

Visibility Maps for Remote Sensing

CATAPULT
Satellite Applications



University of Brighton

William Jay willjay8@hotmail.com
Faculty of Science Technology, Engineering and Mathematics,
The Open University

Abstract

An automated geoprocessing tool for ArcGIS has been developed to calculate **the three dimensional area visible from a ground based imaging radar**. The visible area is then transformed to polar **radar coordinates** which allow for the analysis of **angles of incidence**. Additionally, areas of interest such as calibration points and land use can be optionally transformed. The only data required to be input into the tool is a Digital Surface Model (DSM), coordinates of the instrument location along with the geometric parameters of the radar system. These parameters can be programmed to suit different instruments on ground based, airborne or spaceborne platforms.

The Radar Visibility Model

The model has been constructed using the 'ModelBuilder' feature in ArcMap 10.1 and can be executed on any system with an ArcGIS licence. There are three main features to the model:

- 1) Visible surfaces and their angles of incidence to the radar are calculated, **accounting for vertical and horizontal beam widths and the height of the radar above the ground**. The visible area from a radar positioned at the edge of a quarry is shown on Figure 1 & 2. The input parameters and DSM are processed to create classifications of suitable area according to following criteria:

Suitable area must be...

- **In the line of site (viewshed) to the radar.**
- **Within the horizontal and vertical beam width of the radar.**

Figure 2 shows the area suitable according to each criteria and the resulting radar visibility area.

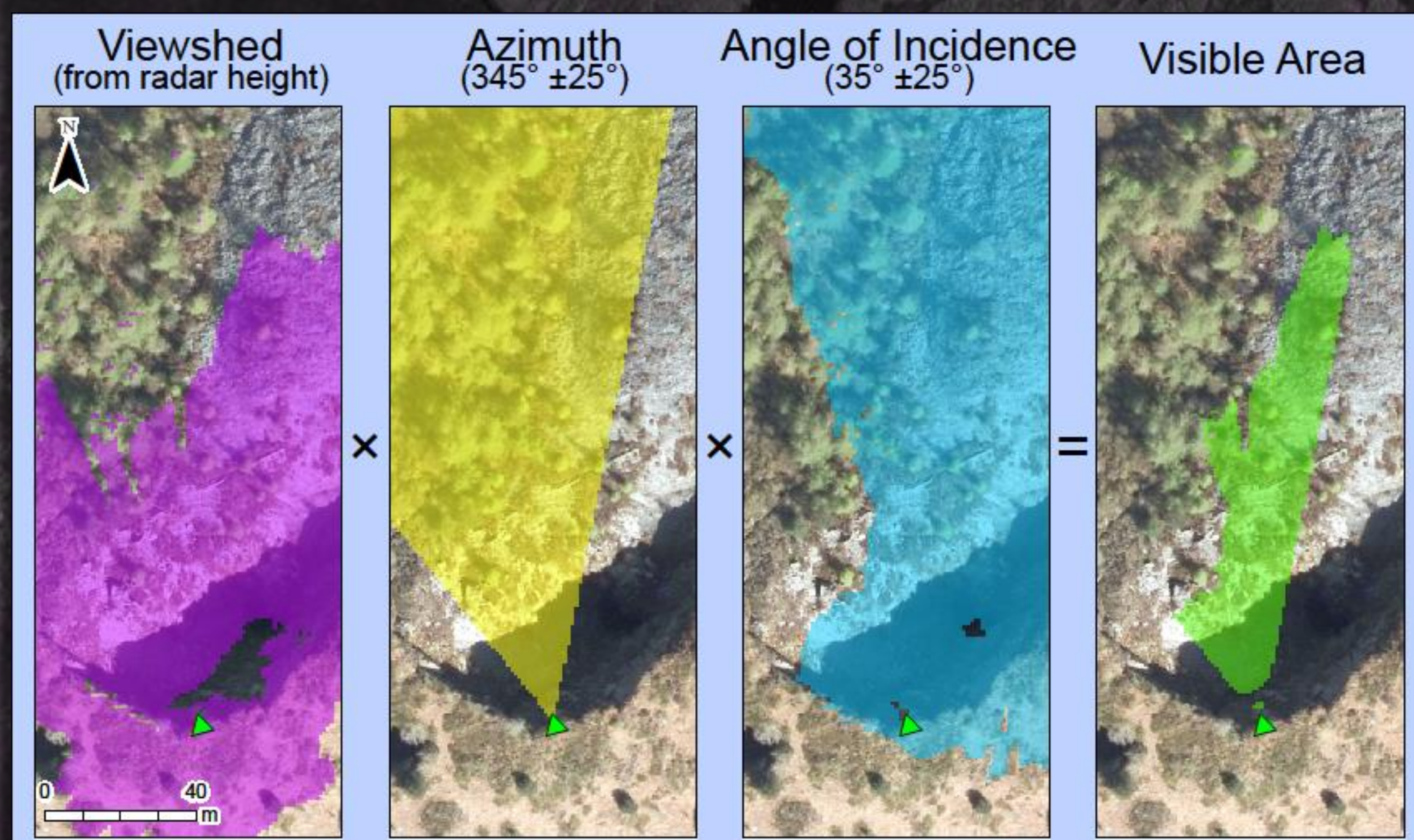


Figure 2. Suitability maps for the three visibility criteria. These three output rasters are subsequently multiplied together to produce the visible area – the area suitable in all criteria.

- 2) The incidence angles of the visible area are **transformed from Cartesian coordinates to radar coordinates**. Figure 1 shows how the incidence angles are displayed according to each pixel's azimuth angle (x axis) and their distance from the radar (y axis).
- 3) **Areas of interest such as calibration points or land use data processed and transformed to radar coordinates if desired.**

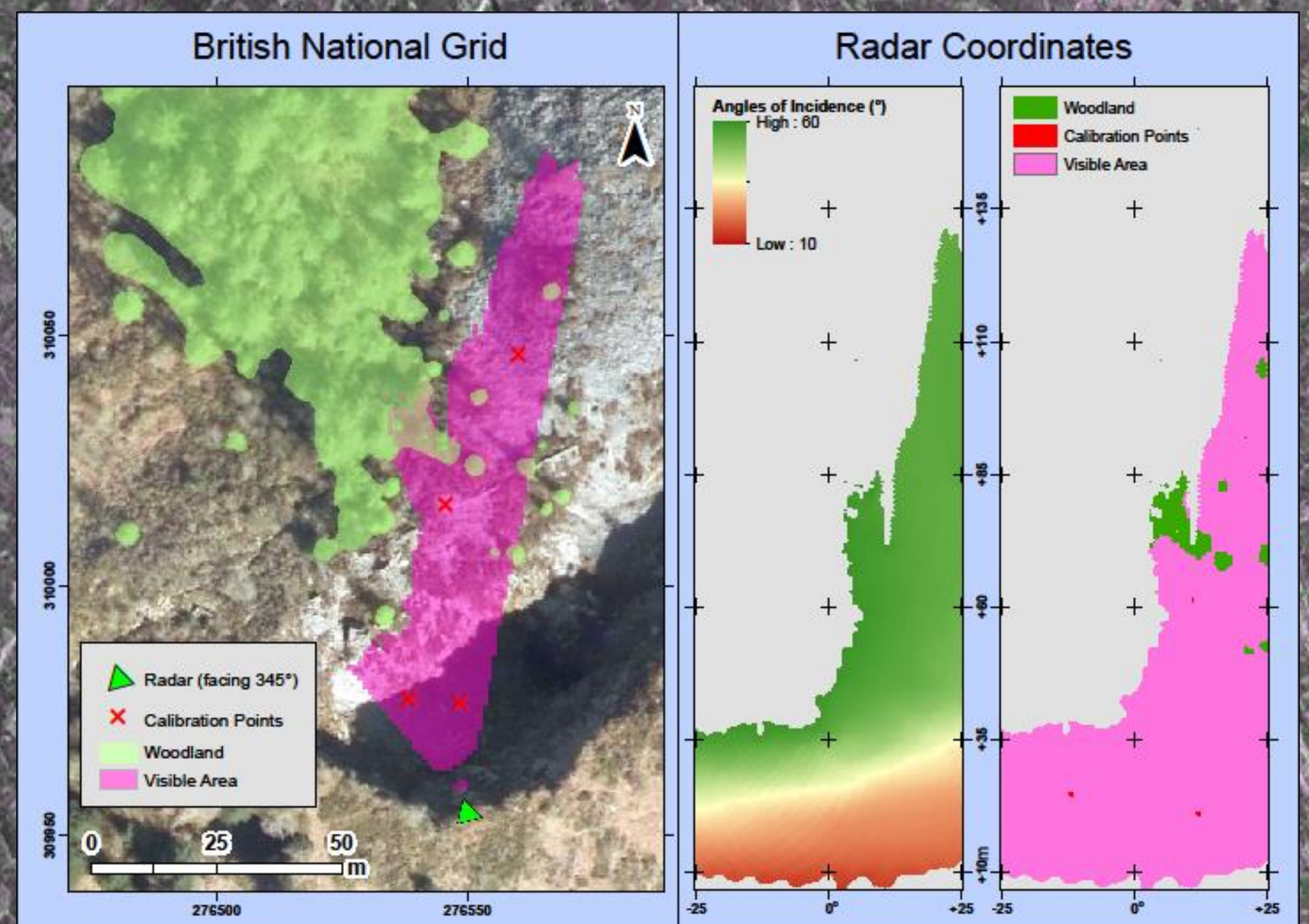


Figure 1. The outputs of the visibility model conducted with a fictitious radar in Aberllefenni, Wales. The visible area is shown on the British National Grid along with the visible area's incidence angles and land use visualised using radar coordinates.

Rationale

A ground based radar with C- or P- band capabilities has been developed by Dr. Armando Marino of the Open University with the aim to monitor biomass in forests.

In order to accurately monitor surfaces with radar, it is vital that the angles of which each pixel is observed from are known. However the need for such measurements is not limited to this specific application of radar monitoring and has value for a variety of innovative applications in the remote sensing and surveying research and industry.

Additional Applications

- **Environmental Monitoring:** Locate suitable areas for remote sensing surveys.
- **Aerospace:** Calculate a airborne or spaceborne sensor's cover.
- **Town Planning; Construction; Conservation:** Analyse the visible impact of potential obstructions.
- **Security; Crime:** Model CCTV coverage to identify blind spots or higher risk areas.
- **Military:** Identify areas vulnerable to sniper attacks.