points is a large number, so anything we can do to reduce the survey size will help. Simply ordering a less dense dataset might wall be the solution. It would certainly cost less, but it is important to be aware of the hidden cost of doing this.

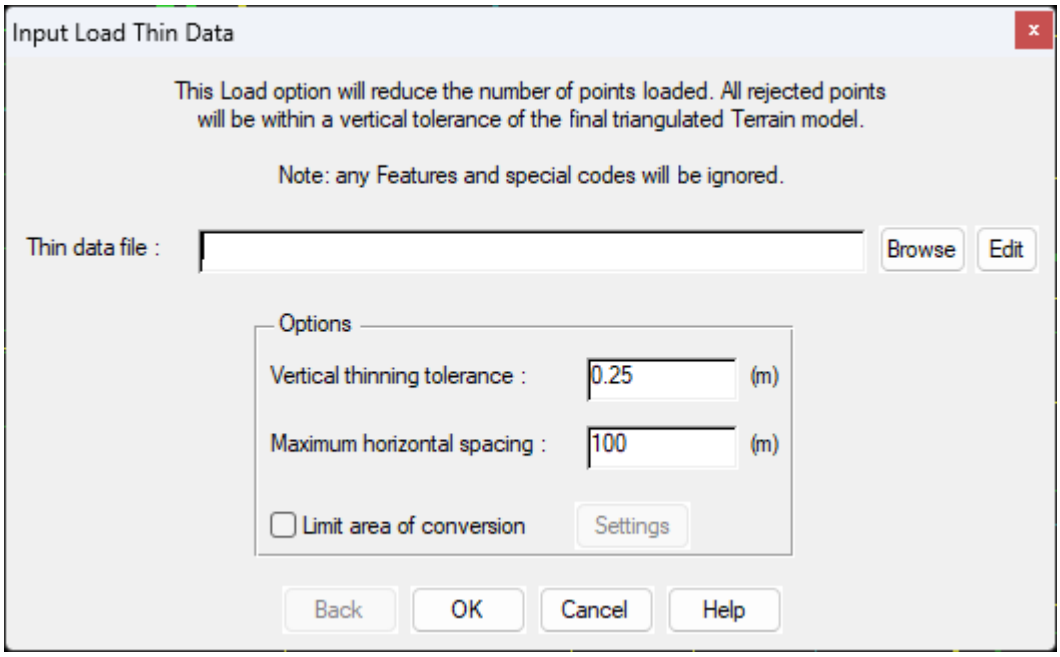
Take the NextMap Briatain 5m terrain dataset for instance. A 10kmx10km area would contain 4 million points. Ordering their 10m gridded dataset would reduce this to 1 million points, but what would be the tradeoff in terms of accuracy? With only a ¼ of the original points remaining it may be possible to 'miss' important objects in the terrain.

There is a better way and it is called 'data thinning'

Thinning point cloud and terrain datasets

Imagine a tabletop. It is a flat plane which can be defined by only 4 points. However, a remote sensing solution to surveying the table would be a dense grid of closely spaced points in order not to miss the edge of the tabletop. Too fine a grid and the table wouldn't look rectanguler. Too many and the data processing would be prohibitively time consuming. There is an alternative approach and that is to use the 'Data Thinning' command "Input / Load Thin Data".

Start with either a normal LSS loadfile, or any ASCII XYZ file.



The thinning process is an iterative exercise whereby, depending on the user-defined vertical tolerance, fewer or more points will be retained. The important thing to note is that the resultant DTM post-thin is guaranteed to be within +/- the vertical tolerance everywhere in the model when compared to a model created with all the original points in place.

Specifying datasets for thinning

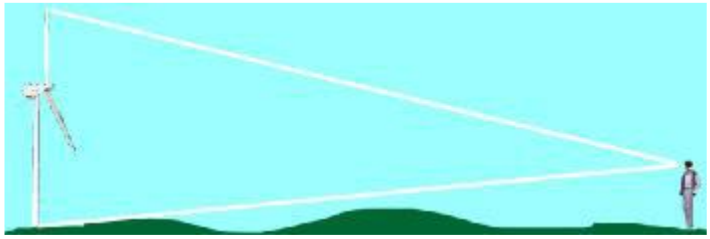
When Purchasing terrain data it will save effort if it were supplied in the correct format.
Either ASCII XYZ or ESRI ASCII Grid format would be acceptable. If the former then converting it using 'Input / Convert from XYZ' would be appropriate, or if the file contains a large number of points then rename it as surveyname.nnn and run it through the thinning without having to convert it into an LSS loadfile.

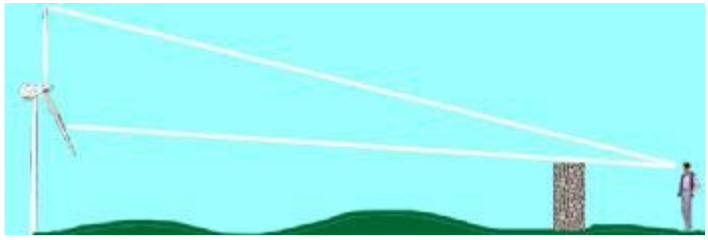
Otherwise, if it is in ESRI ASCII Grid format then use the 'Input / Convert from ESRI ASCII Grid' command to produce an LSS loadfile.

Visibility analysis in support of 3D visualisation

Introduction

LSS is of particular value in Baseline studies of Environmental Assessment (EA). It provides a number of tools of value in determining the likely impact of potential developments, but the significance of such results is very much down to the individual expertise of the Landscape Architect. LSS addresses three areas of interest in EA, namely Visual Impact, Visual Influence and Visual Intrusion.





IMPACT: The ability to visualise the proposed scheme in 3D, with or without draped aerial orthophotos, textures and heighted features is an important precursor to many EA studies. It can also be of particular use when presenting a scheme for planning approval much later in the EA cycle. A realtime 3D fly-through can communicate much more information than a traditional contour plan.

INFLUENCE: Often referred to as the 'Visual Envelope' this indicates whether the development is visible from a single or multiple locations. A simple 'Line of Sight' radiating out from the target defined as a single point, or a counter describing how many targets are visible from selected 'receptors' (eye points) outside the development.

INTRUSION: The degree to which a development intrudes upon the field of view. It is often not sufficient to count the number of targets visible from a particular location, but to take into account the effect distance may have on the degree of intrusion into the field of view of the observer. An object close to the observer may have a greater intrusion than one that is hundreds of metres away.

Examples

IMPACT: What does the proposed development look like?

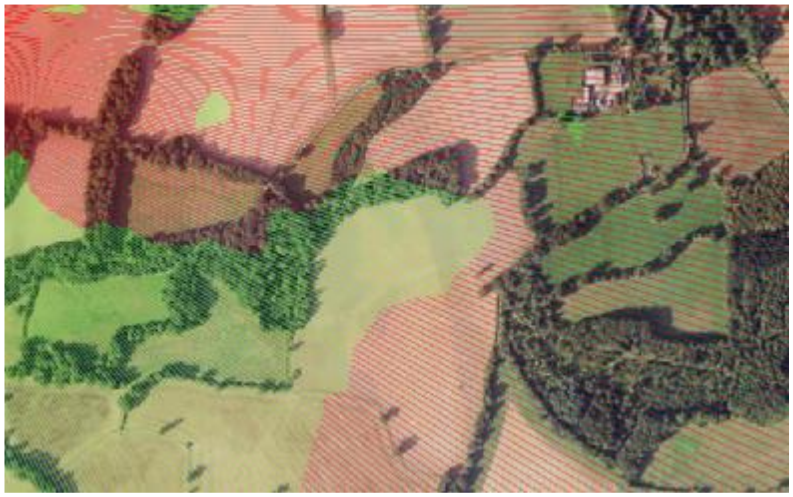
Use LSS 3D view to determine the impact of a development. Utilise heighted point and link features and where an impression of height is required, such as a coppice of trees, use surface codes with a height applied.

Drape digital orthophotos onto the terrain surface for a more realistic view of the terrain.

Raster map images may be used in the same way to assist in the orientation of the viewer.

LSS OPTION: 3D VIEW

INFLUENCE: Can a single object be seen or not?

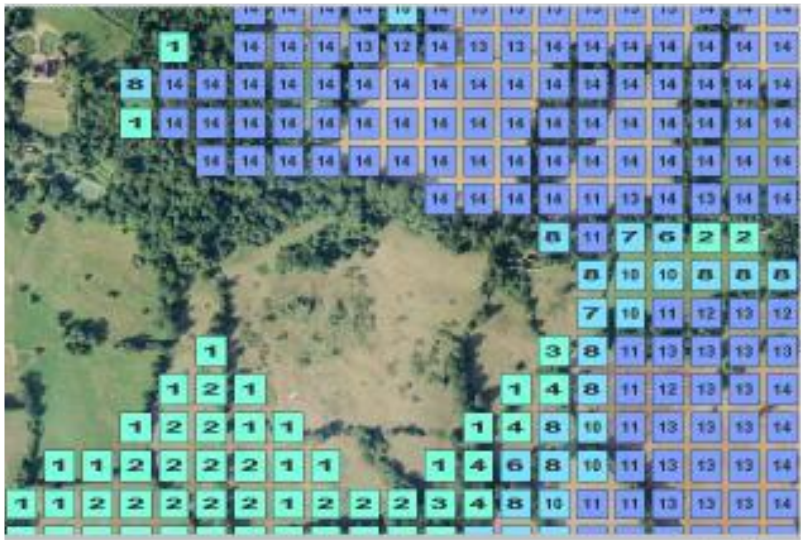


Single point line of sight looking outwards from a single pivot point. Specify the height of the pivot point and target above the DTM. Define either a full 360deg sweep or arc between two bearings at a stipulated angular interval. LSS will then draw lines radiating out from the pivot until it reaches the maximum sight distance, the edge of the DTM or a void surface code. As the line goes from visible to invisible along each sight line, LSS will create link features as defined. A correction for earth curvature and refraction is optional.

The resulting survey can be over displayed on top of the original survey and/or orthophoto/raster map for a clearer picture of which parts of the DTM are visible and which are invisible from the pivot.

LSS OPTION: OUTPUT VISIBILITY POINT FEATURE

INFLUENCE: How many targets can be seen from a grid of eye points?



Multiple point line of sight looking outwards from any number of points with a common feature code, optionally within a specified surface coded area or all such coded points anywhere in the survey.

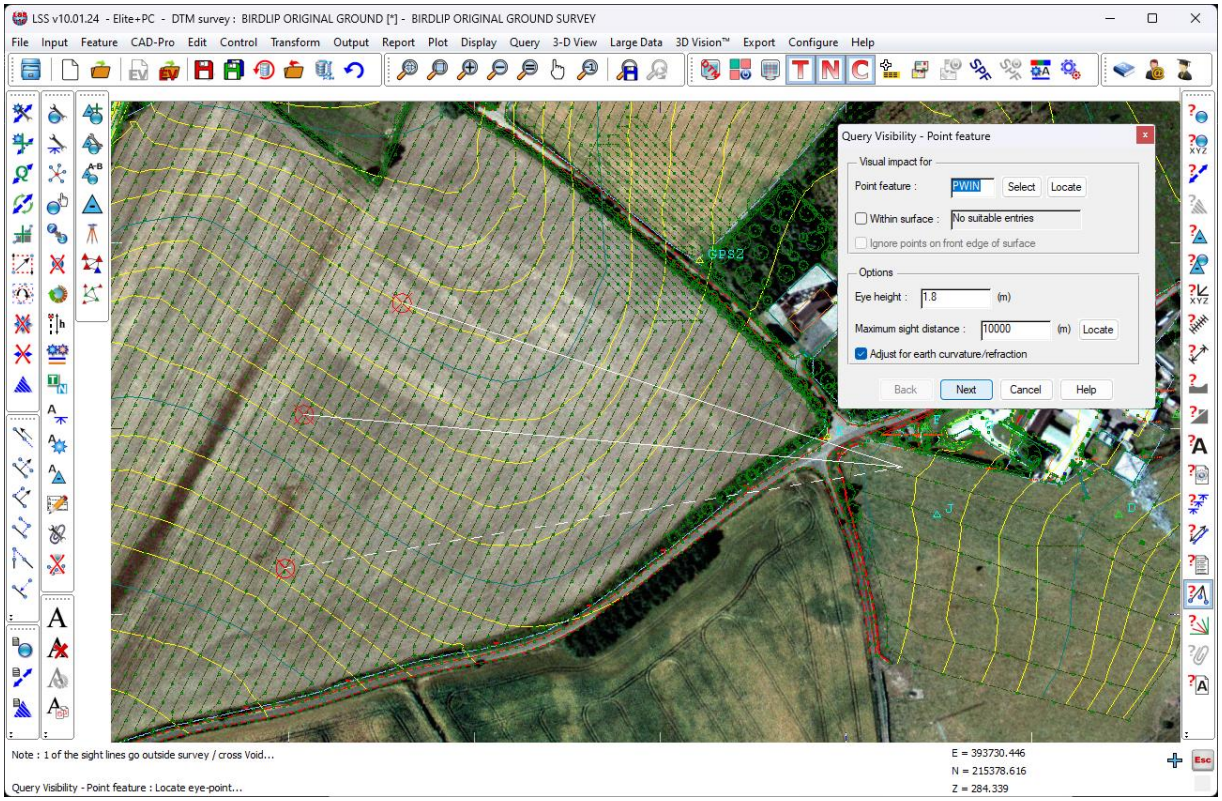
This method allows the user to define a grid of 'target' points at the required positions and height above the ground.

The user has full control over the colour banding to define the number of points visible from each grid eye location.

What is produced is a survey containing text boxes whose colour is defined by the number of points visible from the grid point beneath the box and the number contained is the exact counter value. The user may choose a transparent box to enable the display of the DTM behind the ZVI result.

LSS OPTION: QUERY LINE OF SIGHT AND OUTPUT LINE OF SIGHT

INFLUENCE: Which of the target points are visible from specific locations?



The target counter option (above) has determined that there is line of sight from some receptors to some or all of the target points, but it may be necessary to assess which targets are visible.

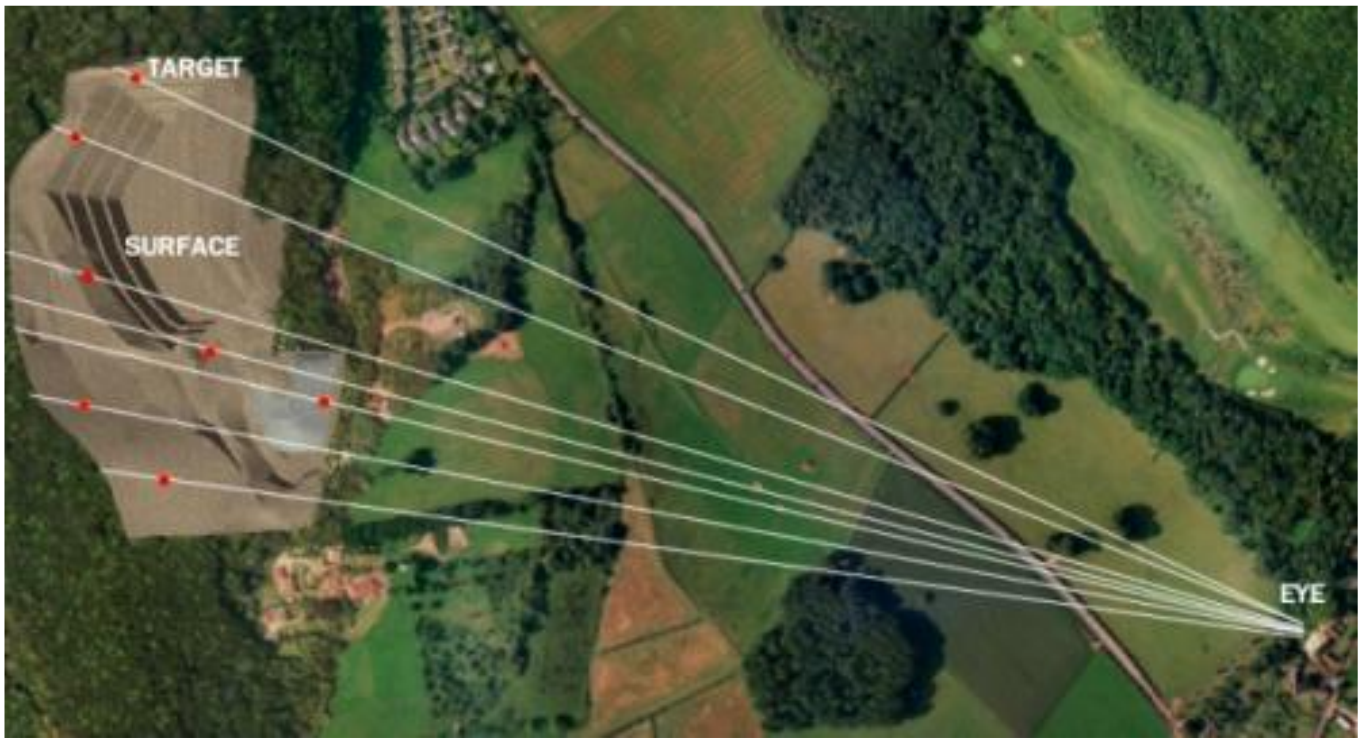
The user may select any location within the DTM and LSS will draw lines radiating out towards every visible target point. What is more, because LSS works on a triangular mesh at all times, the user is free to select any point within the DTM and LSS will interpolate the elevation from the triangular mesh.

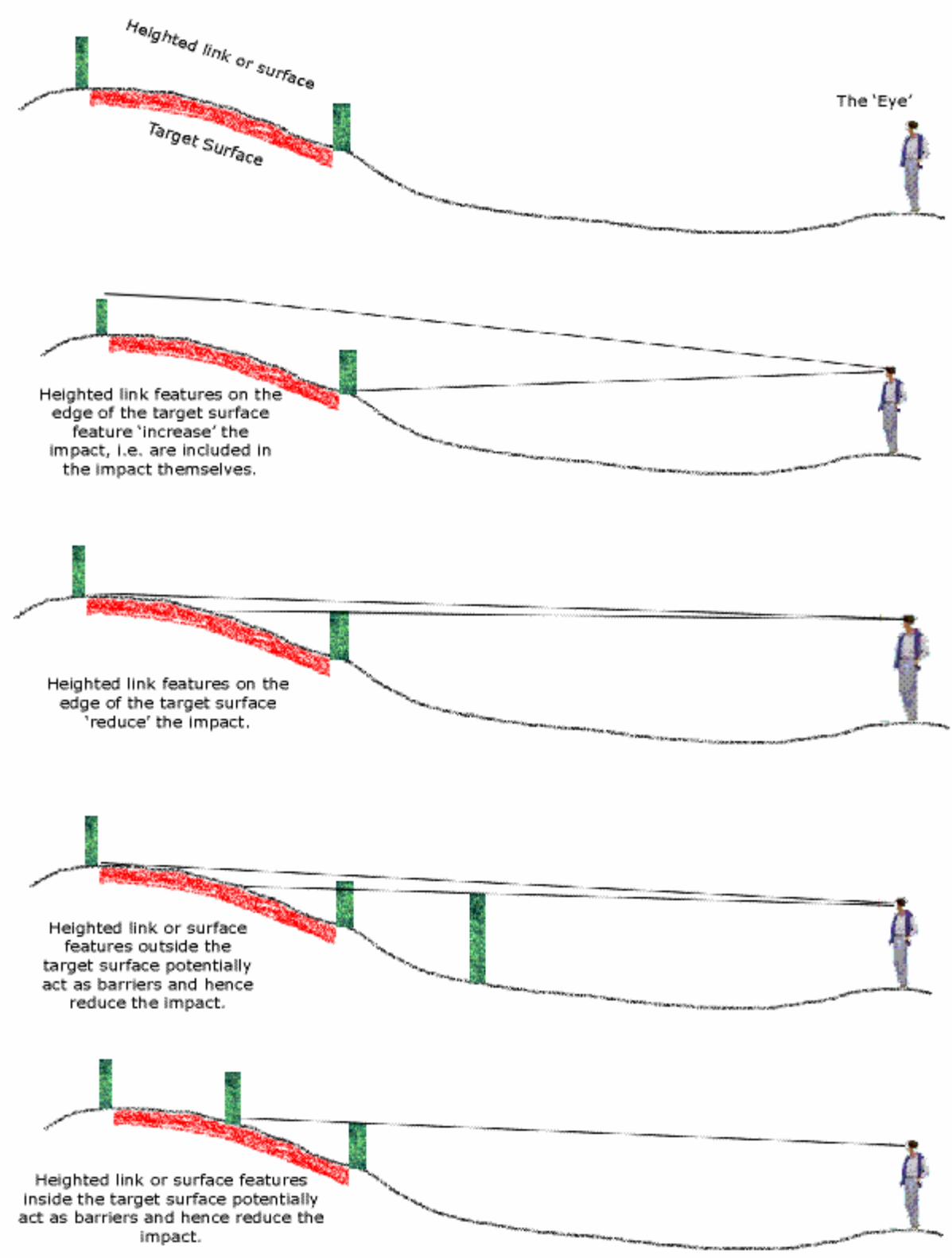
The user has control over eye and target heights above the DTM and the calculation will take into account any heighted linear or surface obstructions in the way.

LSS OPTION: QUERY VISIBILITY POINT FEATURE

INTRUSION: How much of an observer's vertical field of view is taken up by a development?

Here we define a grid of eye points as above, but we are interested in the degree to which the target(s) fill the viewers field of view as defined by points within specified surface coded areas.





Imagine lines drawn from each eye point, through the DTM to each of the chosen target points. These targets simply define the line to follow from the eye. In fact the sight line itself will continue through each target until it reaches the edge of the surface coded area within which it resides. What will then be calculated at the eye point will be the vertical angle between the lowest and highest point along each sight line (if the target surface is visible along this line). What is actually stored at the eye point is the highest of these values, together with the observation number of the point with the greatest influence.

'Contours' on the resulting LSS model are in fact Isopleths and should prove valuable in the quantification of intrusion across large and small areas alike.

LSS OPTION: OUTPUT VISIBILITY SURFACES

INFLUENCE: Can any of a selection of link and surface features be seen from a grid of eye positions?

A proposed development is defined by both heighted link features to represent fences and walls and surface features representing buildings. What the planner need to know is, from a grid of receptors, are any of the user-defined link and/or surface features visible from here? LSS draws a radial line of sight from each of the grid locations and continues until it meets a target feature. If a target is encountered the point feature code 'PVIS' is applied and a level of +1 is given. If, following the line of sight none of the targets have been encountered a code of 'PINV' is applied and a level of –1 is given. This method is appropriate for large or complex developments and less appropriate for small or simple developments where single points may be missed in the line of sight sweep.

If you need further Technical Support, or you wish to attend any training courses please contact us…

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