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MEMO: WORKING WITH INNOWIND FOREST DATA LAYERS IN WINDPRO

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Introduction

This memo describes recommended approaches on how to read and use high-resolution forest GIS data-layers in windPRO 3.4. The land-surface descriptions from InnoWind premium data typically come with 3+2 geotiff files at a high grid resolution, 20m. The 3 basic files are:

- Land cover in 5 land-cover classes, *LC*
- Forest height, *h*
- Leaf area index, *LAI*

These 3 basic layers are used to calculate layers of the aerodynamic roughness, z_0 , and displacement height, d . This may be done using one following models: ORA-model [1] (as implemented in windPRO), Raupach [2] or the SCADIS [3]. The 2 derived files are:

- Displacement height, d
- Roughness length, z_0

If parameters of (d , z_0) are modelled by external tools to windPRO, the data-layers are typically also stored as geo-tiff files. To use the data for flow-modelling within windPRO, the gridded data of z_0 and d needs to be converted into contour lines. If source data is stored as raster data, this conversion may generate the millions of points and lines into vector-data-structures that were originally designed to consume hand-digitized lines. This memo describes recommendations on how to best load and use the data.

Workflow

The workflow with high-resolution forest data in windPRO differs only from a traditional energy yield calculation by having forest height data within an elevation grid object and an associated displacement height calculator. Roughness lines are stored in a line object (even if it may come from an external tool) – or from the ORA tool in windPRO).

Forest Height Data (h) → Elevation Grid Object

Forest/canopy height data is loaded into an elevation grid object with datatype set to 'Heights above terrain (a.g.l)...'. Load the color-legend from the definition-files named 'InnoWind_ForestH_15m.RasterColorSetup'.

Land Cover Data (LC) → Result Layer Import

It is recommended to inspect the land cover geotiff-file by loading it into a 'Result Layer'. Load the color legend from the definition-file: 'InnoWind_LandC.RasterColorSetup'.

Land Cover Data (LC) → Area Object

Land cover data is loaded into an area object with purpose set to 'Roughness map based on closed lines'. Add a roughness class for each land cover type. A default setup is available from the legend file: 'InnoWind_LC_AreaObject.lty'. These data may be exported to contours in a line object – or used in the windPRO ORA tool.

Leaf-Area Index (LAI) → Result Layer Import

This data layer is typically not loaded into windPRO – but can be inspected in a result layer. Legend can be loaded from 'InnoWind_LAI.RasterColorSetup'.

Displacement Height (d) → Elevation Grid Object and Displacement Calculator

The calculated displacement heights are loaded into the 'Elevation Grid'. Data usage is configured from within the 'Displacement Height Calculator Tool'. The tool needs to be configured to take displacement heights from the elevation grid. In this case, the 'factor' is set to 1.0. WindPRO modules like PARK and RESOURCE can be configured to use the displacement heights.

Precalculated Roughness Lengths (z_0) → Line Object

The pre-calculated roughness lengths (calculated outside windPRO) are loaded into the 'Line Object'. Data usage is configured via a site-data object.

Precalculated Roughness Lengths (z_0) → Area Object (alternative)

As an alternative, the pre-calculated roughness lengths can be loaded into an 'Area Object'. windPRO will then group individual classes into individual polygons. These polygons can be exported to a line object. Data usage (of the data inside the line object) is configured via a site-data object.

Generate Roughness Lengths (z_0) → windPRO ORA Tool

windPRO will calculate the ORA roughness map based on two data sources: A background roughness map (LC), typically stored within an area object. Second source is the forest height map (h), with data available from the displacement height calculator. From the ORA-tool, the new roughness-contour map is generated. The roughness map is loaded into a line object.

Sample Data and More Information

Get more information, data samples and legend-files at the InnoWind Premium Data Page at our windPRO knowledgebase – available [here](#).

References

- [1] R. Floors, P. Enevoldsen, N. Davis, J. Arnqvist, and E. Dellwik, "From lidar scans to roughness maps for wind resource modelling in forested areas," *Wind Energy Sci.*, vol. 3, no. 1, pp. 353–370, 2018.
- [2] M. R. Raupach, "Simplified expressions for vegetation roughness length and zero-plane displacement as functions of canopy height and area index," *Boundary-Layer Meteorol.*, vol. 71, no. 1–2, pp. 211–216, 1994.
- [3] A. Sogachev, "Airflow modelling over complex natural landscapes: SCADIS model achievements," in *VindKraftNet: Forest workshop*, 2008.

SCHEMATIC OVERVIEW OF THE USAGE OF LAND-SURFACE DATA AND MAPPING IN WINDPRO

