New high-res resource map for the WASA domain and improved data for wind farm planning and development

Mortensen, Niels Gylling; Hansen, Jens Carsten; Kelly, Mark C.; Mabille, Eugéne; Prinsloo, Eric; Szewczuk, Steve; Spamer, Yvette

Publication date: 2014

Citation (APA):

General rights
Copyright and moral rights for the publications made accessible in the public portal are retained by the authors and/or other copyright owners and it is a condition of accessing publications that users recognise and abide by the legal requirements associated with these rights.

- Users may download and print one copy of any publication from the public portal for the purpose of private study or research.
- You may not further distribute the material or use it for any profit-making activity or commercial gain
- You may freely distribute the URL identifying the publication in the public portal

If you believe that this document breaches copyright please contact us providing details, and we will remove access to the work immediately and investigate your claim.
Microscale Modelling and Applications

New high-res resource map for the WASA domain and improved data for wind farm planning and development

Niels G. Mortensen, Jens Carsten Hansen and Mark C. Kelly
DTU Wind Energy

Eugéne Mabille, Eric Prinsloo, Steve Szewczuk and Yvette Spamer
CSIR Built Environment

WASA Final Wind Seminar
Cape Town, South Africa
Microscale Modelling and Applications

• Microscale modelling (here WAsP)
  – Verification of measurements
  – Verification of microscale modelling
  – Verification of mesoscale modelling

• High-resolution resource maps for the WASA domain
  – WAsP Resource Mapping System
  – 2013-edition based on KAMM/WAsP
  – 2014-edition based on WRF/WAsP
  – Changes from 2013 to 2014

• Summary and conclusions

• Improved data for wind farm planning and development
  – 3-km generalised wind climates (WRF, 2014)
  – Case study examples
Microscale modelling using WAsP

Wind-climatological inputs
- Three-years-worth of wind data
- Ten 62-m masts in domain
- Five levels of anemometry

Topographical inputs
- Elevation maps (SRTM 3)
- Different roughness maps

Results and data
- Wind measurements verification
- Microscale modelling verification
- WAsP workspaces and projects

Documentation reports
- Site and Station Inspection
- Observational Wind Atlas
Microscale modelling based on one met. mast
Numerical Wind Atlas 2014 – many virtual masts
WAsP Resource Mapping System

- New implementation of WAsP
  - Database of wind climates
  - Database of elevation maps
  - Database of roughness maps

- Principle of operation
  - Batch mode operation
  - Distributed computing
  - Wind atlas interpolation to every prediction site.
  - Export to GIS formats

- WAsP standard modelling
  - Industry-standard model
  - Linearized flow model
  - Default parameters
  - Standard atmosphere (ρ)
Available input data for detailed resource mapping

- Verified Numerical Wind Atlas
  - WRF mesoscale model, 3 km

- Elevation
  - 100-m elevation grids from Space Shuttle Topography Mission, SRTM version 3.

- Land cover and roughness
  - USGS Global Land Cover Characteristics database.
  - Transformation table for $z_0$
Elevation input – SRTM 3.0 versus SUDEM
WASA wind resource @ 100 m – wind speed

Mean wind speed [ms⁻¹] @ 100 m
WAsP modelled, 250 m resolution
WASA wind resource @ 100 m – power density
WASA domain terrain elevation

Terrain surface elevation [m a.s.l.]
WASp modelled, 250 m resolution
WASA domain terrain ruggedness index

Terrain surface ruggedness index
WAsP modelled, 250 m resolution
Verification using measurements @ 10 masts

- WRF Verified Numerical Wind Atlas compared to observed winds (3y).
- Testing wind-climatological inputs
- WAsP Resource Mapping System compared to observed winds (3y).
- Testing wind & topographical inputs
Difference between 1st and 2nd edition maps
Difference between first and second edition map

- Differences from 1st to 2nd edition
  - WASA domain +1.0 ms\(^{-1}\)
  - Northern Cape +1.1 ms\(^{-1}\)
  - Western Cape +0.8 ms\(^{-1}\)
  - Eastern Cape +1.2 ms\(^{-1}\)

- Differences are largest in some
  - Coastal regions
  - Escarpments
  - Ridges and hills
  - Mountain areas

- Differences are large too in
  - Low-wind regions
  - NE Eastern Cape
High-resolution wind resource map availability

- Metadata for data sets
  - Data set specifications
  - Data set provider
  - Contact information
- Data set parameters
- Coordinate system
- Technology
  - models & input data
- Detailed notes
  - Purpose
  - Methodology
  - Limitations
  - Available documentation
  - Acknowledgements
  - Disclaimer
  - Maps of $U$, $P$, $z$ and RIX
Summary and conclusions – detailed resource map

- Wind resources in WASA domain have been mapped (again)
  - Large-scale: \(~346,500\text{ km}^2\) (5,605,565 sites)
  - High-resolution: 250-m between model sites
  - Results in public domain: [wasadata.csir.co.za/wasa1](wasadata.csir.co.za/wasa1)

- Data sets specifically developed for
  - Planning and Strategic Environmental Assessment
  - Wind farm planning and development

- Comprehensive verification and quality assurance
  - Software development phase
  - Manual checks in several areas

- Wind resources estimated quite well now
  - VNWA on average 2% too high
  - Detailed wind resource map on average 1% too low
Wind farm planning and development

- Identification and ranking of potential wind farm sites.
- Initial analyses and design
- Project planning
- Pre-feasibility studies
  - Resource assessment
  - Some site assessment
- Design of measurement campaign
  - Number of masts
  - Siting of masts
  - Orientation of sensor booms
  - Mounting of lightning rod and navigation lights.