



## Wind atlas for Egypt. A national database for wind resource assessment and wind power planning

**Mortensen, Niels Gylling**

*Publication date:*  
2006

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*Citation (APA):*

Mortensen, N. G. (2006). Wind atlas for Egypt. A national database for wind resource assessment and wind power planning. Abstract from 3. Middle East - North Africa renewable energies conference (MENAREC 3), Cairo (EG), 12-14 Jun, .

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## Wind Atlas for Egypt

A national database for wind resource assessment and  
wind power planning

Niels G. Mortensen  
Wind Energy Department  
Risø National Laboratory

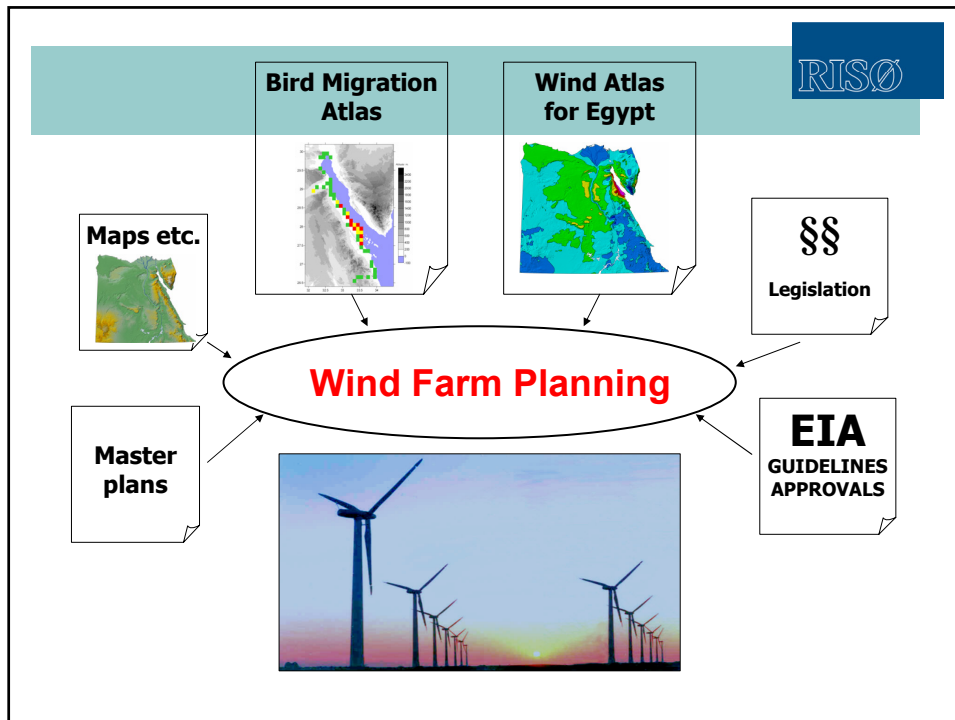
MENAREC 3, Cairo, Egypt  
12 June 2006

## Acknowledgements

The "Wind Atlas for Egypt" is the result of a comprehensive team effort!

- New and Renewable Energy Authority (NREA), Cairo  
Laila Georgy Youssef (PM), Usama Said Said, Ashour Abd El-Salam Moussa, Mohammad Akmal Mahmoud
- Egyptian Meteorological Authority (EMA), Cairo  
Ahmed El Sayed Yousef (PM), Adel Mahmoud Awad, Mahmoud Abd-El Raheem Ahmed, Mohamed A.M. Sayed, Mohamed Hussein Korany, Metwally Abd-El Baky Tarad
- Risø National Laboratory (Risø), Roskilde  
J. Carsten Hansen (PM), Niels G. Mortensen, Jake Badger, Bo H. Jørgensen, Charlotte B. Hasager, Uwe S. Paulsen, Ole F. Hansen, Karen Enevoldsen
- Orbicon (formerly HME and OrnisConsult), Roskilde  
Flemming P. Jensen (PM), Erik M. Jørgensen, Ib Clausager (NERI)

Project funding provided by NREA, EMA and Danida – thank you!



**RISO**

### Wind Atlas for Egypt overview

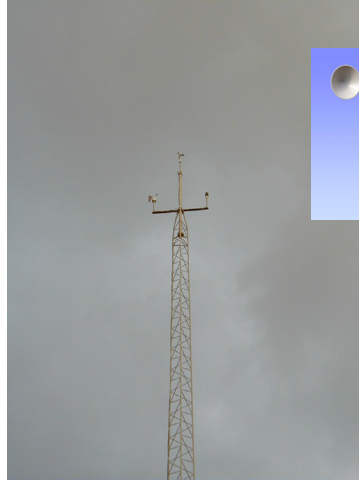
- Observational wind atlas
  - meteorological measurements
  - microscale modelling (WASP)
- Wind resource mapping
  - reanalysis wind climatologies (NCEP/NCAR)
  - mesoscale modelling (KAMM)
- Numerical wind atlas
  - verification – measurements and models
  - Wind Atlas for Egypt book and CD-ROM
- Applications and future
  - planning, feasibility studies, project preparation
  - wind farm planning and annual energy production

## Sample meteorological mast in Zafarana

RISØ



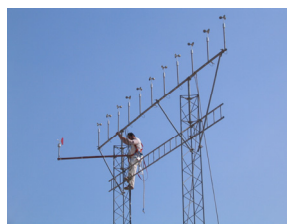
25-m lattice tower, concrete foundation



Top-pole mounting to avoid flow distortion

## Hurghada Cup Anemometer Calibration Facility

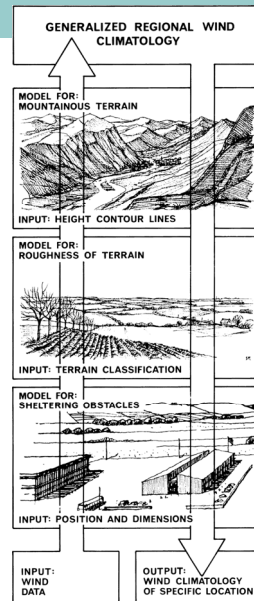
RISØ



10 anemometers being calibrated – reference anemometer in middle position: ○

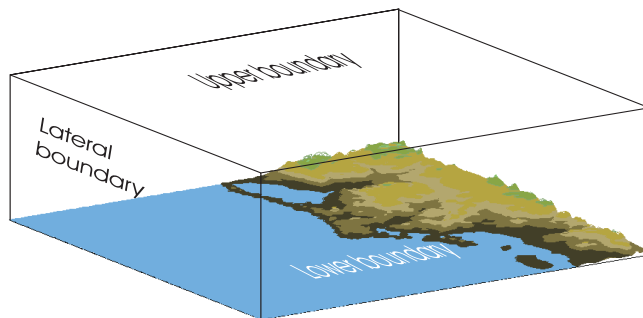
## Observational wind atlas

- Analysis procedure ↑ (WAsP)
  - Observed Wind Climate**
  - + sheltering obstacles
  - + roughness map (GE, SWBD)
  - + elevation map (SRTM 3)
  - ⇒ **Regional Wind Climate**
- Application procedure ↓ (WAsP)
  - Regional Wind Climate**
  - + sheltering obstacles
  - + roughness map
  - + elevation map
  - ⇒ **Predicted Wind Climate**
  - + power and thrust curves
  - ⇒ **Predicted wind farm AEP**

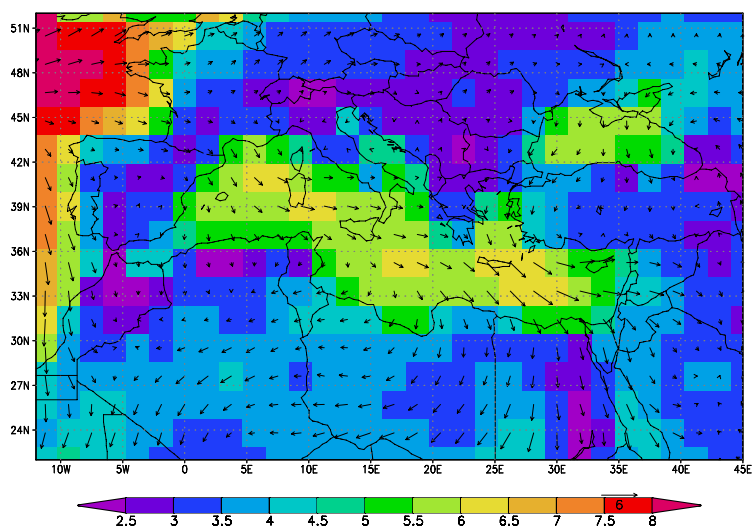


## Wind resource mapping by modelling

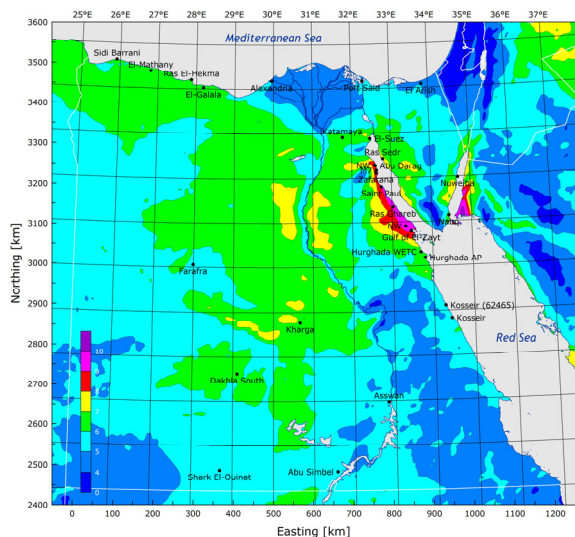
- Mesoscale model
- Output: annual averages of wind speed and power
- Regular horizontal grid
- Area: 10,000-100,000's of km<sup>2</sup>
- Resolution: 3-5 km
- Wind measurements are not required, but...
- Super-computer and skilled staff are needed!
- Uncertainty inherently larger than observational wind atlas



## Regional winds from NCEP/NCAR reanalysis

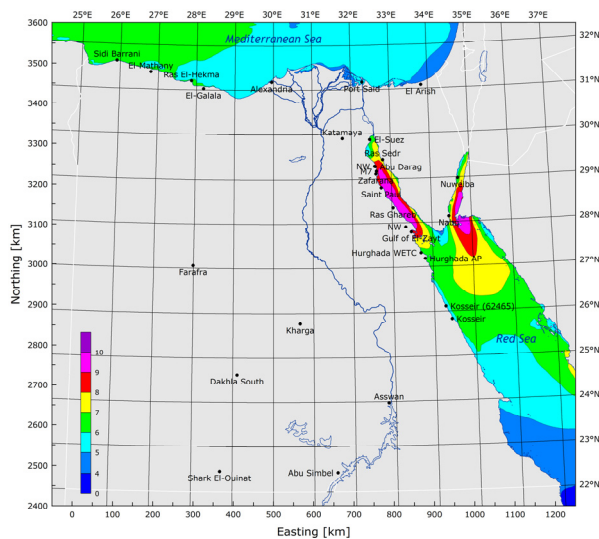


## New wind resource map of Egypt



- Map shows PWC
- KAMM modelling
- Resolution 7.5 km
- Mean wind speed 50 m a.g.l. [ $\text{ms}^{-1}$ ]
- NCEP/NCAR data
- GTOPO30 elevation
- GLCC land cover
- Terrain features may give higher wind speeds locally!
- Output formats:
  - map graphics
  - statistics

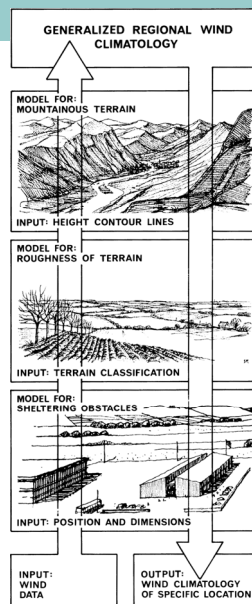
## ...and Egyptian offshore wind resources



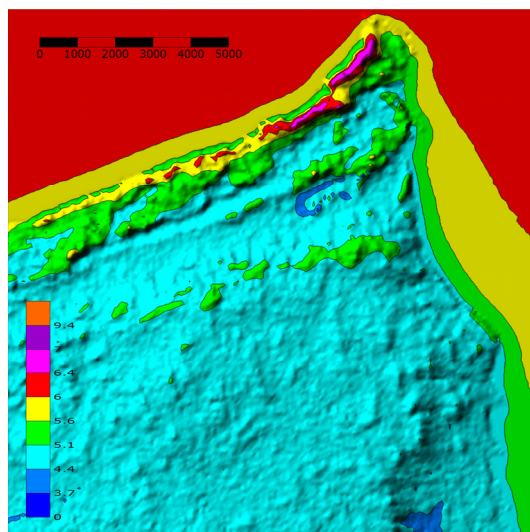
- Map shows PWC
- KAMM modelling
- Resolution 7.5 km
- Mean wind speed 50 m a.g.l. [ $\text{ms}^{-1}$ ]

## Numerical wind atlas

- NWA analysis procedure ↑ (WAsP-like)
  - **KAMM Predicted Wind Climate**
  - (> 50,000 virtual met. stations!)
  - + roughness map (GLCC)
  - + elevation map (GTOPO30)
  - ⇒ **Regional Wind Climate**
- Application procedure ↓ (WAsP)
  - **Regional Wind Climate**
  - + sheltering obstacles
  - + roughness map
  - + elevation map
  - ⇒ **Predicted Wind Climate**
  - + power and thrust curves
  - ⇒ **Predicted wind farm AEP**

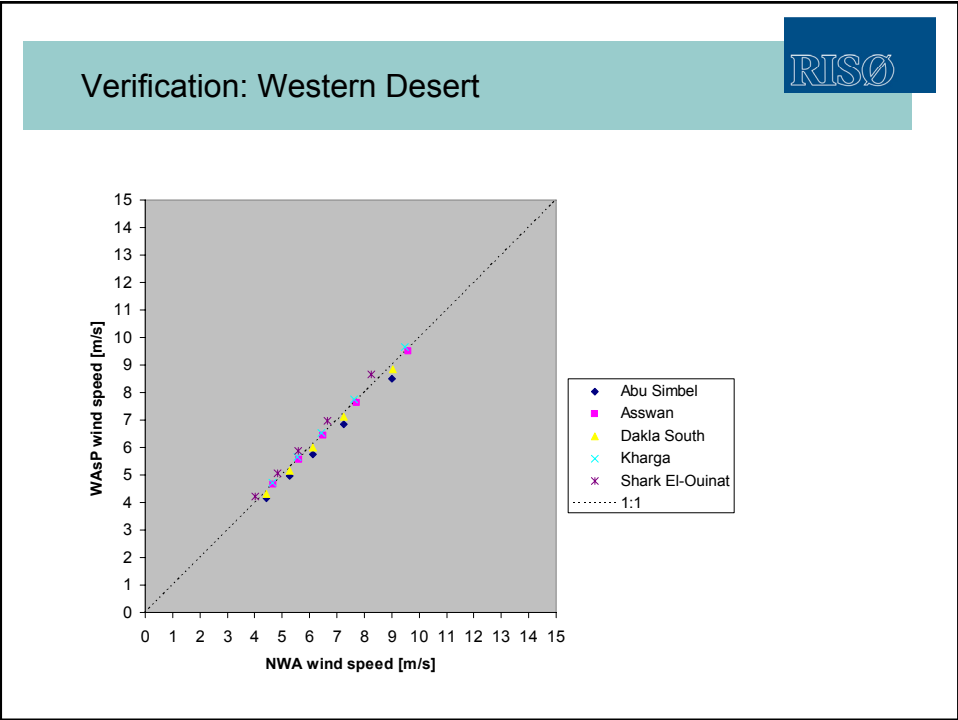
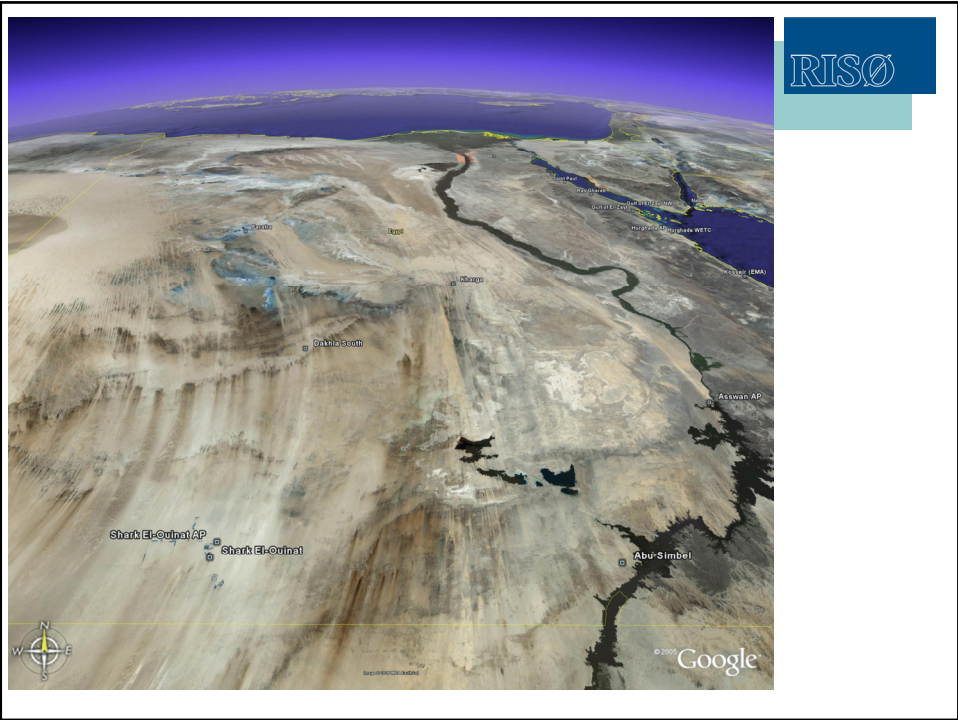


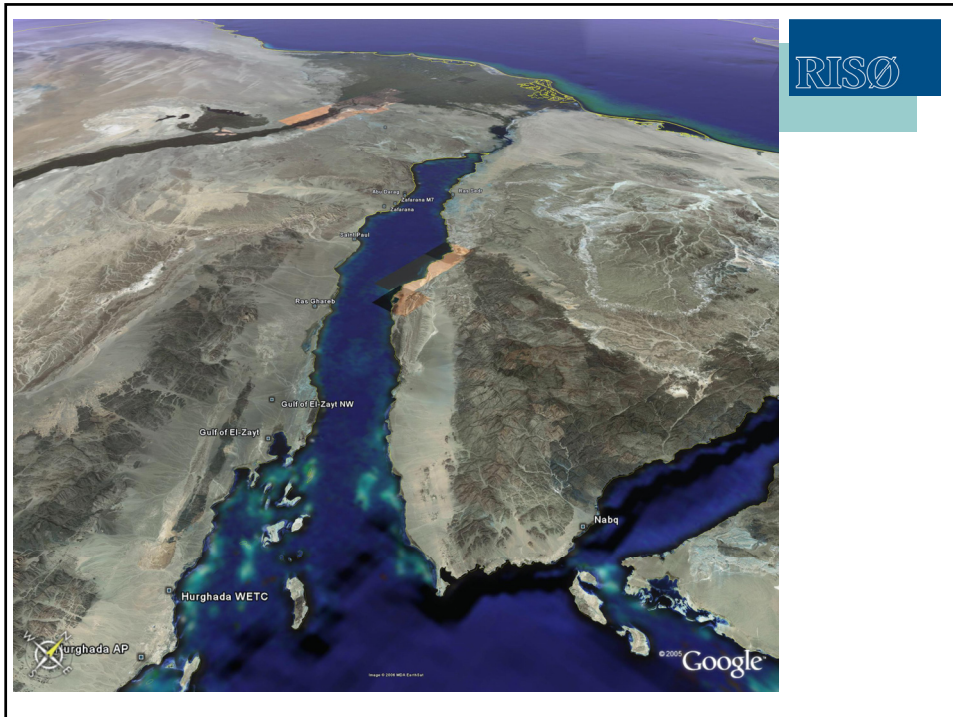
## Detailed wind resources at Ras El-Hekma



- WAsP modelling of detailed wind speed @ 10 m a.g.l.
- Resolution 100 m
- KAMM wind map indicates Class 2
- Offshore resource is higher: Class 5
- Coastal resource is higher: Class 3/4
- Hill/ridge resource is higher: Class 6

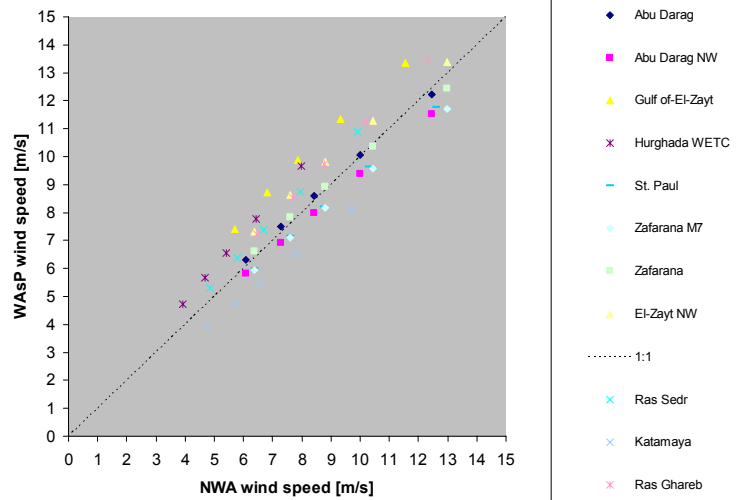






## Verification – Gulf of Suez

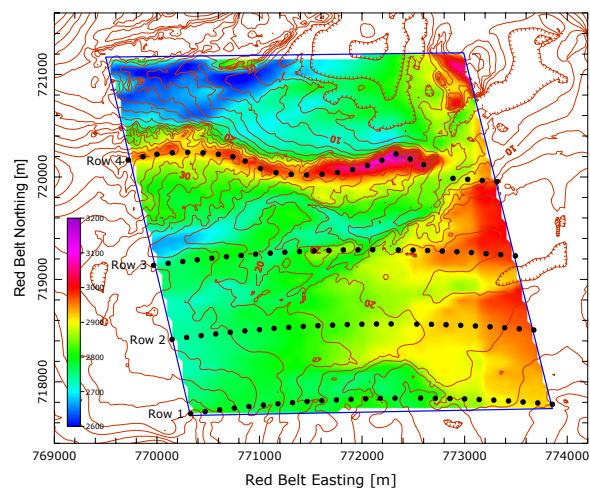
RISO



## Wind Atlas for Egypt – application range

1. Egyptian wind resources on national scale
  - Input: numerical wind atlas database (large domains)
  - Output: resource maps, statistics, GIS data,...
  - Purpose: national planning, decision making, master plans,...
2. Regional resource assessments and wind power planning
  - Input: numerical wind atlas database (regional domains)
  - Output: as 1. + predicted wind climates, power productions,...
  - Purpose: regional planning, feasibility studies,...
3. Local resource assessments and wind farm planning
  - Input: observational wind atlas data
  - Output: as 1. + predicted wind climates, power productions,...
  - Purpose: planning, feasibility studies, project preparation,...
  - Bankable resource assessments close to met. stations

## Detailed wind resources at Zafarana



## A complete package...



- Wind-climatological inputs
  - Observational wind atlas (30+ stations)
  - Numerical wind atlas (all of Egypt)
- Topographical inputs covering all of Egypt
  - SRTM 3" elevation data
  - SRTM Water Body Data (coasts and lakes)
  - Google Earth satellite imagery (land-use)
- Software tools
  - Microscale modelling tools (WAsP software)
  - Terrain mapping tools (Surfer, Map Editor, Didger)
- Other resources
  - Wind atlases, wind farm planning report, capacity building, ...
  - Bird Migration Atlas, EIA reports, guidelines, ...

## The future...



- Numerical wind atlas (KAMM/WAsP methodology)
  - Long-term data (1968-95) – infrequent updating ok
- Observational wind atlas
  - Some reference met. stations should continue
  - New measurement programmes may be initiated
  - Cup anemometers must be rehabilitated and recalibrated
  - Wind Atlas for Egypt can be updated, extended and detailed
- Main conclusions
  - wind resource assessment, siting and wind farm planning can now be done within hours anywhere in Egypt
  - present approach to wind resource assessment and siting in Egypt may be continued for several years
  - numerical wind atlas methodology can be applied elsewhere

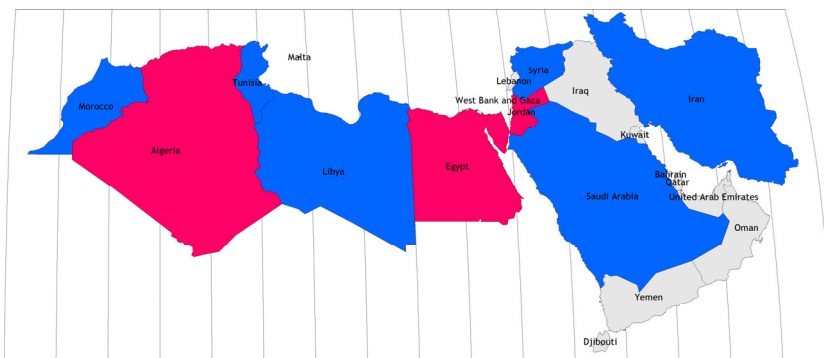
# THE END

Thank you for your attention! 😊



(slide by Magnus, 10 years old)

## MENA Region overview



- 3 countries with national wind atlases: Algeria, Egypt and Jordan
- 7 countries with some wind resource assessment and siting activities
- 10 countries where no information was available (to me at least)
- if you have any other or more information I'd like to know...