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IDEAS THAT WORK
8-9 October 2015 | CSIR ICC

The Wind Atlas for South Africa (WASA): A tool to aid developers and decision makers

Eugene Mabille

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CELEBRATING 70 Years
Ideas that work

The WASA Project Team

SANEDI *South African National Energy Development Institute*

- executing agency – contracting the implementing partners
- coordination and dissemination

UCT CSAG *Climate System Analysis Group, University of Cape Town*

- mesoscale modelling

CSIR *Built Environment, Council for Scientific and Industrial Research*

- measurements and microscale modelling

SAWS *South African Weather Service*

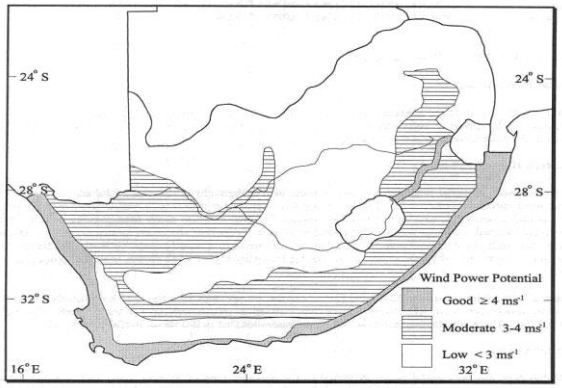
- extreme wind assessment

DTU Wind Energy *Dept. of Wind Energy, Technical University of Denmark*

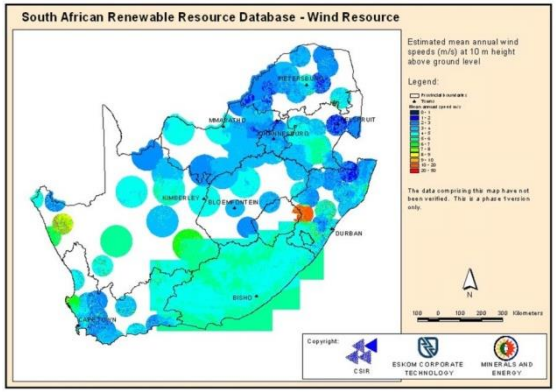
- partner in all activities

Why a WASA?

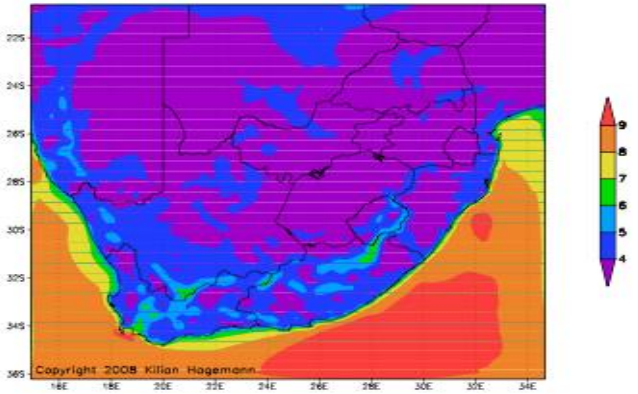
DME; R. Diab 1995



SARERD, 2001



K Hagemann, UCT (2008)



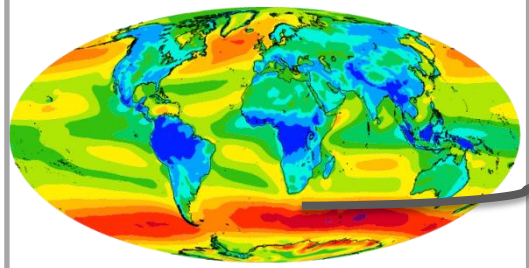
Tripod Review of Wind Energy Resources in South Africa (2002) concluded:

- These studies are inconclusive and under estimate the true wind energy potential as weather measurement stations at 10 m were used and in many cases these stations are shaded, by buildings etc., from measuring the true wind potential; and

- Recommended that a dedicated wind energy measurement programme needs to be undertaken to confirm the true wind energy potential in SA.

WASA methodology

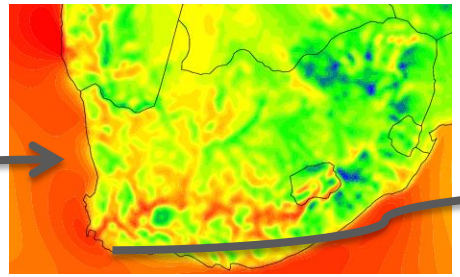
Global wind data



200 km x 200 km

Mesoscale modelling

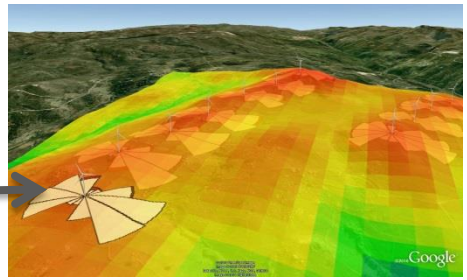
Regional wind climate



3 km x 3 km

Microscale modelling

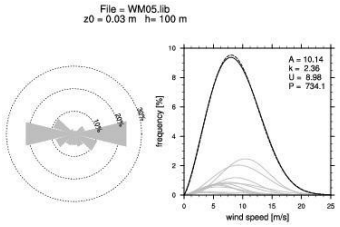
Local surface wind



1 – 10 m

Verification

Measurements



Microscale modelling

Local surface wind

Mesoscale models

KAMM/WAsP

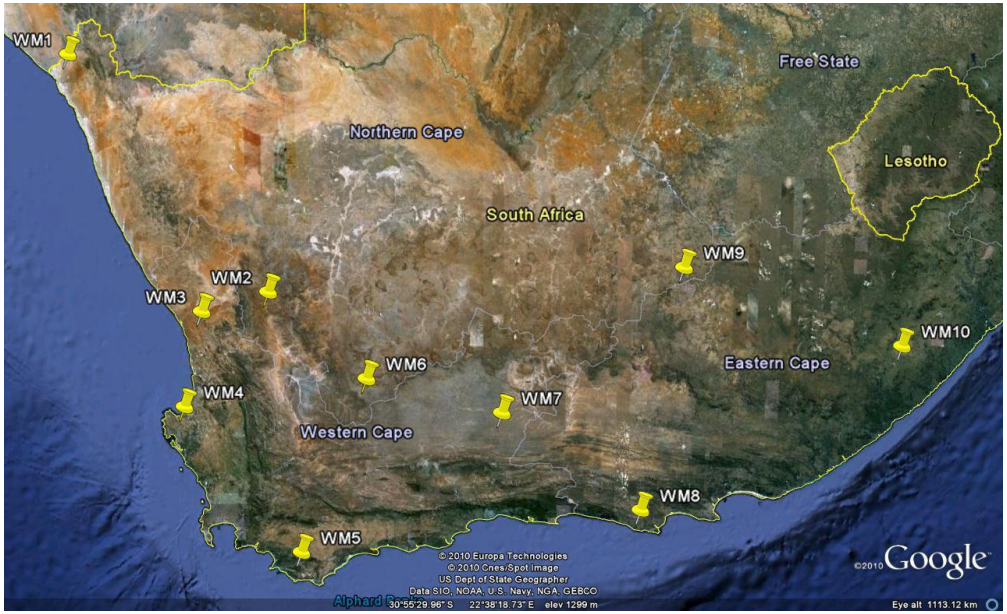
- Based on the generalisation of the wind climatologies derived from the mesoscale modelling.
- NECP DOE 2 data set used to create 100 wind classes that represent the large scale wind climate.
- KAMM model applied to each of these wind classes to make the wind classes meaningful at a smaller scale.
- Post processing of the simulations to produce wind atlas for generalised surface conditions (uniform terrain and roughness). Files compatible with WAsP software.
- Used for the first WASA published in 2012.
- KAMM/WAsP method, numerically very cheap, gives good results
  - underestimation of mean wind speed at most sites; specially at sites influenced by thermal processes

WRF

- First time the generalisation has been carried out using the WRF model.
- WRF method, numerically very expensive, gives excellent results
  - Stability conditions should be taken into account at generalization
  - Stability conditions should be taken into account when applying WRF-derived wind atlas – where should this come from? How to verify?
- New dimension to numerical wind atlases

Observational Measurements

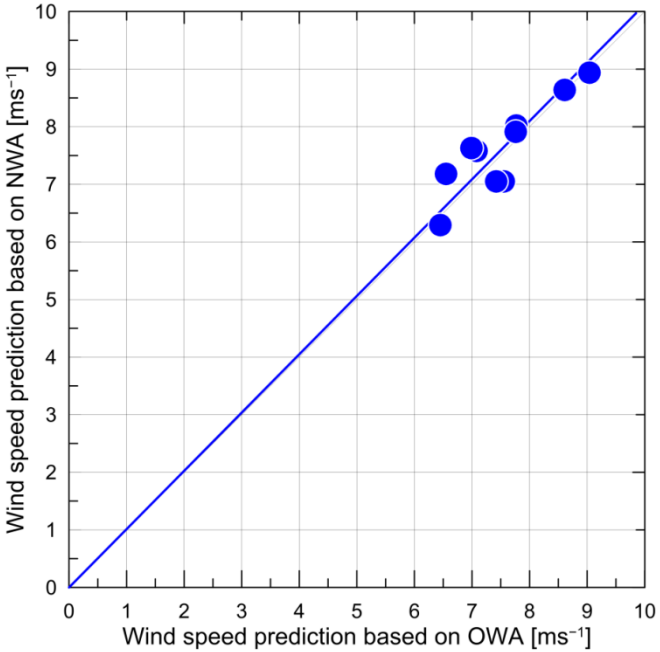
- 10 measurement sites established.
- Observational measurements at 10m, 20m, 40m, 60m and 62m
- Three-year period 2010-10-01 to 2013-09-30; except WM08, WM09 and WM10 for which only 2 years are available. Data recovery above 90% for all masts as indicated in the table.

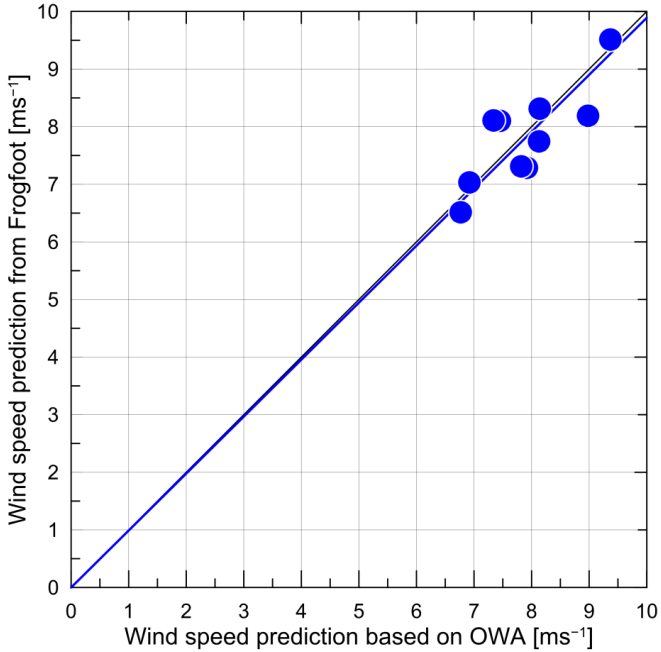


WASA	U_{mean} @ 61.9 m - 1 YEAR	U_{mean} @ 61.9 m - 3 YEARS*	ΔU	Data recovery
	[m/s]	[m/s]	[%]	[%]
WM01	5.86	6.06	2.7	100
WM02	6.21	6.14	-1.8	93.4
WM03	7.09	7.14	0.0	100
WM04	6.59	6.71	0.9	100
WM05	8.64	8.56	-0.8	98.6
WM06	7.02	7.36	1.6	99.9
WM07	6.85	6.93	0.3	97.0
WM08	7.36	7.34	0.3	100
WM09*	7.58	8.22	3.0	99.7
WM10*	6.55	6.55	0.0	98.8

* 2-year periods for WM09 and WM10:
WM09: 2010-10 to 2013-09 minus the year 2011.
WM10: 2011-03 to 2012-02 plus 2012-10 to 2013-09.

Verification





- 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*

Microscale Modelling

Wind-climatological inputs

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

Topographical inputs

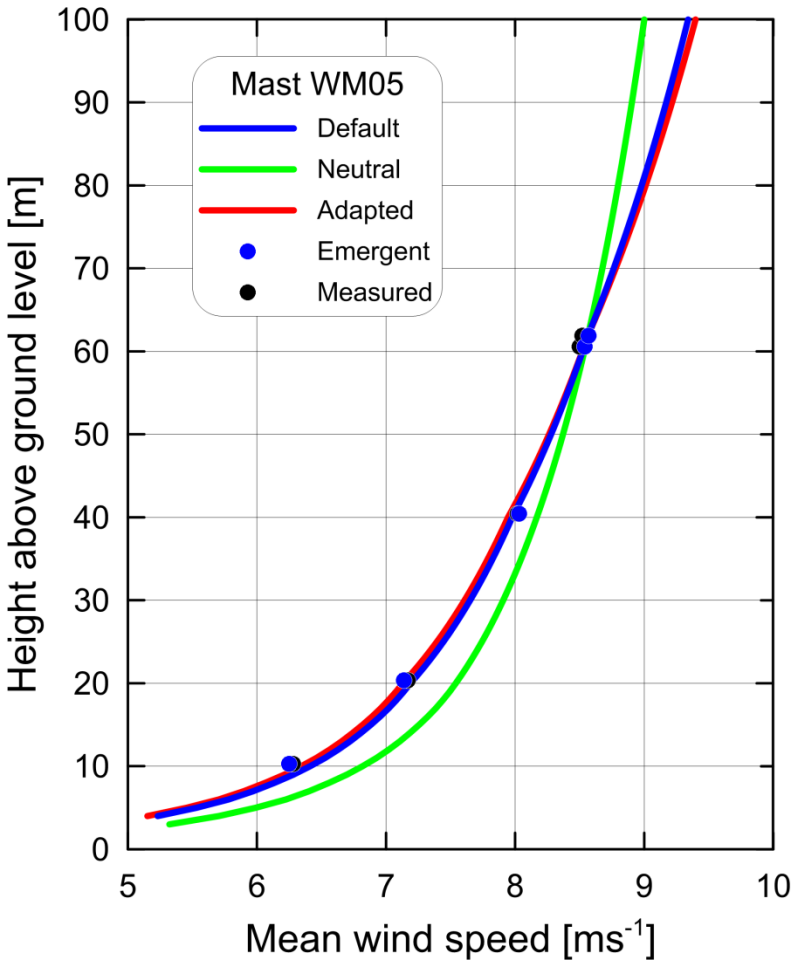
- Elevation maps (SRTM 3)
- Different roughness maps

Results and data

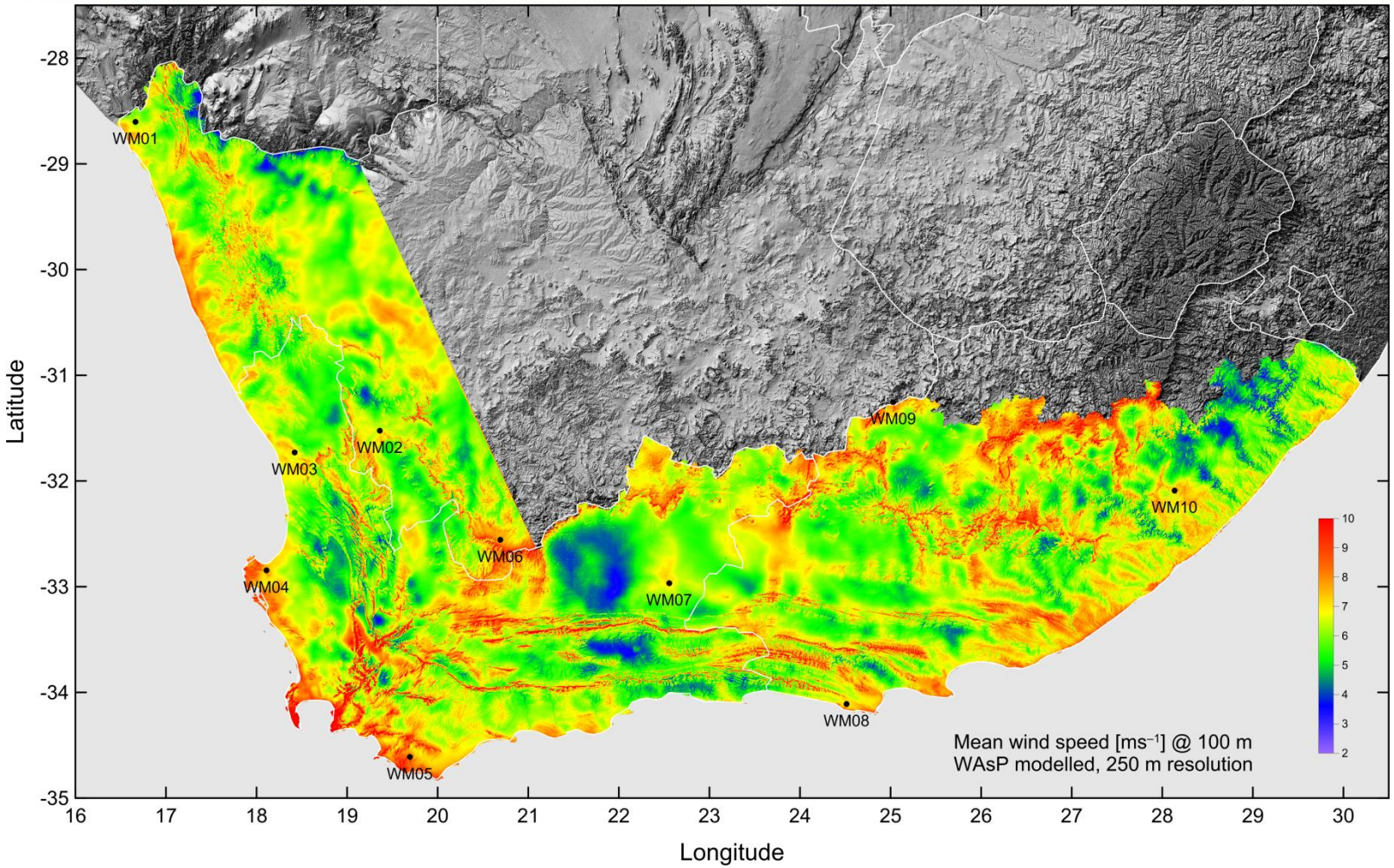
- Wind measurements verification
- Microscale modelling verification
- WAsP workspaces and projects

Documentation reports

- Site and Station Inspection
- Observational Wind Atlas

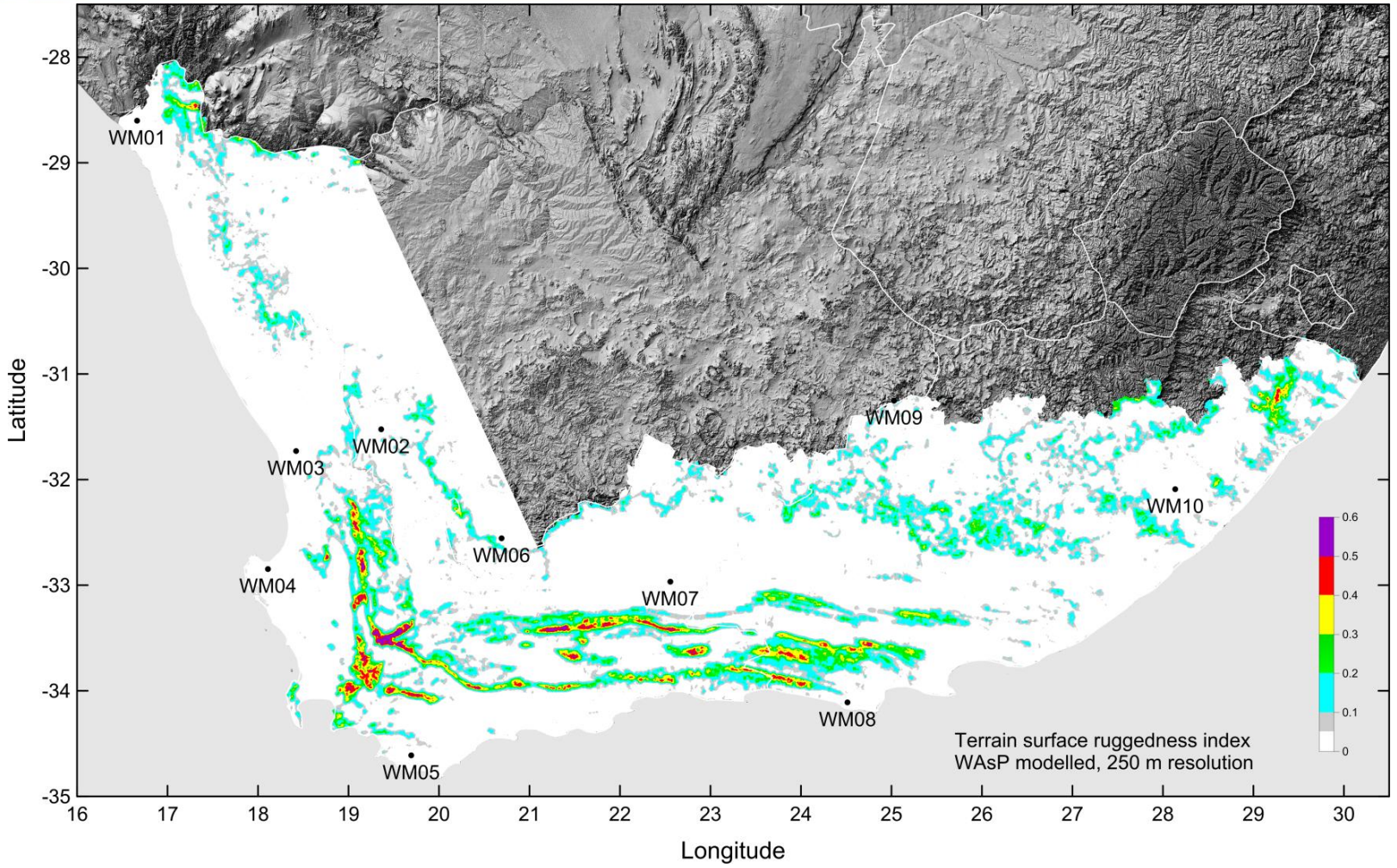


Verified Numerical Wind Atlas



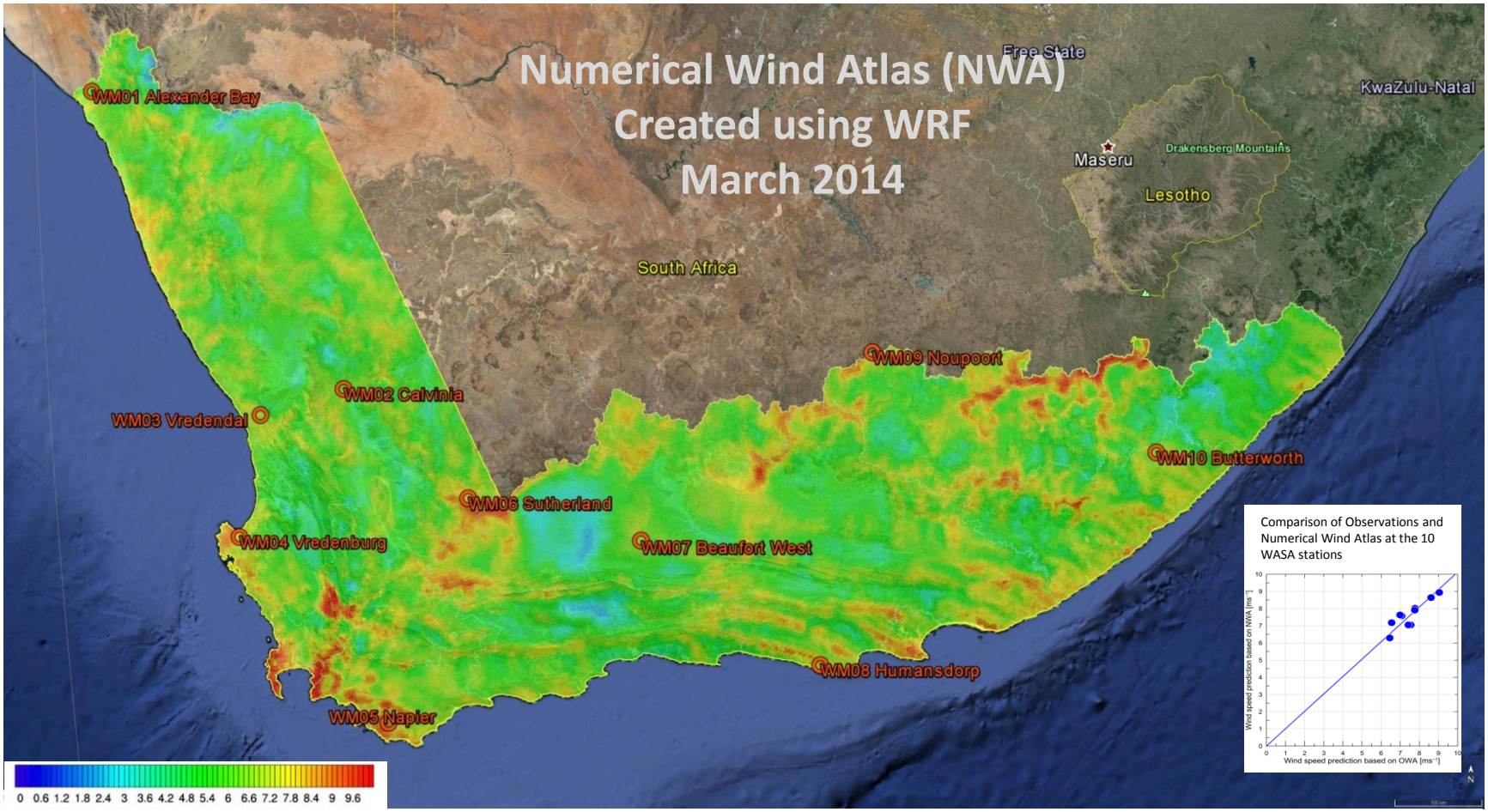
WASA wind resource @ 100 m – wind speed

WAS terrain ruggedness



WASA domain terrain ruggedness index

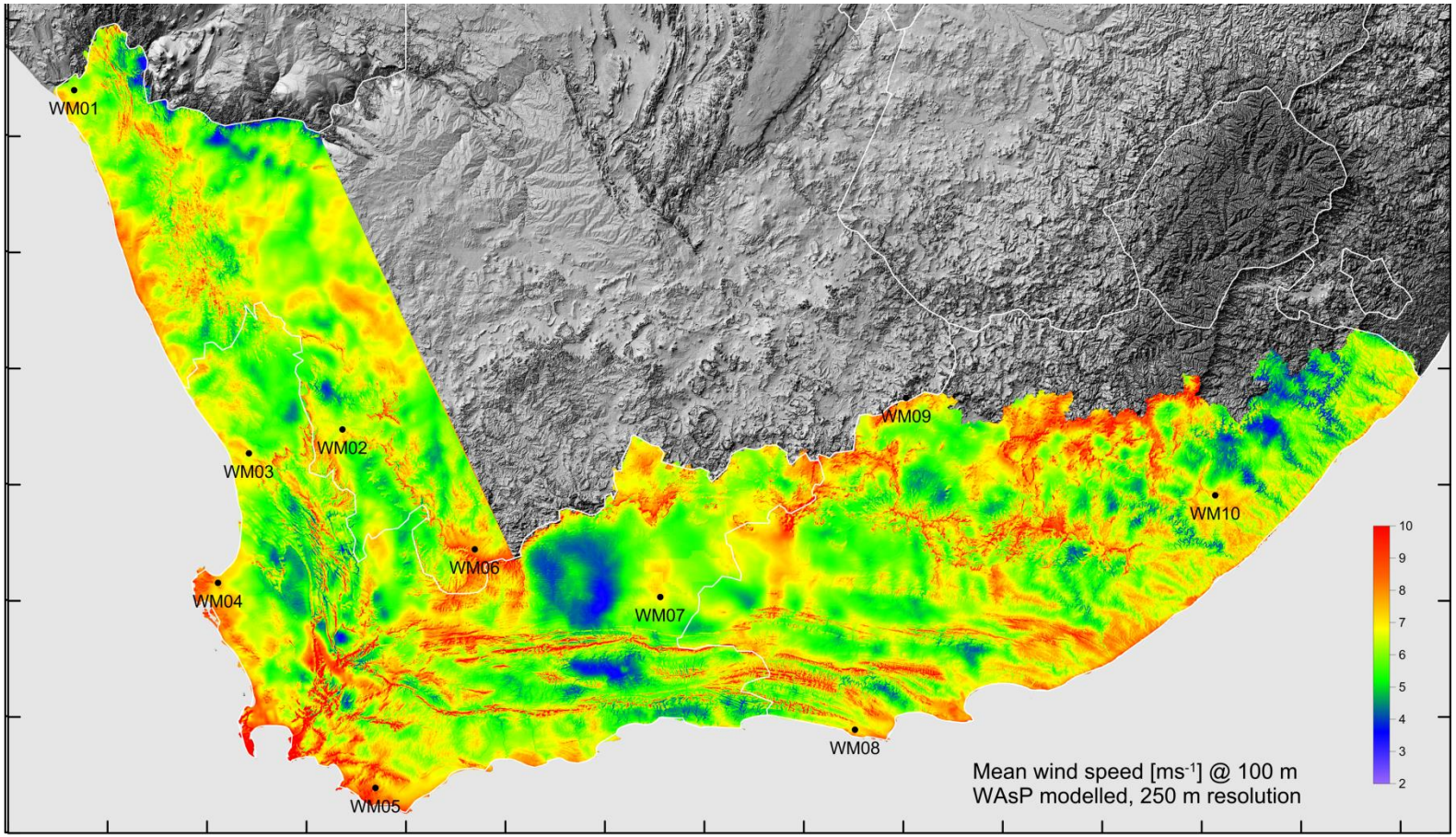
Numerical Wind Atlases



Generalised wind speeds – based on WRF mesoscale modelling

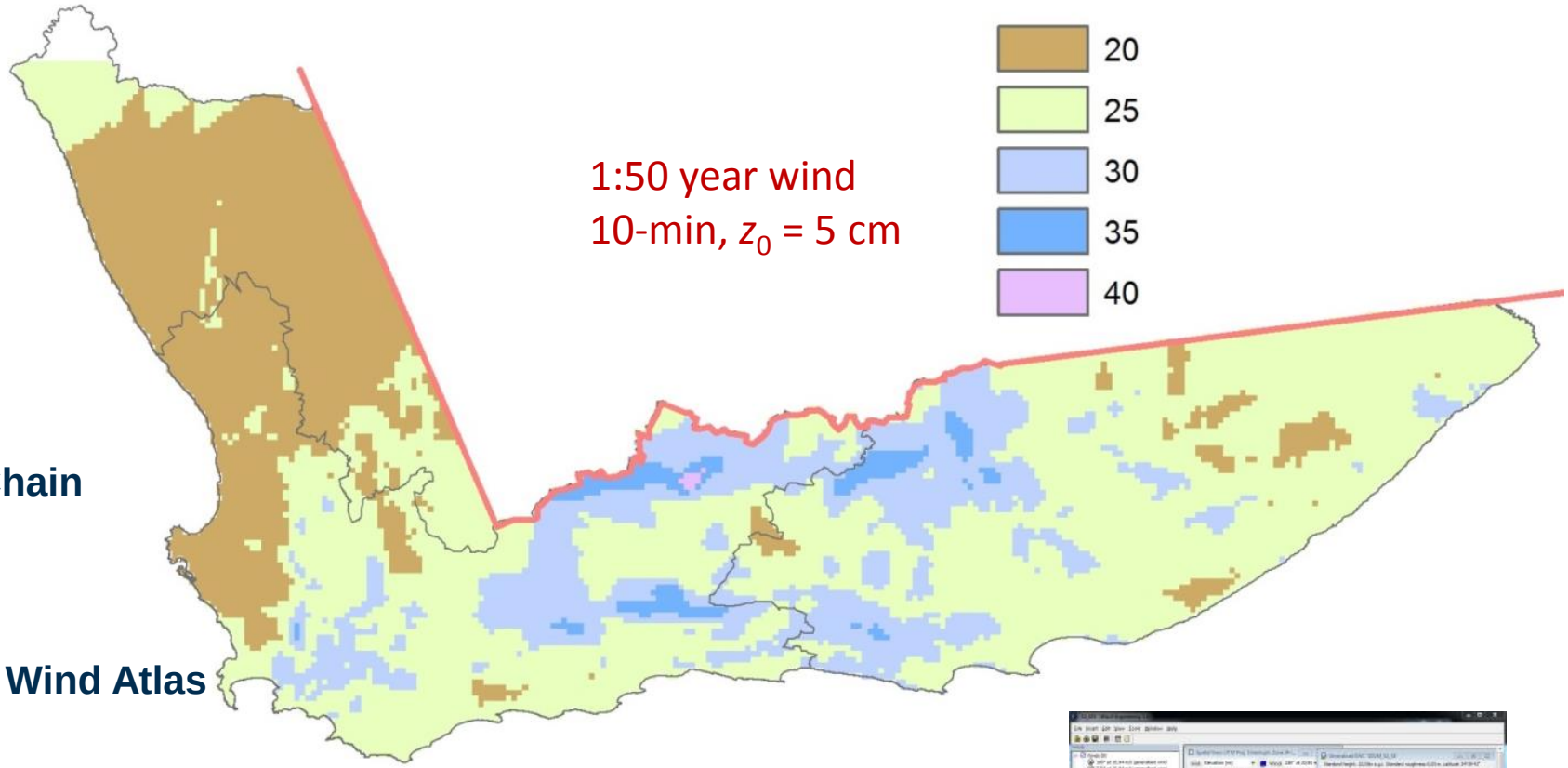
mean wind speed [m/s] 100 m above ground level, flat terrain, 3 cm roughness everywhere

High Resolution Wind Resouce Map



High-Resolution Wind Resource Map using WRF-based NWA, March 2014
mean wind speed (m/s) at 100 m agl in a grid spacing of 250 m.

Extreme Wind Atlas



1:50 year wind
10-min, z_0 = 5 cm

Model Chain

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Extreme Wind Atlas

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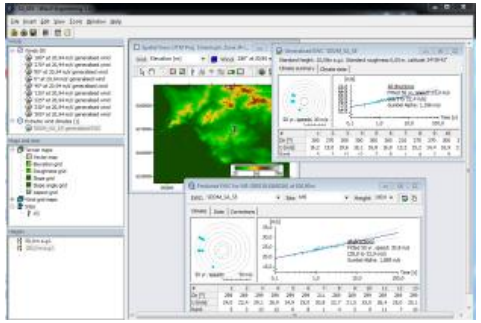
Calculation of design parameters at site



Information Sharing

- All information available in the public domain
- Reports and guides on how to use the wind atlas
- Data in real time and historical data for download
- High resolution wind resource maps
- Extreme wind atlas
- All information and data is free
- Portal:

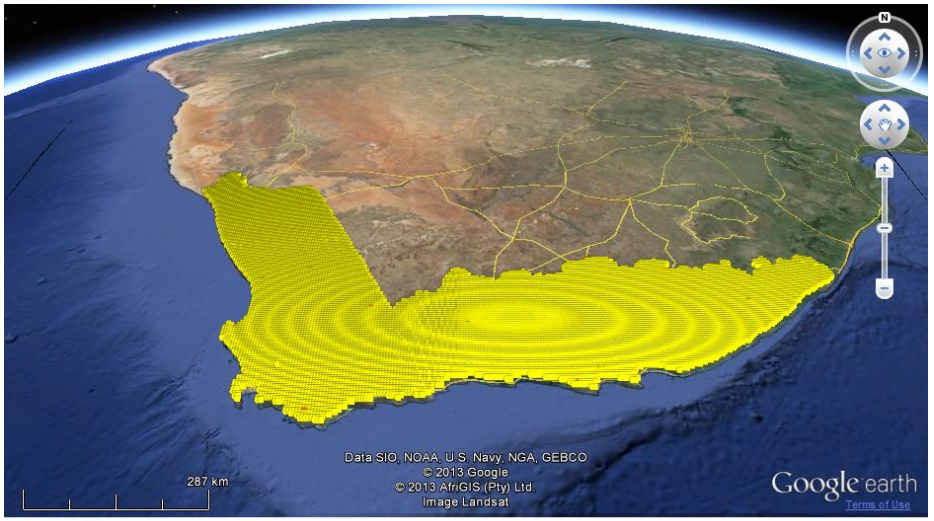
Data, methods, tools, guidelines

www.wasa.csir.co.za

Reports and presentations

www.wasaproject.info

In the WASA modelling domain wind climate data is available in grids of 3, 4 and 5 km spacing – virtual masts.



Acknowledgements

The Wind Atlas for South Africa (WASA) project is an initiative of the South African Government - Department of Energy (DoE) and the project is co-funded by

- UNDP-GEF through South African Wind Energy Programme (SAWEP)
- Royal Danish Embassy

WASA Project Steering Committee:

DoE (chair), DEA, DST, UNDP, Danish Embassy, SANEDI

energy
Department:
Energy
REPUBLIC OF SOUTH AFRICA

UNDP
Empowered lives.
Resilient nations.

gef

EMBASSY OF DENMARK

sanedi
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Thank you

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