

## GIS Viewshed Analysis to Identify Zones of Potential Visual Impact on Protected Landscapes

### Background

Natural England is consulted by local planning authorities on increasing numbers of development proposals, such as wind energy schemes, which have the potential to impact on the purposes of designation and special qualities of Protected Landscapes. These include proposed developments both within the statutory boundaries of protected landscapes and outside of those boundaries but within the setting of a National Park or AONB.

Natural England needs to be able to make rapid and reliable judgements on the likely significance of any visual impact of these development proposals so that we can provide local planning authorities with clear and timely advice, and decide where we need to engage or investigate further and where we do not. Currently, consultations received by Natural England are screened using spatial data within our internal interactive mapping website known as WebMap, where simple criteria, based on the scale of development and distance from the protected landscape, are applied to assess potential risk. This project seeks to create datasets that allows terrain based screening assessment to be made, using zones of visual influence.

The analysis was run for all National Parks, AONBs, Heritage Coasts and National Trails.

### Methodology

#### Overview

The methodology is based on standard GIS tools for calculating viewsheds based on a digital terrain model and a set of observer points. The model analysis takes the observer and analyses which cells can be seen by the observer and which cannot, typically because a landscape feature is in the way (e.g. a hill). This binary layer of areas visible/not visible from the observer location forms the initial output of the modelling but because this analysis has been undertaken within ArcGIS 3D Analyst version 10.1 this also includes an option to generate an *Above Ground Level (AGL)* raster. This additional output allows planners to go further than simply evaluating whether or not a proposed new structure would be visible at a location, it also allows one to identify how high a structure at a location in the currently *non visible* zone would need to be before it became visible to the observer. Hereafter the AGL layer is referred to as the *Height at which Objects become Visible (HOBV)* as we felt it is a more understandable term.

It should be noted that the use of a Digital Terrain Model (DTM) instead of a Digital Surface Model (DSM) makes this a conservative model because the DSM would also include surface features (Trees and Buildings) which could obscure visibility. At the time of analysis, a DSM was not available. However, the methodology could equally be applied to a DSM.

In order to analyse visibility over larger areas such as national parks, one needs to have multiple observers as inputs to the model. However, because viewshed analysis is computer processor intensive, one also needs to minimise the number of observers while also preserving the area over

which viewsheds are calculated. This is a fairly typical optimisation issue but in landscape terms, the locations of the observer points chosen influences the viewshed generated. Typically high points (ridges and peaks) are better vantage points and so a method to select candidate points was required and is discussed in the next section.

## Identification of Observer Locations

Observer locations were selected based on techniques used by Kim et al, 2004<sup>1</sup> who identified classes of terrain features using Landserf<sup>2</sup>. Landserf is a GIS program for the visualisation and analysis of digital elevation models. Landserf was used to classify the digital elevation model into six categories: pits, channels, passes, ridges, peaks, and planar surfaces. This is based on an evaluation of a terrain model pixel in relation to its immediate surroundings (window size). As recommended by Kim et al., slope and curvature parameters were left as their default values, but the window size was increased from 3\*3 cells to 9\*9 cells.

Due the high resolution and large extent of the DEM, the DEM was resampled DEM to a coarser resolution (50m) and clipped the DEM by the designated area boundaries in order for it to process successfully within Landserf. Landserf was then also used to produce a vector feature network, with points representing peaks, ridges, passes, pits and channels, and lines representing ridges and channels.

A subset of the point features identified by Landserf were used as observer points. This subset consisted of all identified peaks, as well as a sample of ridges and passes. Ridges and passes were sampled by overlaying a 5km\*5km "fishnet" grid over each boundary polygon, and selecting up to 5 ridges and up to 5 peaks at random from each grid cell. Sampling the ridges and passes in this way reduced the number of observer points for subsequent viewshed calculations, whilst maintaining the spread of points across the area. The linear features (National Trails and Heritage coasts were calculated in the same way but based on a 25m buffer (to match the 9 \* 9 cell Landserf window size) of the GIS feature depicting the coast or trail.

While the observer points were identified on the downgraded DTM, the analysis was run on the full resolution (5m) DTM. The number of input points generated were based on processing practicalities with each run taking c. 6 hours to generate the viewshed and a further c. 6 hours to combine the data (based on the South Downs National Park). ArcGIS Python processing was used to create individual viewsheds and then to combine them into a single layer. This generated 60GB of by products and the final layer was 37MB as a TIFF image (compressed).

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<sup>1</sup> Exploring multiple viewshed analysis using terrain features and optimisation techniques - Kim, Y and Rana, S and Wise, S (2004) Exploring multiple viewshed analysis using terrain features and optimisation techniques. *Computers and Geosciences*, 30 (9-10) 1019 - 1032.

<sup>2</sup> Landserf - <http://www.soi.city.ac.uk/~jwo/landserf/>

## Sensitivity Analysis

While there was little scope within this project for detailed sensitivity analysis of the model outputs to its inputs, the effects of varying the number of observer points on the resultant viewshed was explored and the results indicated that the methodology produced a good while also efficient result. See Table 1 below:

**Table 1 - Sensitivity analysis for the modelling**

Model Run	No. Observer Points	Visible Area (sq km)	Change in visible area
Standard run	2,263	6,164	
plus 10%	2,489	6,189	+ 0.4%
plus 25%	2,829	6,242	+ 1.2%
minus 10%	2,037	6,155	-0.1%
minus 25%	1,697	6,067	-1.5%

## Computation of viewsheds and above ground level rasters

For each observer points, the Viewshed tool in ArcGIS 3D Analyst was used to compute a viewshed and the *Height at which Objects become Visible (HOBV)* layer. The viewshed raster layer identifies which cells in the DEM are visible from the observer point, with a value of 1 indicating the cell is visible and 0 indicating it is not visible. *Height at which Objects become Visible (HOBV)* layer gives the height that would have to be added to a nonvisible cell for it to become visible. When running this analysis, observer points were given an offset of 2m above the DEM height (to simulate a 2m tall observer), and a maximum radius of 20km was used - a threshold provided through consultation with Natural England. No correction was made for the curvature of the earth.

The viewshed tool was run separately for each individual observer point. A python script was used to spawn a separate process for each instance of the tool, making use of Python's multiprocessing module to distribute processes between all the CPU cores of the PC. Individual PCs were allocated to the processing, one for each designated area (National Parks, AONBs, Heritage Coasts and National Trails).

## Moosaicking the *Height at which Objects become Visible (HOBV) layers*

For each type of designated area, the individual HOBV rasters output by the Viewshed tool were combined into a single raster within ArcGIS. Where there was an overlap between two or more individual HOBV rasters, the *minimum* value of the overlapping cells was used.

## Clipping HOBV layers to each area

Finally, the mosaicked HOBV rasters were clipped to produce a layer for each designated area. The clipping polygons were generated by buffering all observer points within a designated area by the viewshed radius (20km). Results are provided as a single national layer for the different designated area types but also by individual areas (e.g. South Downs National Park).

The output of the viewshed and the spread of observer points is shown in the image below Figure 1.



Figure 1 Viewshed based on 2,263 points on the 5m DTM (Red is not Visible).

The other major output is a layer showing the Heights at which Objects Become Visible (HOBV) for the non-visible area (ie the height a new structure would need to be before it became visible to the protected area). This is a contour surface showing the variation in the height required.

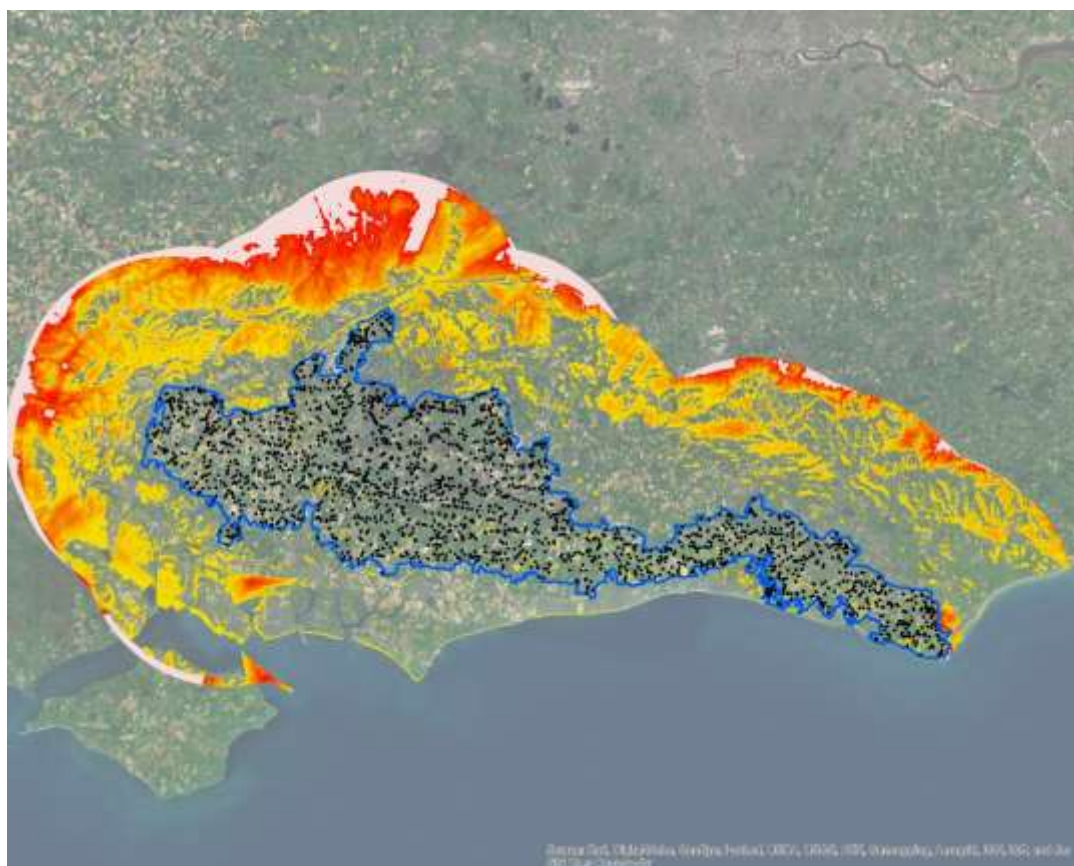


Figure 2 a Height Objects would Become Visible (HOBV) - NB: Results shown in 10m height bands but the user can choose a different classification which should also incorporate a maximum likely feature height.

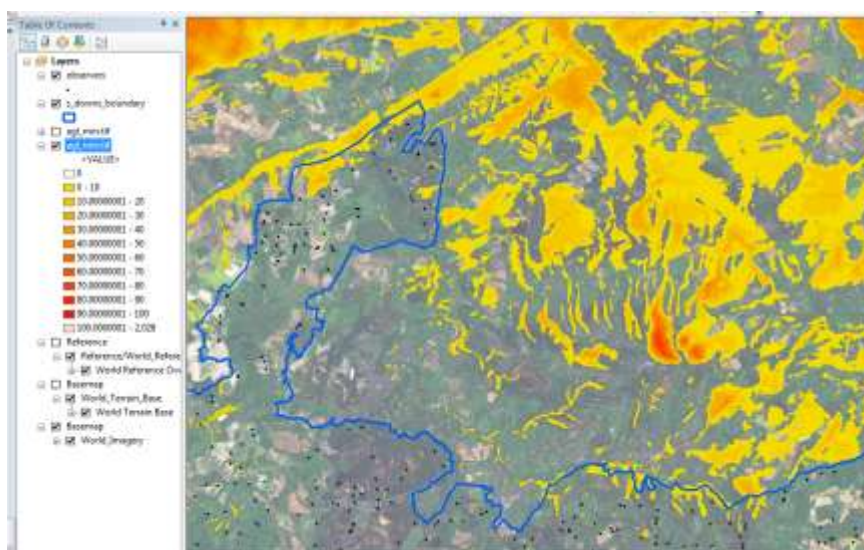
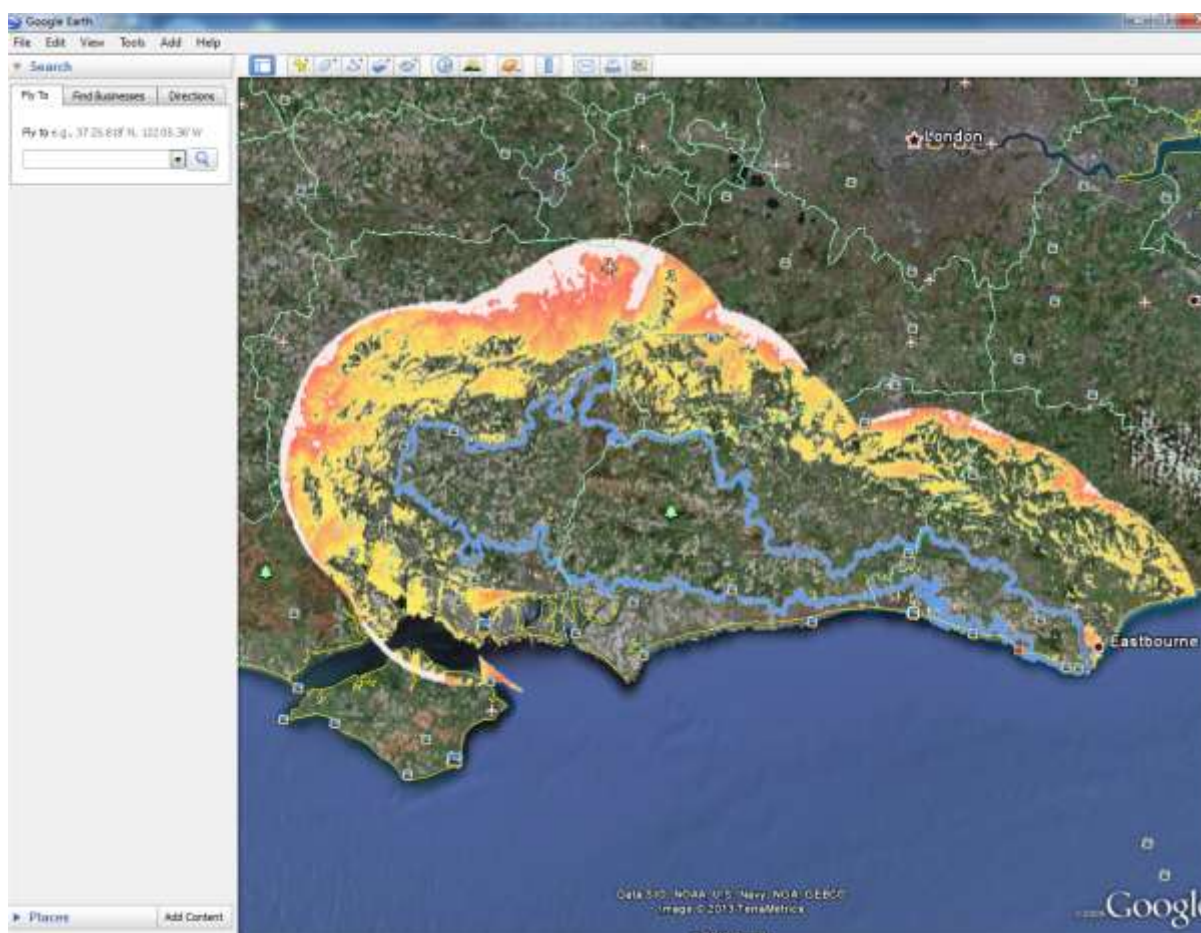


Figure 2 b - image detail showing possible places for new structures and the heights they would become visible.

Users would overlay this layer with the location of any new planning application and check whether it fell within the visible area. In addition, they can also check that if it falls within the non-visible area, what the height of the proposed structure is and how this relates to the Height at which Objects would Become Visible. If the height of the structure is greater than the values for the equivalent footprint in the HOBV layer, then the proposed structure would be visible from the protected area - based on the assumptions of the model.

## Consultation with Protected Area Managers

The next phase of the project will seek feedback on the outputs and potential modifications. The suggestion is that this be based on some form of markup of the areas (e.g. within GoogleEarth as illustrated below).



**Figure 3 - Viewshed in GoogleEarth**

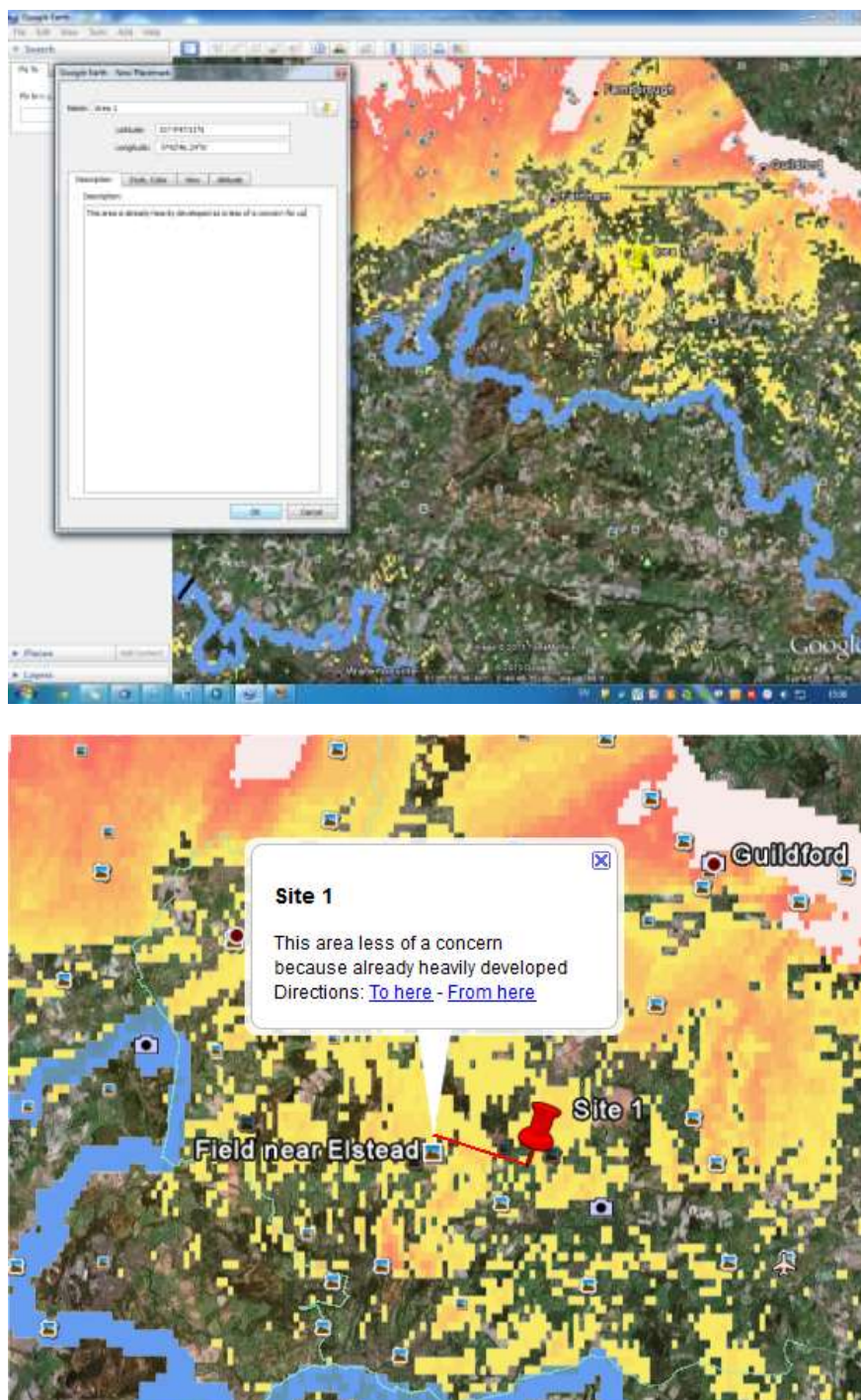


Figure 4 - Viewshed in GoogleEarth and Mark up of comments for specific locations

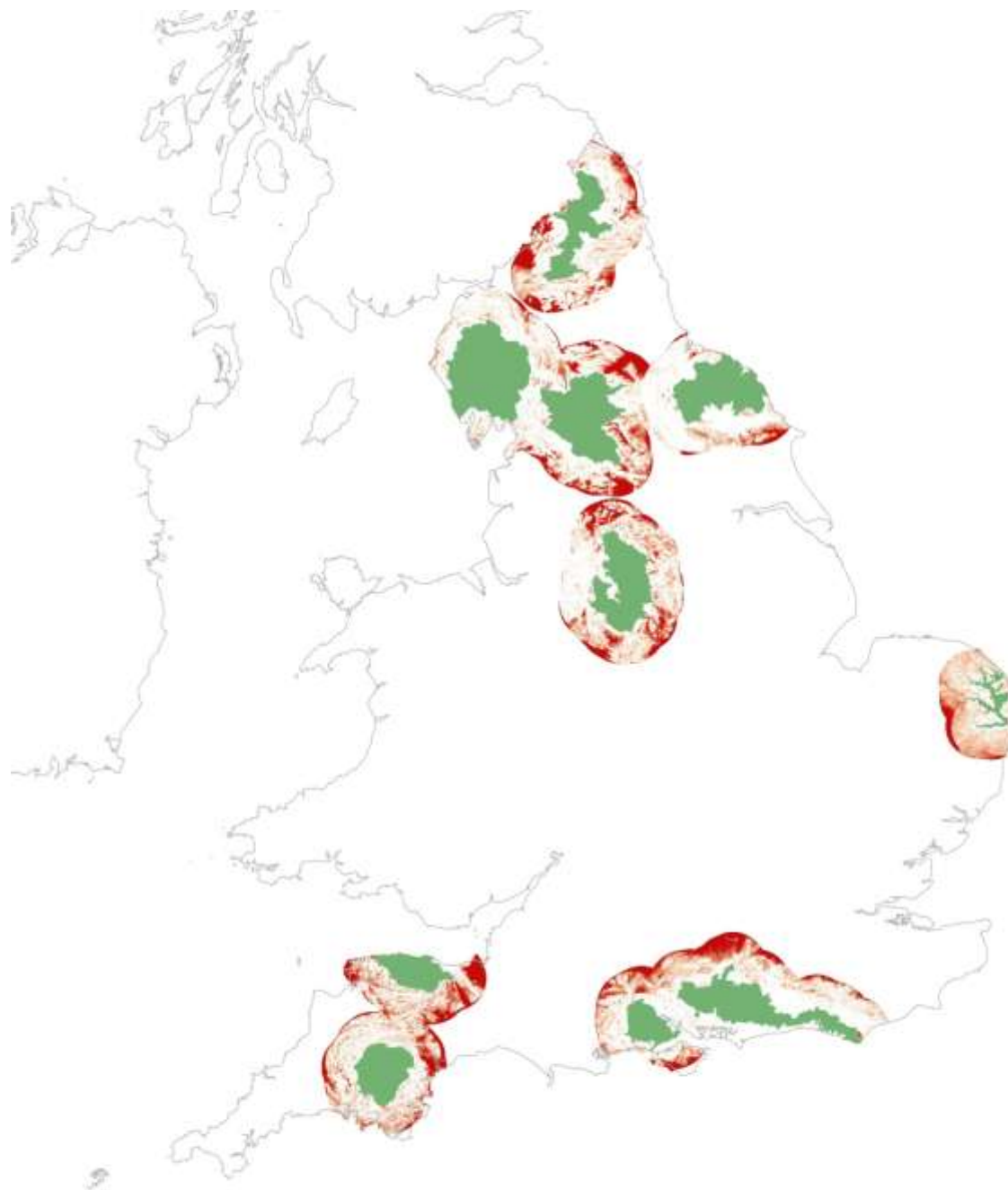
For further information about the analysis and data, please contact.

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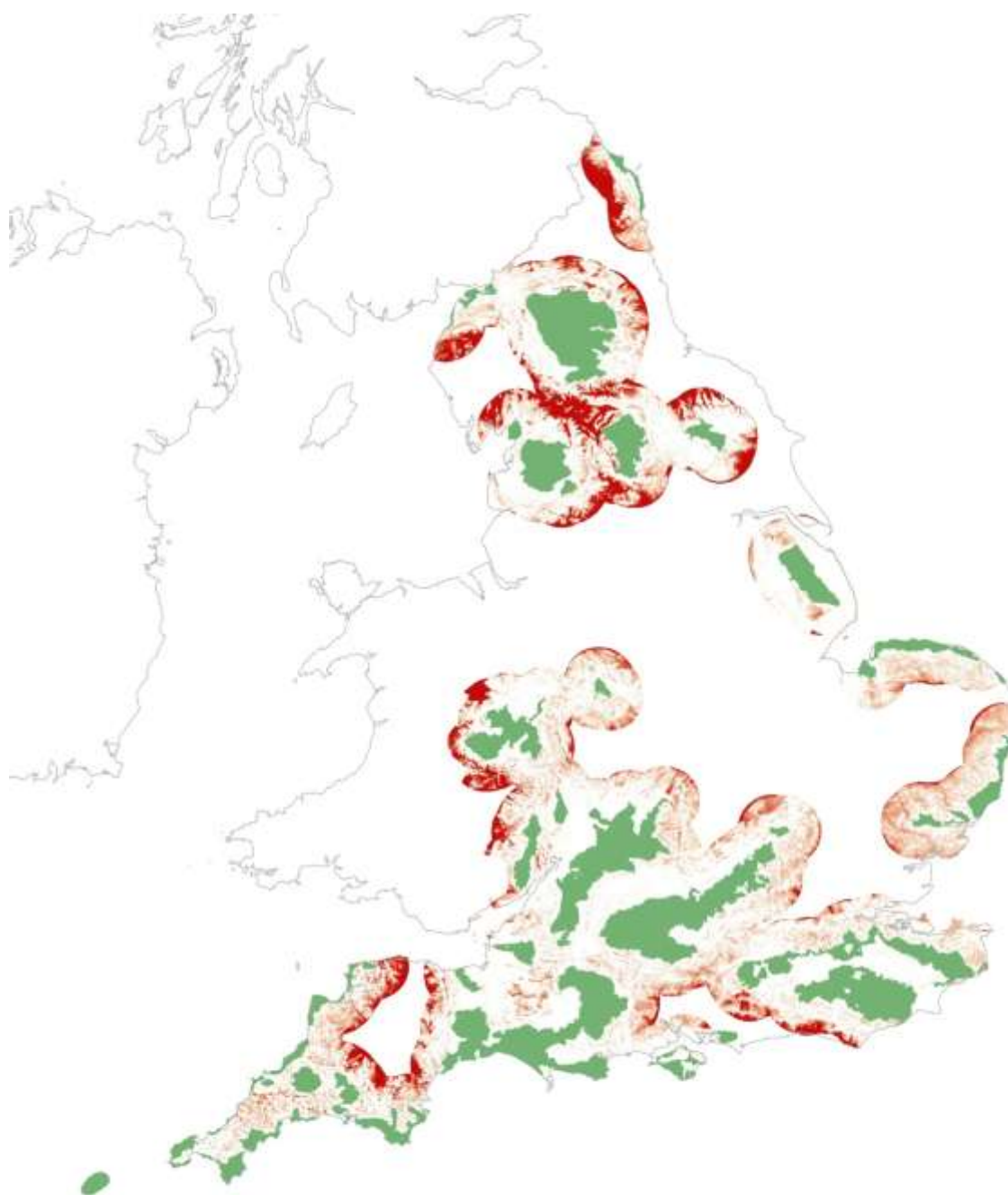
## Appendices - Model Outputs

### National Parks

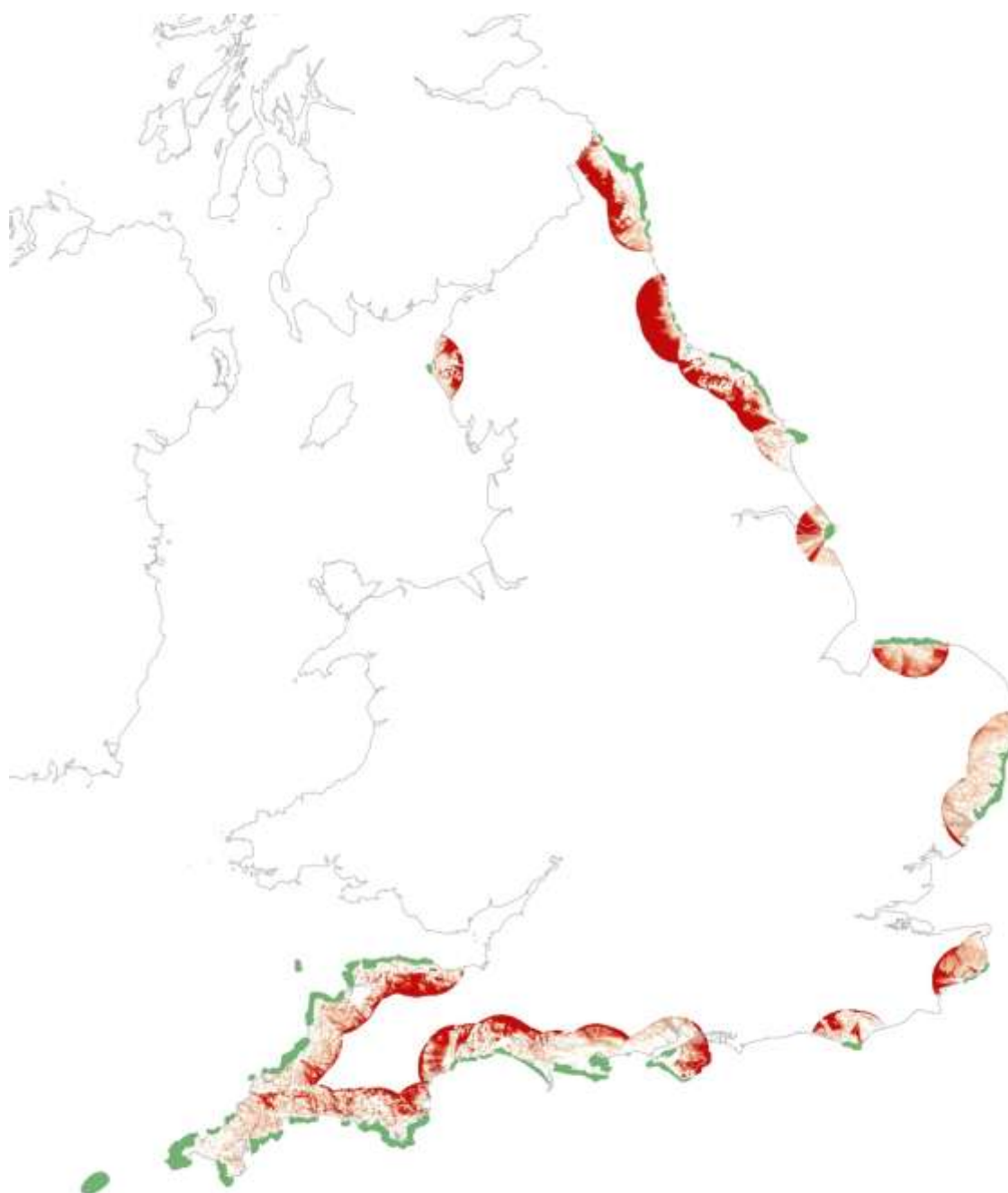




## AONBs



## Heritage Coasts



## National Trails

