Wind Atlas for South Africa (WASA)

Guidelines for using WASA phase 3 extreme wind statistics in the WAsP Engineering environment

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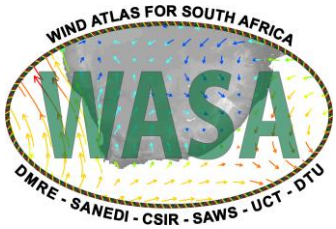

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1. Introduction

This guideline serves to obtain design parameters as required in the applicable IEC standard, by the application of the 1:50 year 10 minute wind speed statistics in the DTU WAsP Engineering (WEng) software.

It is introduced here how to use the software WEng to calculate the 50-year return wind at a particular site, at a certain height (e.g. hub height). The calculation in WEng is done through the linear computational model LINCOM.

For a particular site, the input data required by WEng could be available in one or more forms as described in Larsén et al. (2018) for WASA 1 and 2 results. Below is a copy of the list from Larsén et al. (2018):

(1) One single value of the 50-year wind of standard condition (10 m high over homogenous surface with a roughness length of e.g. 5 cm) from measurements or modeling.
(2) A collection of annual maximum wind speed, corrected to the standard condition already.
(3) A collection of annual maximum wind speed, directly from mesoscale modeling, using the selective dynamical downscaling method (SDDM).

WASA 3 uses long-term mesoscale model results (Larsén et al. 2021). The outputs are prepared in the format of (2) in the above list. The following section describe the procedures for applying WEng with input from WASA 3.

To prepare WEng, the orographical and roughness length maps should be made ready. The details of making such maps can be found in Mortensen (2020).

2. WASA 3 data as input to WEng

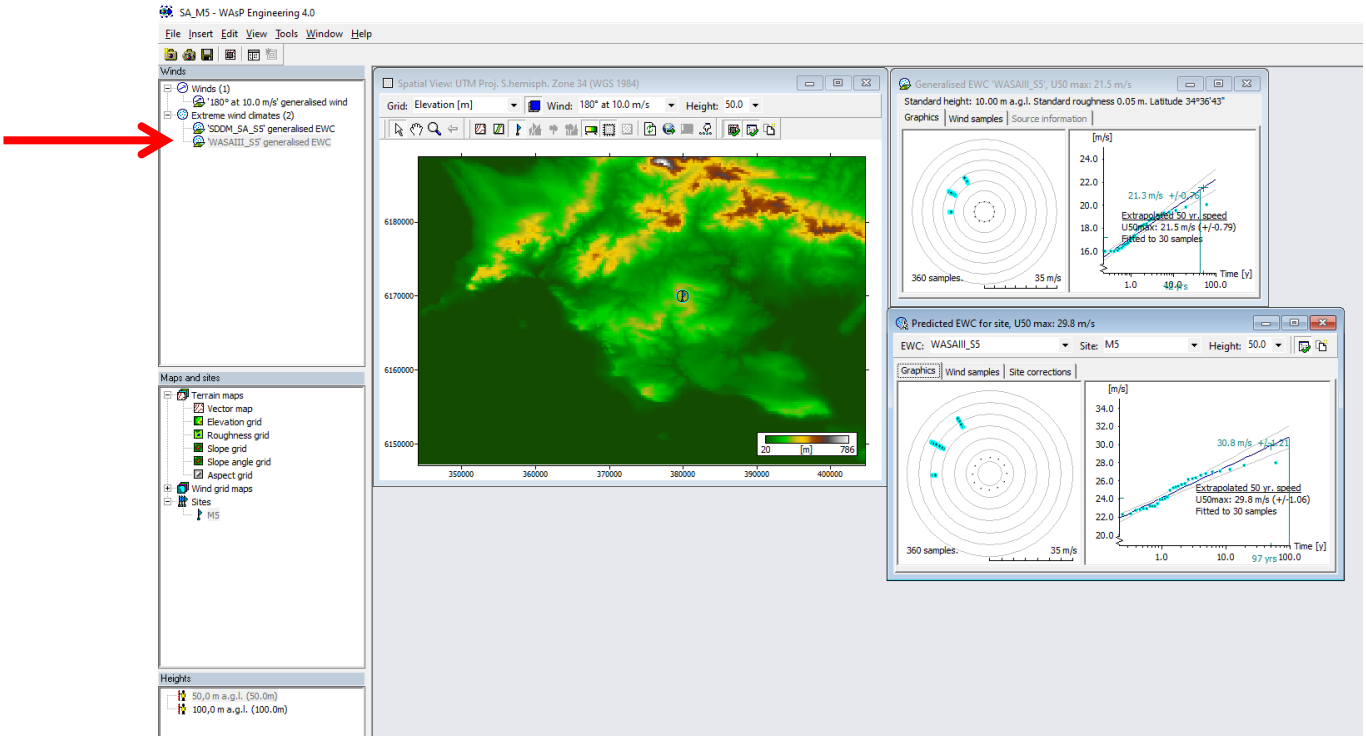

Figure 1. Screen shot of WEng project. The red arrow shows the input of the REWC-file. Also shown are the directional distribution of the winds and the Gumbel fit.

Figure 1 is a photo shot of WEng applied to a site M5. The middle window shows the topography around mast 5 (M5). From the left-upper window where the red arrow points at, is the input file for driving the model LINCOM. Our data from WASA III are prepared in a format so that they can be used here as input to LINCOM.

WASA III data have been prepared as a collection of the annual wind maxima at standard conditions for each grid points. There are altogether 453 by 630 grid points over the model domain. The data can be written in the format of REWC (regional extreme wind climate), see the file (WASAIII_S5.rewc) as an example for the site M5. The rewc-file is used as input, as shown in Figure 4 with a thick red arrow. This file WASAIII_S5.rewc is a text file. It includes the corresponding direction to the wind samples.

The standard winds and the corresponding direction are shown in the window “Generalized EWC ‘WASAIII_S5’” as the wind rose in Fig. 1. The Gumbel fit to the samples provides an estimate of the 50-year wind at the standard condition to be 21.5 m/s (shown in the window “Generalized EWC ‘WASAIII_S5’”) and the actual 50-year wind at M5 at a height of 50 m is 29.8 m/s. The corresponding value at 60 m is 30.5 m/s.

3. WASA 3 datasets

Several datasets are prepared in WASA 3, as introduced in Larsén et al. (2021) and briefly repeated here:

1) The 10-min values of 50-year wind at 10 m, 50 m, 100 m and 200 m. The 10 m winds were not one of the direct outputs from the mesoscale modeling but serve as output for this project. The output of the 10m wind speed was used to estimate the 1:50 year wind statistics and these were critically compared to the outputs from historical observations, also at 10 m height.

   The data files are:
   U50_10m_10min_1col.dat
   U50_50m_10min_1col.dat
   U50_100m_10min_1col.dat
   U50_200m_10min_1col.dat

2) The 10-min values of 50-year wind at 50 m, 100 m and 150 m at a spatial resolution of 250 m over South Africa through the GASP project.

   This will be made available through Global Wind Atlas web Data portal for GASP.

3) The 3-s values of the 50-year gust at 10 m at a spatial resolution of 3.3 km.

   The data files are:
   Gustvalue_ori.dat

4) Generalized 50-year wind (converted from dataset-1 above to 10 m over a homogeneous surface with a roughness length of 5 cm). This is the data that can be further applied to microscale, linear computational model LINCOM as described in section 2, to obtain local extreme wind statistics at a resolution of tens of meters. Through WEng where LINCOM is implemented, the extreme winds and turbulence can be obtained at given hub heights.

   The data files are:
   Ust_YYYY.dat, where YYYY is from 1990 to 2019. There are two columns: the generalized annual maximum wind speeds, and the corresponding direction. There are 453x630 rows for all the grid points in the model domain.

   Datasets 1), 3) and 4) need to be read together with the latitude and longitude data:
   gust_lat_1col.dat
   gust_lon_1col.dat

Dataset 1) to 3) are useful for regional planning.

Dataset 4) is most suitable for siting condition assessment and it is the one most relevant for the functions related to WEng, as introduced in this report.

4. Data links

Currently, gust_lat_1col.dat and gust_lon_1col.dat are stored in Dropbox directory GUST
https://www.dropbox.com/sh/c72c825ud068pj8/AAARwqT5ymaHlEA7GrV07NY-a?dl=0

The other data files are stored under folder ‘Original’.

5. References

Larsén, X., Kruger A. and Cronin T. (2018): Guidelines for using WASA Phases 1 & 2 extreme wind statistics in the WAsP Engineering environment. WASA II report

Larsén X., Kruger A, Floors R., Cavar D. and Hahmann A. (2021): Atlas of extreme wind and gust for South Africa. WASA III report.

Mortensen, N. G. (2020). Wind resource assessment using WAsP software. DTU Wind Energy. DTU Wind Energy E No. 0211

Guidelines for using WASA III extreme wind statistics in the WAsP Engineering Environment