WINDFARMER

Shapefiles and WindFarmer

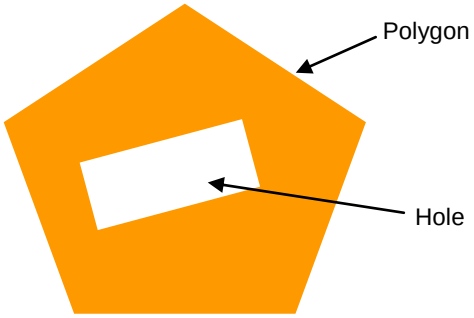
WindFarmer, the wind farm design software package, is capable of importing data in the form of ESRI Shapefiles. Shapefiles are a very flexible data format, however, and if care is not taken in their preparation they can become awkward and time consuming to process.

This document is intended to give guidance to both GIS analysts who generate shapefiles, and WindFarmer users who read them. It describes a way of working which will make the passage of data from GIS to WindFarmer straightforward and manageable.

1 General information

1.1 Polygon Holes, Islands and Doughnuts

Shapefile polygons support the concept of 'holes'. These are also known as 'islands' or 'doughnuts', and are shown in the diagram below:



WindFarmer is capable of reading polygons which contain holes, but in general we recommend avoiding their creation. The presence of holes can slow down processing within WindFarmer, and restrict the ability of users to apply setbacks.

1.2 Attributes

In general, WindFarmer will not read any attribute information contained in shapefiles. There are two exceptions to this: 'name', and 'elevation'.

1.2.1 Name attribute

If an object has the attribute 'name', then when it is loaded into WindFarmer the object will be labelled with the same name.

1.2.2 Elevation attributes for terrain contours

Line objects representing terrain contours should be given an attribute to describe the elevation. If this attribute is called either 'ELEVATION', 'CONTOUR', 'HEIGHT', or 'ALTITUDE', then it will be correctly interpreted by WindFarmer.

1.3 Metadata files

A 'shapefile' is actually a collection of at least 3 files, all with the same name but different extensions:

1) Filename.shp 2) Filename.shx 3) Filename.dbf

These three files should be kept together in the same directory. The *.SHP file should be selected when loading these files into WindFarmer.

WindFarmer is also capable of interpreting the metadata file:

4) Filename.prj

This file, which is not essential, contains the definition of the map projection which is used by the shapefile. If it is present, WindFarmer should be set to *Enable coordinate projection selection* (in Control Panel > Preferences).

2 Generating boundary shapefiles in a GIS

At least two shapefiles are usually required to describe a project's boundaries:

One shapefile containing the site limits – the boundary within which turbines must be placed.

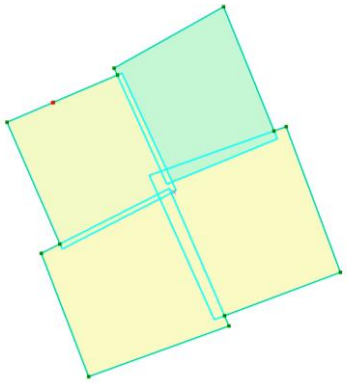
One or more shapefiles containing the exclusion areas, within which turbines must NOT be placed.

2.1 The site limits shapefile

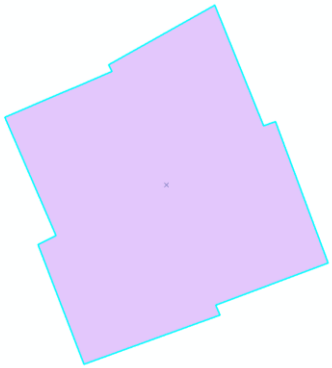
The site limits shapefile should contain one or more polygons which describe the whole area in which turbines may be located, ignoring any exclusions. WindFarmer will convert the outer edge of this polygon into the boundary which is set to *contain turbines*.

Polygons may contain holes, but this is not recommended. Holes will be converted by WindFarmer into boundaries which *exclude turbines*. Rather than using holes, it is recommended that these areas be described in a separate exclusion areas shapefile – see section 2.2 below.

If the site limits have been defined from several areas, these should be merged into a single polygon before exporting the shapefile. This will prevent the risk of there being overlapping polygons in the exported file. For example, imagine a site which is composed of four neighbouring fields. Their boundaries have been inaccurately defined so that they overlap slightly:



Using GIS functions such as *Union*, *Aggregate* and *Dissolve*, these four polygons should be reduced to a single one:

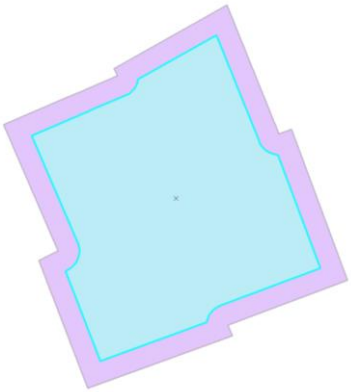


If the site is fragmented for some reason, then several polygons can be used, but these polygons **must not** overlap.

2.1.1 Setbacks

It is frequently a requirement that turbines are set back a certain distance from the site boundary, for example to ensure that rotor blades will not overhang the boundary.

If required, a setback can be applied to this polygon by using the *Buffer* command in the GIS, reducing its size, or this can be set as a boundary property in WindFarmer.



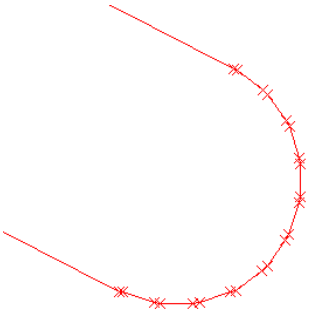
Alternatively, the setback could be treated as a separate exclusion area – see section 2.2 below.

2.1.2 Point reduction

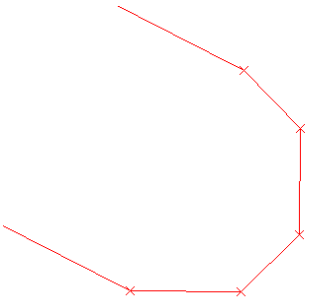
Shapefiles are typically generated by GIS programs with an extremely high level of detail. In particular, curved areas of a complex polygon edge may be represented by several thousand points. This volume of data can be too large for WindFarmer to successfully process.

To avoid this problem, when generating a shapefile the number of points on curves should be reduced by using functions such as *Generalise* and *Simplify*. A tolerance of around 0.5 to 1m should produce satisfactory results without adversely affecting the quality of finished work. Care should be taken to ensure that this operation does not cause holes within a polygon to overlap its edge.

Before simplifying…



and after…



2.2 The exclusion areas shapefile

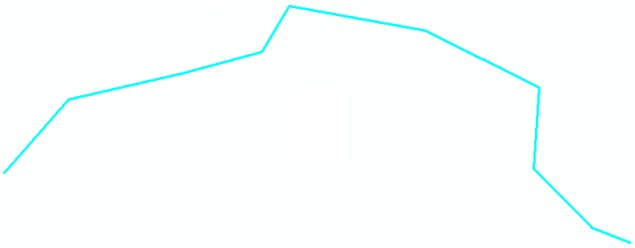
The exclusion area shapefile is used to define the areas where turbines cannot be placed. Each area should be defined with a polygon – when loaded in, WindFarmer will convert the perimeters of these polygons into boundaries which *exclude turbines*.

There may be many reasons for exclusion areas – water, forests, housing, roads, telecommunication links and so on. It is recommended that a separate shapefile is used for each type of exclusion. This will allow maximum flexibility when the data is loaded into WindFarmer.

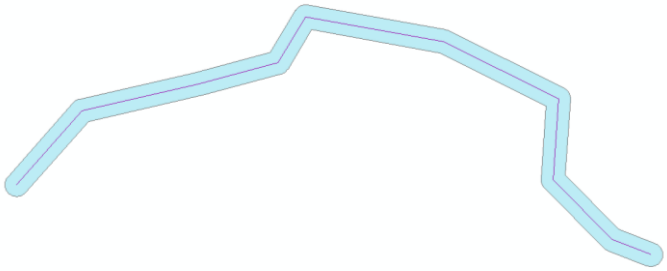
It is not a problem for these exclusion polygons to overlap.

2.2.1 Point and line objects for exclusion areas

Shape files for exclusion data should only contain polygons, not lines or points.



Line or point objects (for example telecom links, footpaths, houses etc.) should be converted into polygons in the GIS by applying an appropriate buffer (at least 1m).



2.2.2 Setbacks

It is frequently a requirement that turbines are set back a certain distance from the exclusion boundary, for example to ensure that rotor blades will not overhang the boundary.

If required, a setback can be applied to this polygon using the *Buffer* command in the GIS, increasing its size, or this can be set as a boundary property in WindFarmer.

2.2.3 Point reduction

When generating this shapefile, you should reduce the number of points on curves, as described in section 2.1.1. It may also be appropriate to remove very small polygons of only a few square metres, if they exist. If you are working in a region which contains a large number of small polygons, it may be useful to *aggregate* them into fewer, larger, polygons.

2.2.4 Cropping

Exclusion areas are often defined using data sets which cover very large areas, such as an entire country. The data should be cropped to an area slightly larger than the site before exporting the shapefile.

2.3 Suitable GIS software

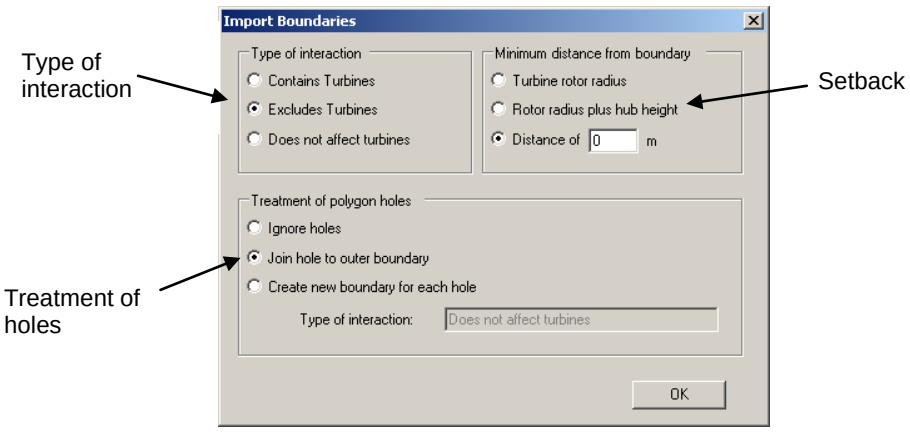
Many GIS software packages exist with the necessary tools to prepare shapefiles for use with WindFarmer. This includes ArcView, Global Mapper (version 12 onwards) and the free, open source, Quantum GIS.

3 Loading boundary shapefiles into WindFarmer

The GIS analyst should supply WindFarmer with two or more shapefiles containing objects which describe the boundaries of the project.

See the *WindFarmer User Manual* for full details on how to load shapefiles into WindFarmer – remember it is the *.SHP file which should be loaded.

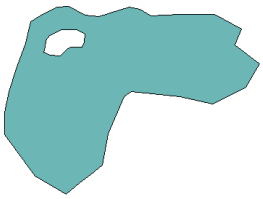
When a shapefile containing polygons which are to be used as boundaries is loaded, the Import Boundaries dialogue box opens:



3.1 Polygon holes

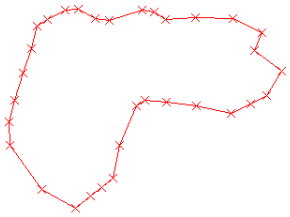
WindFarmer offers three choices of how it should treat holes in polygons:

Original shapefile data: Polygon with a hole

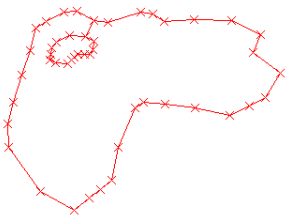


Imported into WindFarmer:

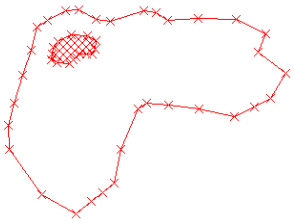
Ignore holes



Join hole to outer boundary



Create new boundary for each hole



The 'join hole to outer boundary' option is the most powerful. Using this option, WindFarmer will allow polygons to be placed inside holes in other polygons.

3.2 The site limits shapefile

Load this file to be interpreted as *Boundaries.*

The type of interaction should be set to *Contains turbines*.

If required, a setback can be applied to the boundary at this stage. If there are several polygons in the file, they will all be given the same setback. Alternatively, setbacks can be applied to individual boundaries through the *Boundary Properties* window.

3.3 The exclusion areas shapefiles

Load these files to be interpreted as *Boundaries.*

The type of interaction should be set to *Excludes turbines*.

If required, a setback can be applied to the boundaries at this stage. If there are several polygons in the file, they will all be given the same setback.

As many exclusion area shapefiles can be loaded as are required. Exclusion areas are automatically set by WindFarmer to be displayed with a red cross-hatching. This pattern can be changed in the *Boundary Properties* window.

4 Using points to set object locations

Shapefiles containing point objects can be used to define the locations of WindFarmer objects such as turbines, dwellings, viewpoints and so on. Each type of object should be stored in a separate shapefile.

If an object is given the attribute 'name', then WindFarmer will use the name as the label for the object when it is loaded.

5 Perform a trial load operation

It can sometimes be a complex process to choose the correct settings when loading in a collection of shape files. For this reason we recommend performing a trial load of your shape files into an empty workbook before you load them into a workbook which already contains a lot of data.

Some example shapefiles can be found in the Demodata subfolder of the WindFarmer installation directory.

Last but not least don't forget that WindFarmer also supports a wide range of import and export options through ASCII files that are optimised for interaction with GIS systems. For details see the WindFarmer online help.