From siting parameters to IEC standards

GASP Project Deliverable 3.2

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Version 1

Preface

This report serves Deliverable 3.2 to the EUDP project GASP (Global Atlas for Siting Parameters). Here we introduce the workflow from siting parameters to wind turbine class following IEC standard.

Risø, June 2021

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1. Introduction

This report briefly introduces the work on converting siting parameters to the atlas of recommended turbine class following IEC standards, including the uncertainty estimation.

2. The variables and workflow

According to IEC standard 61400-1 ed. 4 (2019), siting parameters include

- Terrain Complexity
- Normal Climate
- Extreme Climate

Normal Climate includes sector-wise wind distribution, turbulence, wind shear, flow inclination and air density. Wind distribution is usually through sector-wise Weibull distribution. Turbulence is described through 90-percentile turbulence intensity, described in terms of direction parameter and wind speed: $TI_{p90}(\theta, u) = a_{p90}(\theta) + b_{p90}(\theta)/u$.

Extreme Climate includes extreme wind and air density at high wind speed. GASP calculates terrain complexity, flow inclination, the extreme wind and provides air density at the wind strength of the 50-year wind. The calculation of the 50-year wind and turbulence has been documented in Larsén et al. (2021). In the existing Global Wind Atlas (GWA) project, the following data are already available: wind distribution, wind shear and air density.

Regarding determining design classes, fatigue loads and ultimate loads are calculated and the details can be found in Slot (2019, 2021, D3.1 and D3.3). Fig. 1 shows the workflow from siting parameters to site design class, with the wake-induced turbulence intensity considered (Svenningsen et al. 2021)

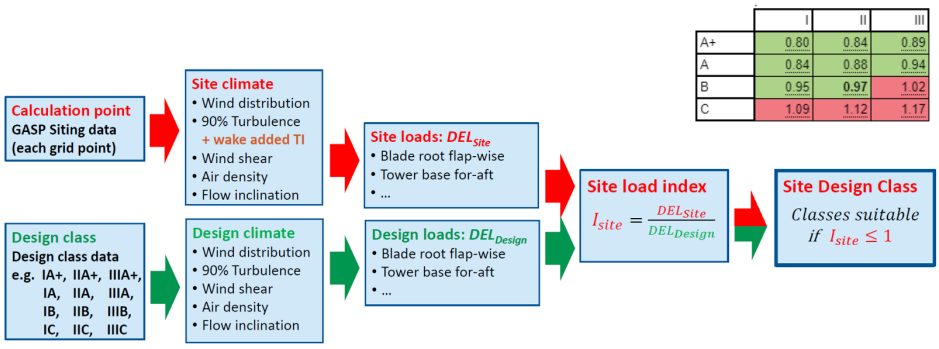

Fig. 1. From siting parameters to the choice of turbine class, with wake effect (from Svenningsen et al. 2021).

The uncertainties related to the 50-year wind and turbulence are calculated using a classification approach as in Larsén et al. (2021b).

3. The atlases

The project provides a list of atlases as shown in Table 1, and they can be found on the public data server https://science-dev.globalwindatlas.info/#/map as well as on EMD's data portal windprospecting.com.

Category	Variable	Definition and methods
Atmospheric Variables	flow-inclination	Flow inclination angle calculated using the LINCOM linear flow model
	shear-exponent	Terrain induced shear exponent calculated using the LINCOM linear flow model
	turbulence-intensity	Turbulence intensity, calculated using an ensemble of four models onshore, and two models offshore.
	V50	The 50 year return wind speed, at a temporal resolution of 10 min. This was calculated by downscaling the CFSR data using a combination of the Spectral Correction method and the LINCOM linear flow model.
Turbine Class	fls-class-nowake	Turbine class including turbulence without accounting for wakes
	fls-class-wake	Turbine class including turbulence accounting for wakes
	uls-class	Turbine class based on the V50
Uncertainty	uncertainty-ti	Uncertainty classification of turbulence intensity
	uncertainty-V50	Uncertainty classification of V50
Terrain	terrain-complexity	IEC based classification of terrain complexity

Table 1. Data layers from GASP.

4. References

Slot R. 2019: Report on framework, GASP Deliverable 3.1 (D3.1)

Slot R. 2021: From siting parameters to atlas of turbine class – processing for commercial value. (D3.3)

Larsén X, Davis N, Hannesdóttir and M. Kelly and B. Olsen and R. Floors and M. Nielsen and M. Imberger Á. Calculation of Global Atlas of Siting Parameters. Tech. Rep. DTU Wind Energy E-0208, ISBN 978-87-93549-76-0, DTU Wind Energy Department; 2021a.

Larsén X, Imberger M, Davis N, Kelly M, Hannesdóttir Á. GASP Uncertainty Classification. Tech. Rep. DTU Wind Energy E-0221, ISBN 978-87-93549-89-0, DTU Wind Energy Department; 2021b.

Svenningsen, Slot, Thøgersen, Larsén, Davis, Floors, Imberger, Kelly, Olsen and Hannesdóttir: "Calculation of a global atlas of expected wind turbine design class", The GASP project, Part 2. The resource session. 2021-05, Hannover, Germany [online]