Austrian Wind Atlas and Wind Potential Analysis

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AUSTRIAN WIND POTENTIAL ANALYSIS

Project key data

- Project Motivation:
  - No comprehensive wind map available for Austria
    - Complex orography; large variety of local winds, low level jets and supra-regional wind streams
  - Political discussions on community, cantonal and national level
    - Designation of eligible areas, RES targets…
- Research Project with two major objectives:
  - Theoretical wind potential: Accurate and highly resolved Austrian wind map
  - Realisable wind potential: Dynamic GIS Modelling
- Timeframe: 2 years (2009-2010)
- Supported by means of the Austrian "Climate- und Energy Fund"

Project Partner

- Energiewerkstatt, Friedburg
- Meteotest, Bern
- Wegener Center, Uni Graz
- Research Studios iSpace, Salzburg

Work Packages	
WP 1	Project Management
WP 2	Wind measurement data
WP 3	Modelling of Wind resources
WP 4	Criteria for realisable wind potential
WP 5	GIS Modelling of realisable wind potential
WP 6	Dissemination

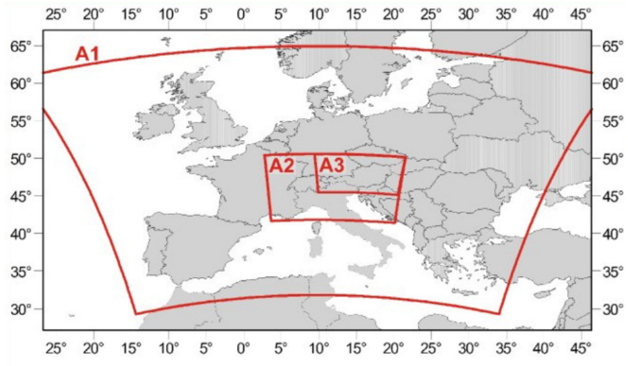
Different model types

- Dynamic models
  - Based on: Simulation of the temporal development of the atmospheric conditions in due consideration of the meteorological processes and the interaction of surface and atmosphere
  - Pros: Independent of measurement data, availability of time series
  - Cons: Spatial resolution ~km; time consuming (several months)
- Statistical models
  - Based on: Interpolation of measurement data in due consideration of the orography and the land use
  - Pros: High spatial resolution ~100m, short computing time
  - Cons: Quality dependent on density/quality of the measurement network
→ local wind systems might not be well recognised;
only mean values no statistics

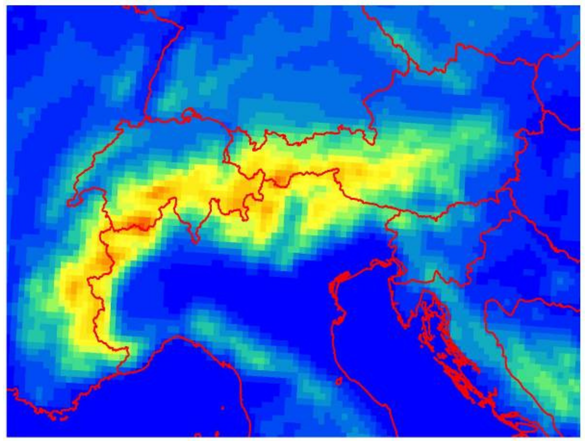
→ Combined approach for AuWiPot

Dynamic modelling

- Climate dataset for a 10 x 10 km resolution had been available from a previous national research project “reclip:more“ (1)
  - Driven by Re-Analysis data set ERA-40
- Dynamic downscaling of those two periods with MM5 from 10 km to 2 km resolution
  - Jülich Supercomputing Centre (JSC)
  - HPC Uni Graz
- Based on “reclip:more” two modelling periods :
  - 1999
  - 1981-1990



10 km x 10 km



(1) Loibl et al. (2007): "Research for Climate Protection: Model Run Evaluation (reclip:more)“

Results of dynamic downscaling

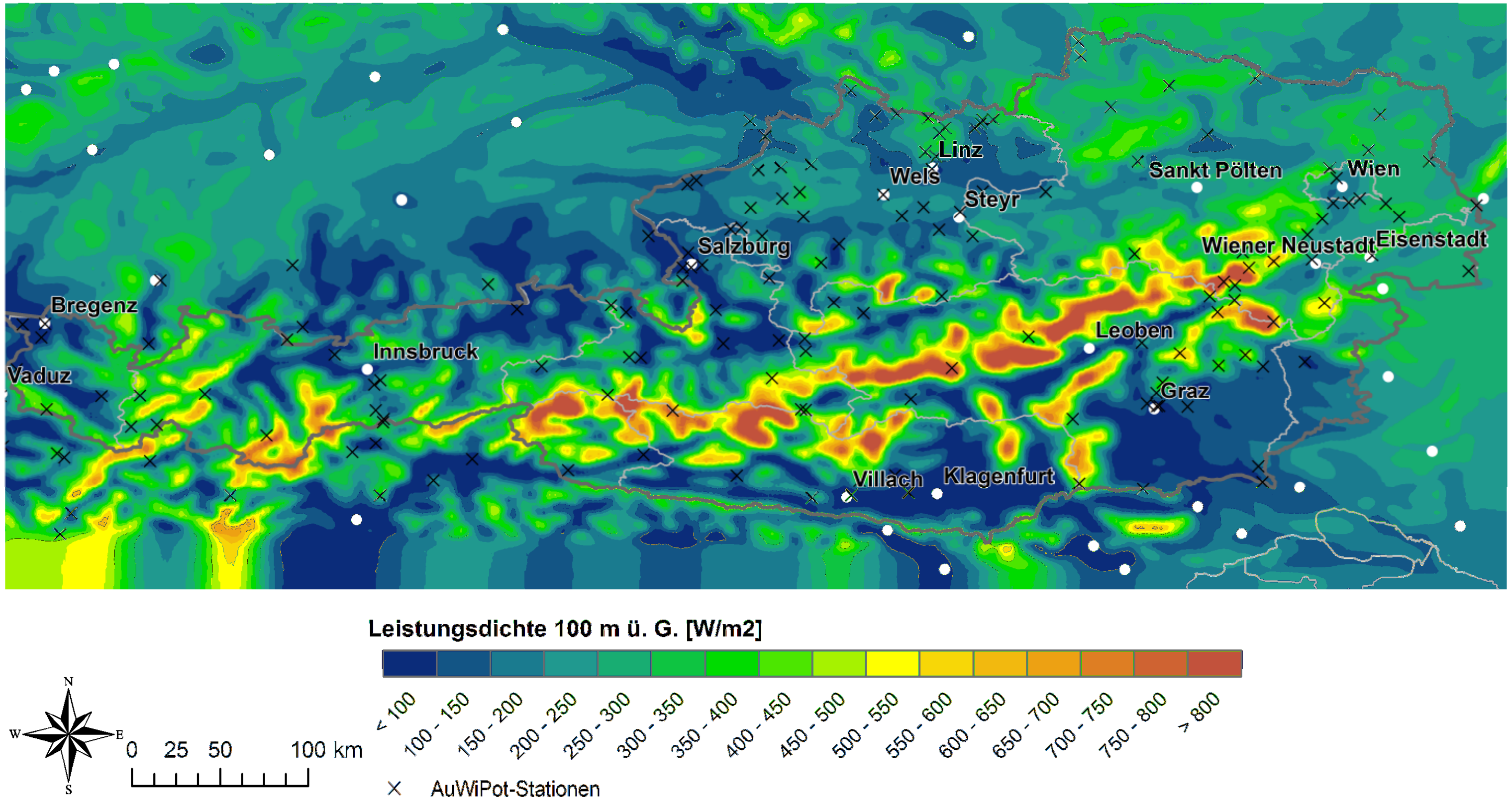
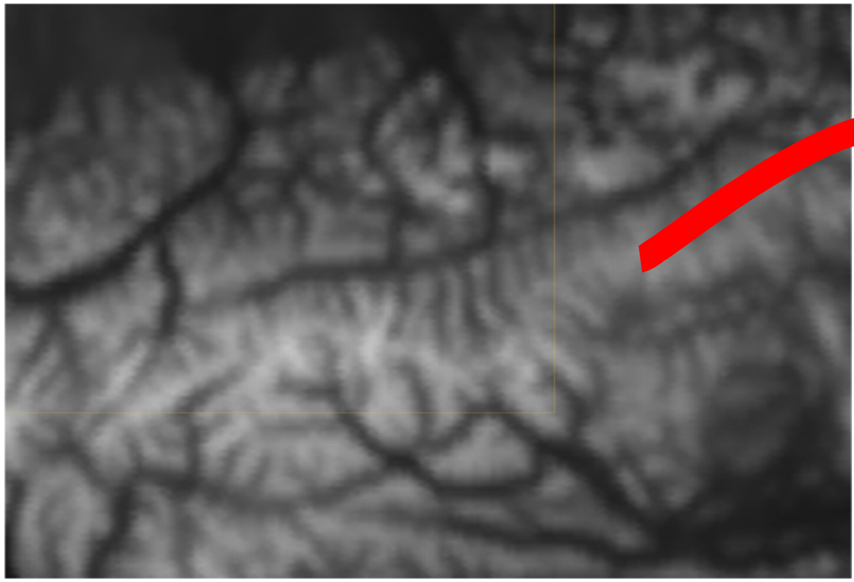


Fig.: MM5 results [W/m²] with 2x2km grid resolution , 100m.a.g.l.

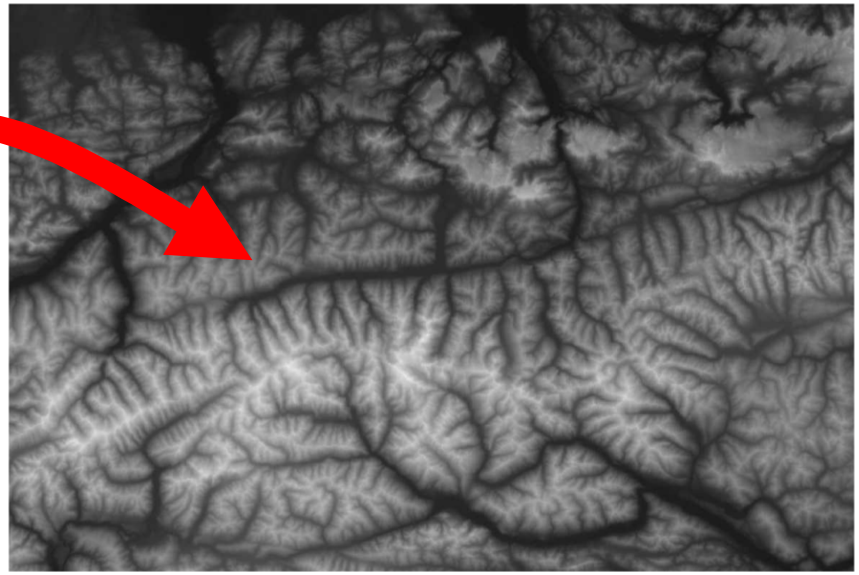
Shortcomings of MM5 in complex terrain

Topography in MM5



Grid resolution 2x2 km

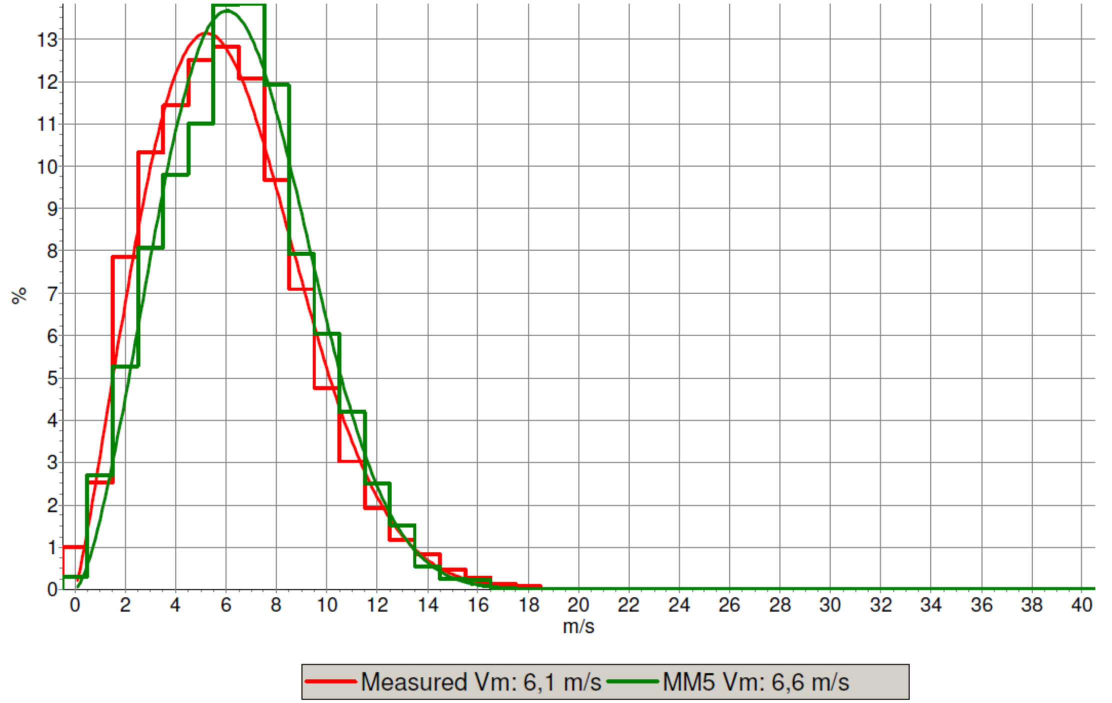
Topography of SRTM

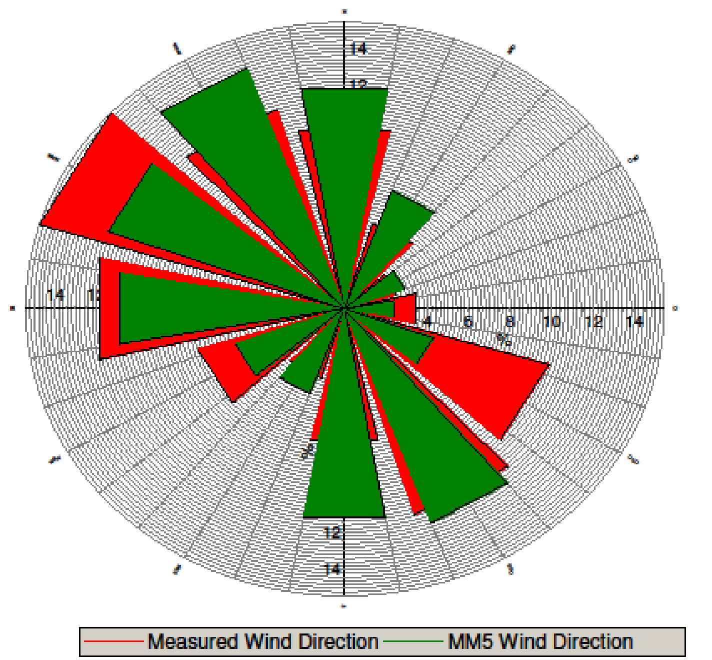


Grid resolution 100x100 m

Evaluation results of MM5 in flat terrain

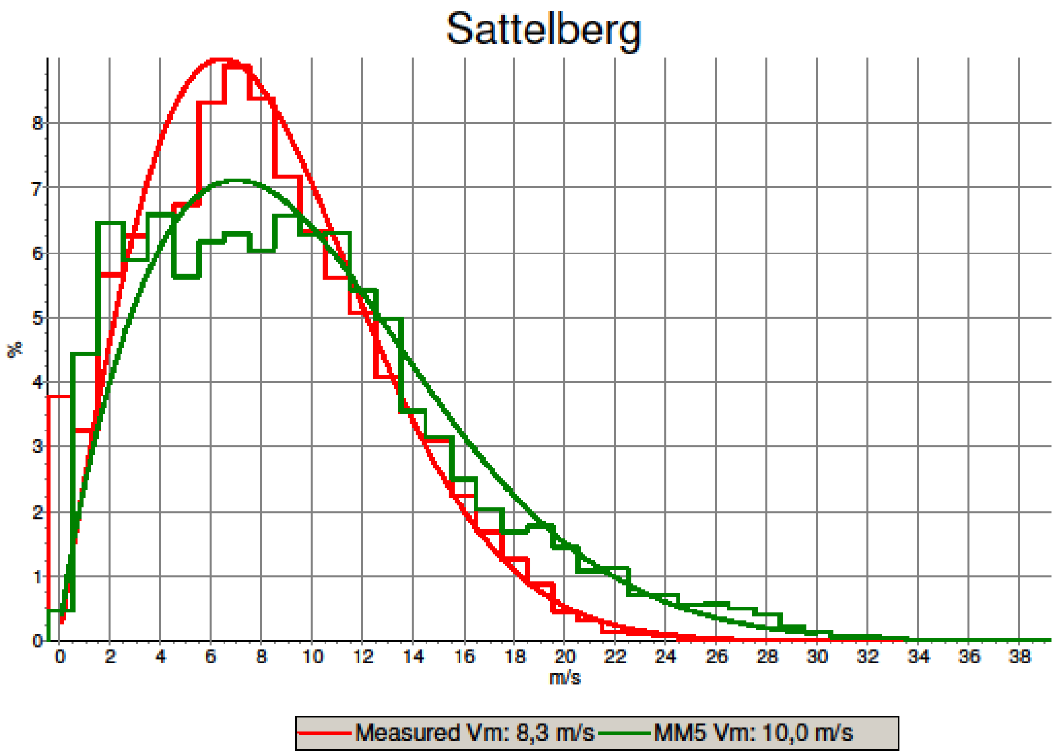
Location close to Mistelbach / NÖ

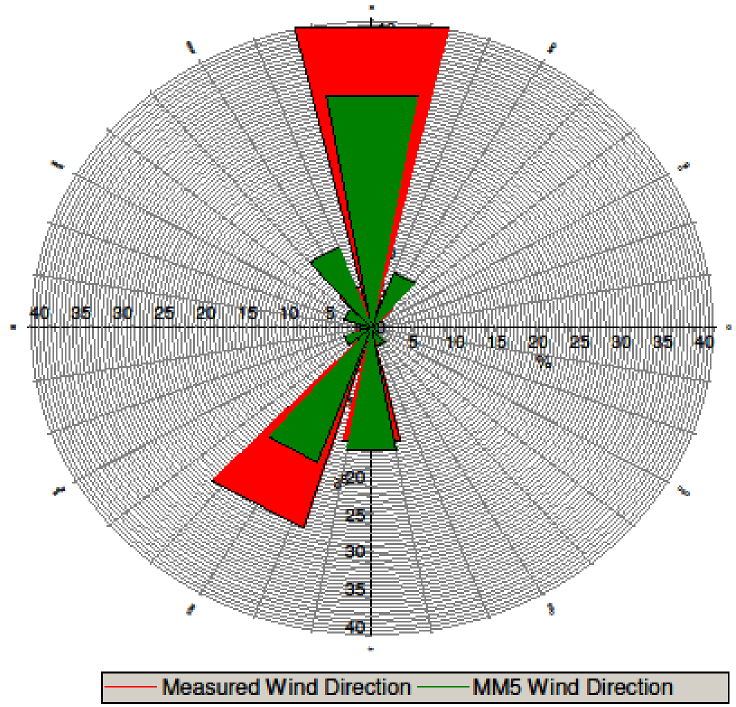




MM5 does good work for the wind-energetic interesting regions in the East for heights between 50 and 150m a.g.l.

Evaluation results of MM5 in complex terrain





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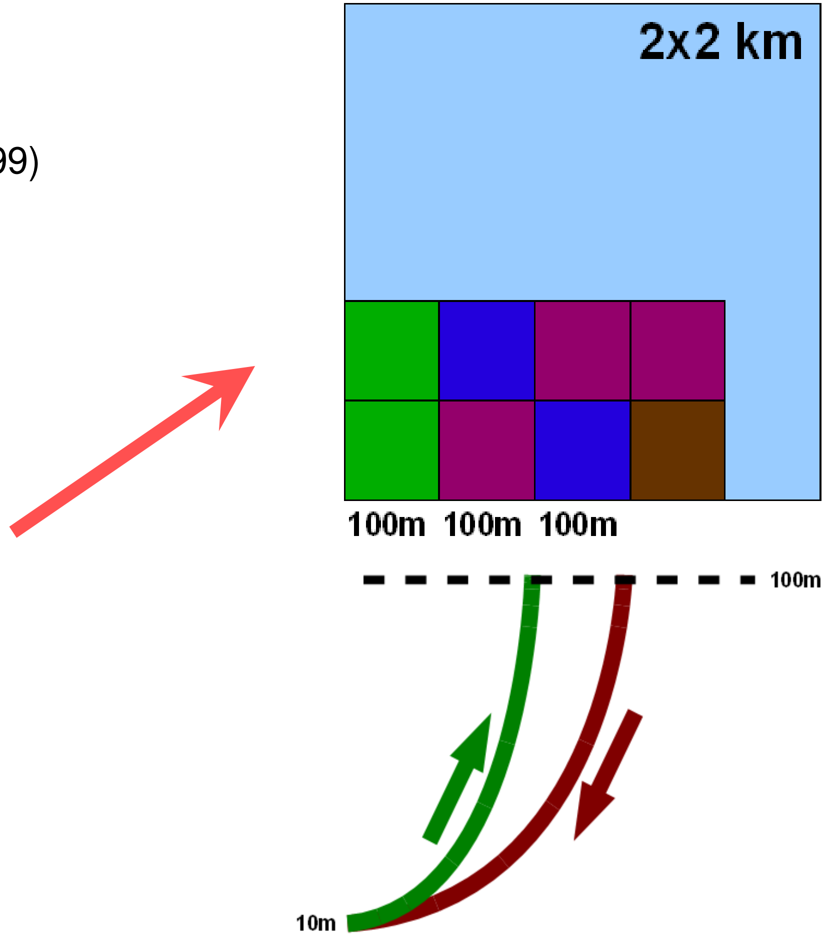
Integration of on-site measurement data

Besides results from dynamic downscaling to 2 x 2 km

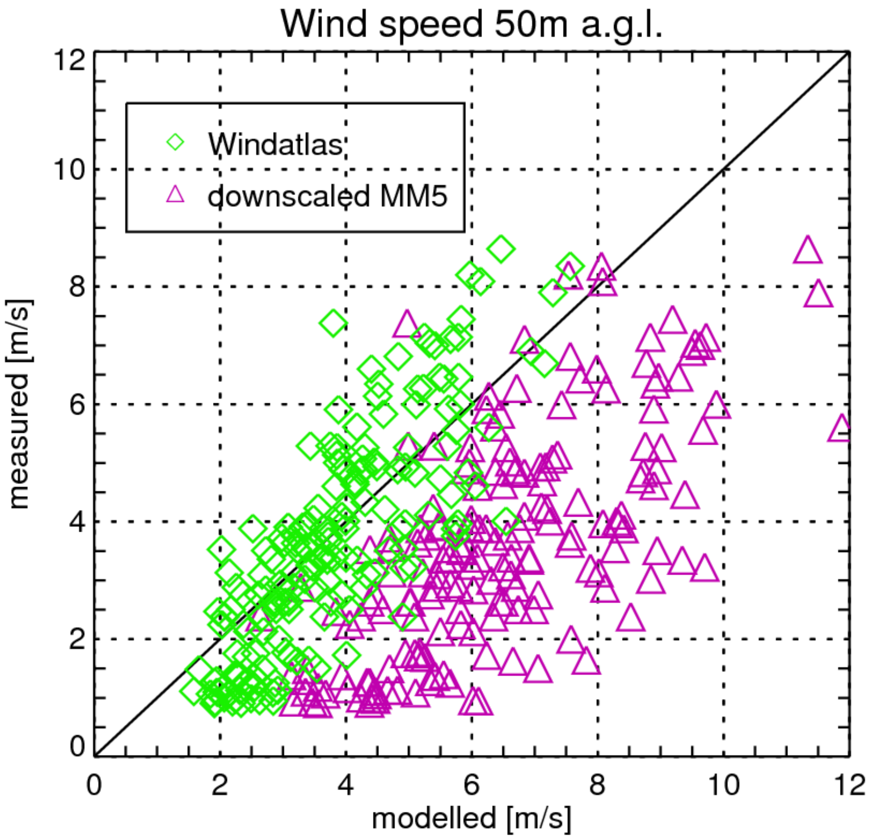
1. Institutional Wind measurements in Austria:
   1. Austrian Central Institute for Meteorology and Geodynamics (ZAMG)
   2. Federal Austrian Governments
   3. University of Innsbruck, Austria
2. Institutional Wind measurements in neighbouring countries:
   1. German National Meteorological Service (DWD)
   2. Swiss Federal Office of Meteorology and Climatology (MeteoSwiss)
   3. Southern Tirol Weather Service
3. Private Wind measurements
   1. Measurements for wind energy projects
   2. Energy yield data of operational wind power plants

Geo-statistical modelling approach

- Validation and correction of measurement data
  - Differences measurement / model year (1999)
  - Extrapolation of data to 100 m a.g.l
- Interpolation of MM5 results to fixed height levels (50-130 m a.g.l.)
- Interpolation to 100x100m grid
- Adjustment to height differences between MM5 topography and SRTM database
- Adjustment to different surface roughness



Observed and modelled annual wind speeds (50m a.g.l.)



Reference: Truhetz, H., S. C. Müller, A. Gobiet (2010), Generation of error-corrected wind climatologies in the Alpine region with 100 m grid spacing, (poster), EGU 2010 General Assembly, 2 – 7 May 2010, Vienna, Austria, Geophysical Research Abstracts, 12, EGU2010-3500

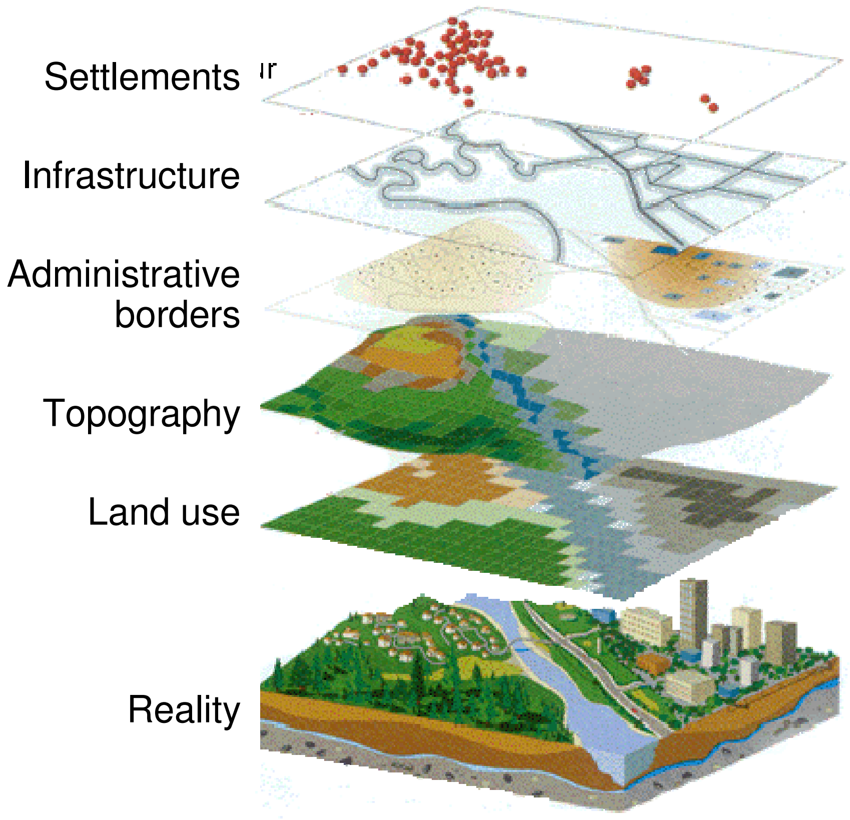
01 Introduction

02 Theoretical Wind potential

03 Realisable Wind Potential

04 Results

Implementation via GIS Modelling



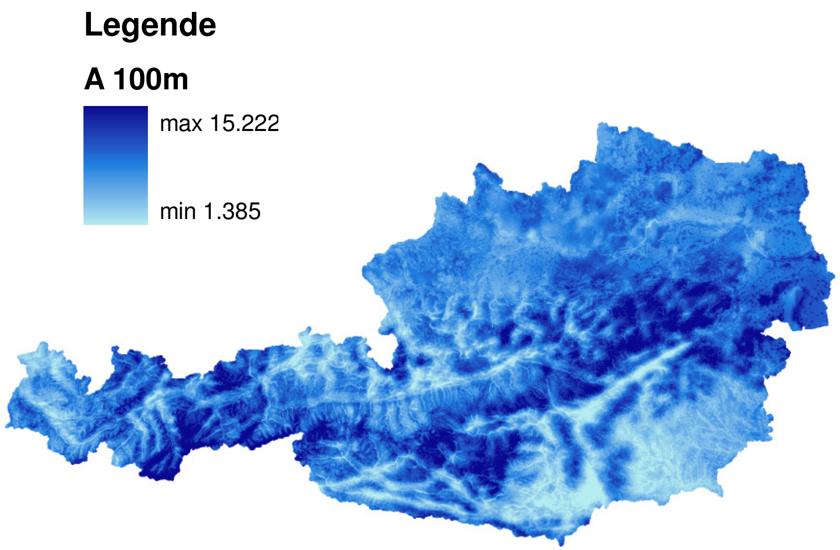
- Separate aspects of reality are presented in special data layers
- Merging of individual information layer in a spatial context

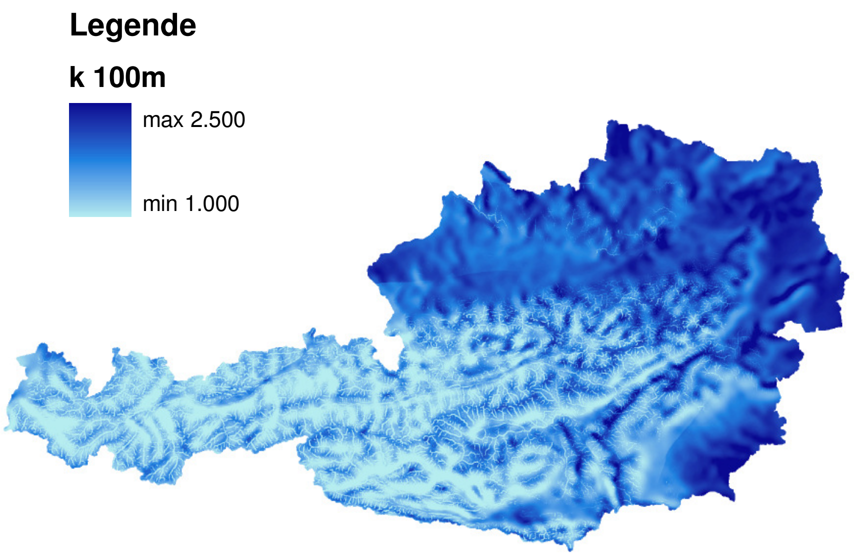
GIS modelling approach

Theoretical wind potential (A, k- Parameter)
Consideration of technical, spatial and economic constraints
→ Realisable wind potential

- WebGIS based software framework allows a manual selection/alternation of the values for constraints
  - Turbine capacity, feed-in tariff [€ct/kWh] …
- Based on those selections the GIS Model calculates the realisable wind potential in 2 steps:
  - Where is it feasible to construct under the chosen technical and spatial criteria?
  - Where is it feasible to construct under the chosen economic parameter
- Consideration of the existing wind power plants/potential
  - Either as Exclusion areas or for a Repowering scenario
  - Used for model evaluations

Wind resources for 100x100m

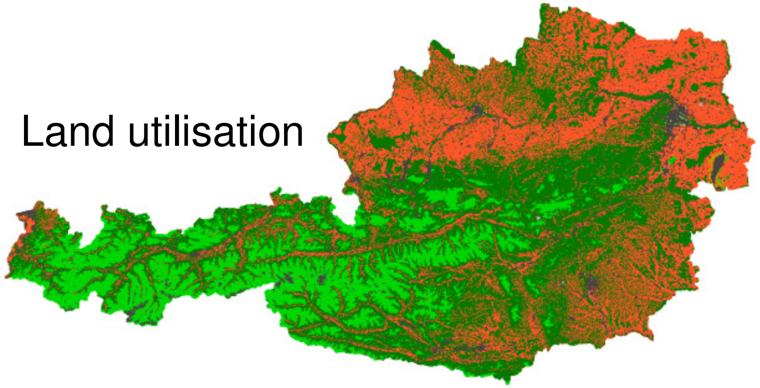




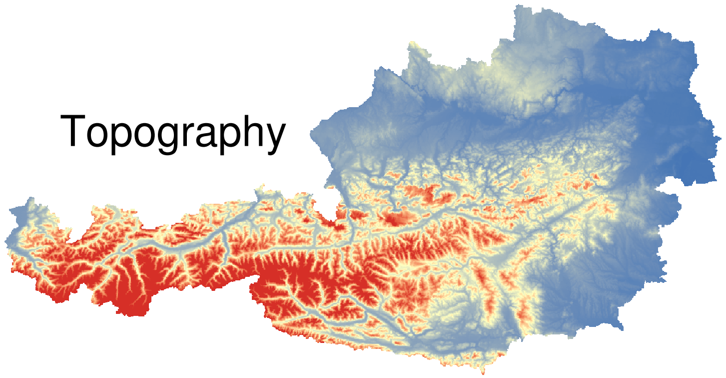
Height levels between 50 and 150 m.a.g.l. are available as input data for GIS modelling.

Topographic database

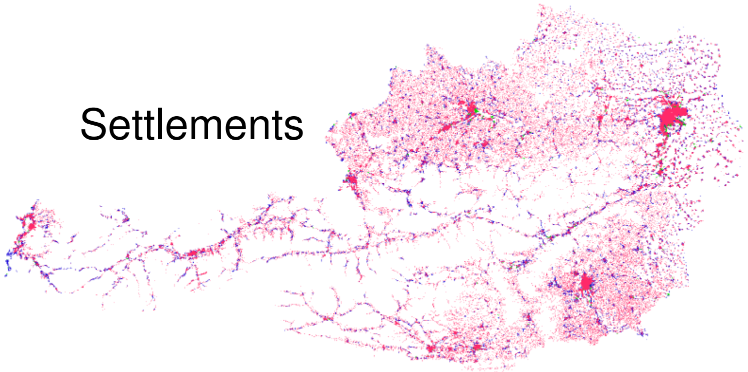
Land utilisation



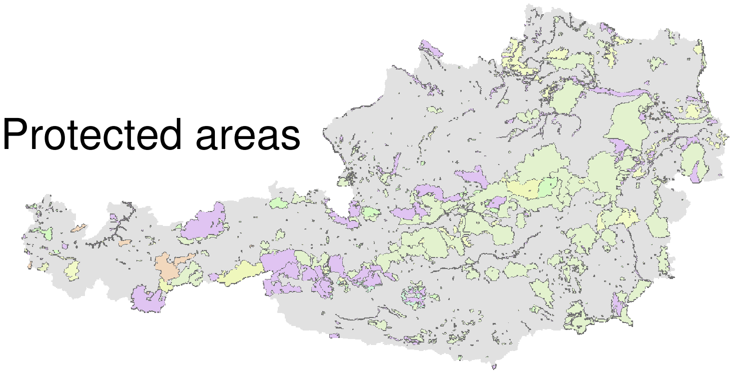
Topography



Settlements



Protected areas



Annual energy yield and energy potential

For the areas remaining from modelling step 1, the annual energy yield [MWh/year] is calculated by means of:

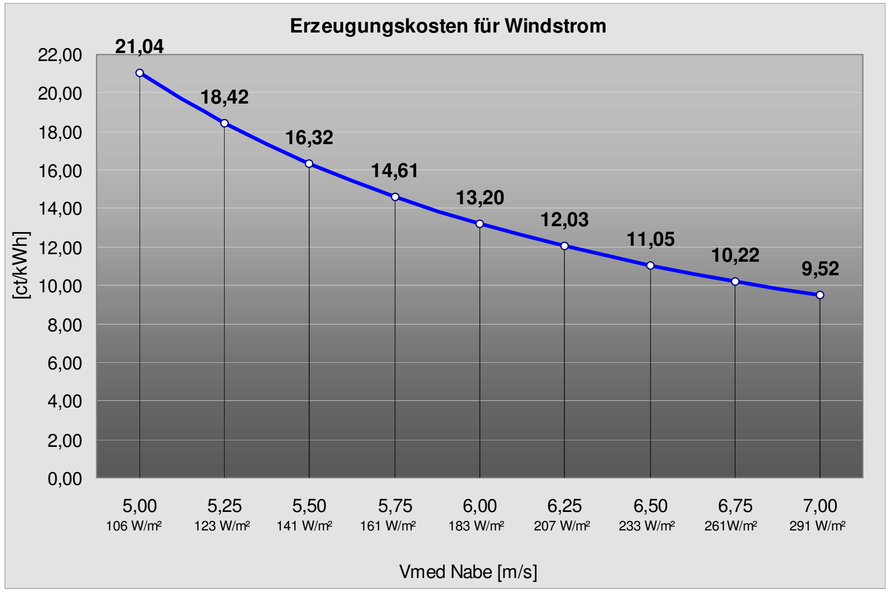
- Wind data at hub height in form of frequency distribution for a 100x100m grid
- The chosen wind turbine capacity
- An idealised specific power curve [W/m²]
- Wind farm efficiency, technical losses, technical availability…
- Sea level and mean annual temperature

Site-specific production costs

Approximation formula (Ref. Garrad, 1992)

$$g = \frac{C \cdot R}{E} + O$$

g:	Costs per kWh
C:	Installation costs per m² rotor area
E:	Annual energy yield per m² rotor area
O:	Operational and maintenance costs
R:	Reflux of capital



In case the site specific production costs for a certain raster cell are above the selected feed-in tariff, this cell is excluded and is no longer considered in the potential analysis.

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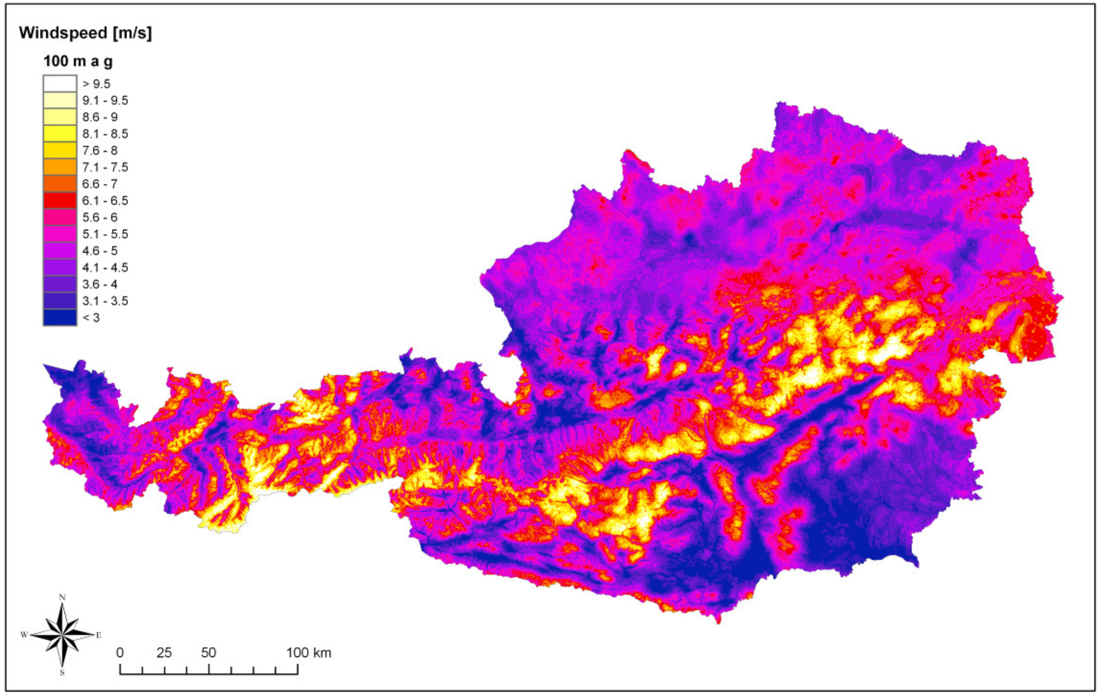
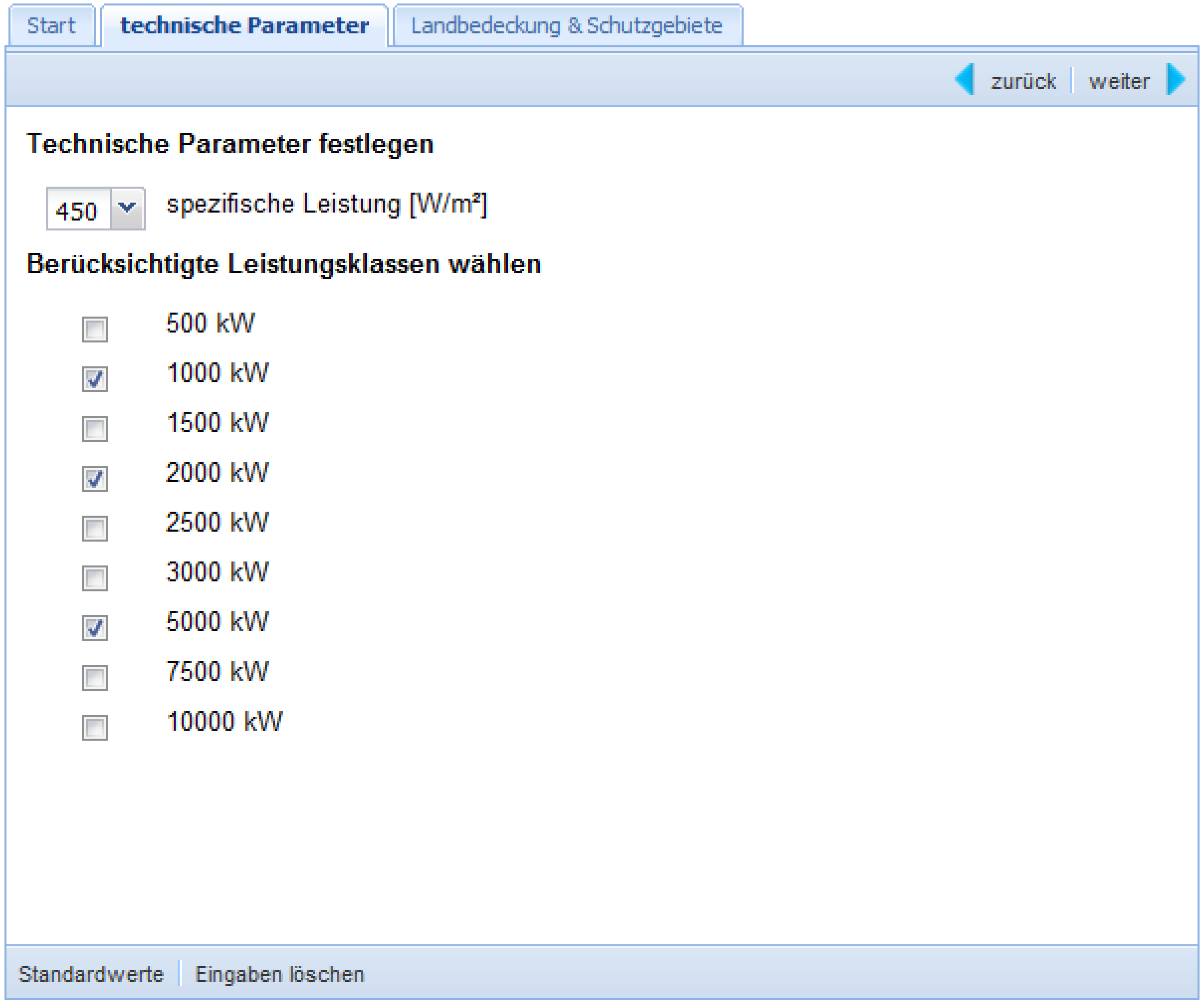
Wind map Austria

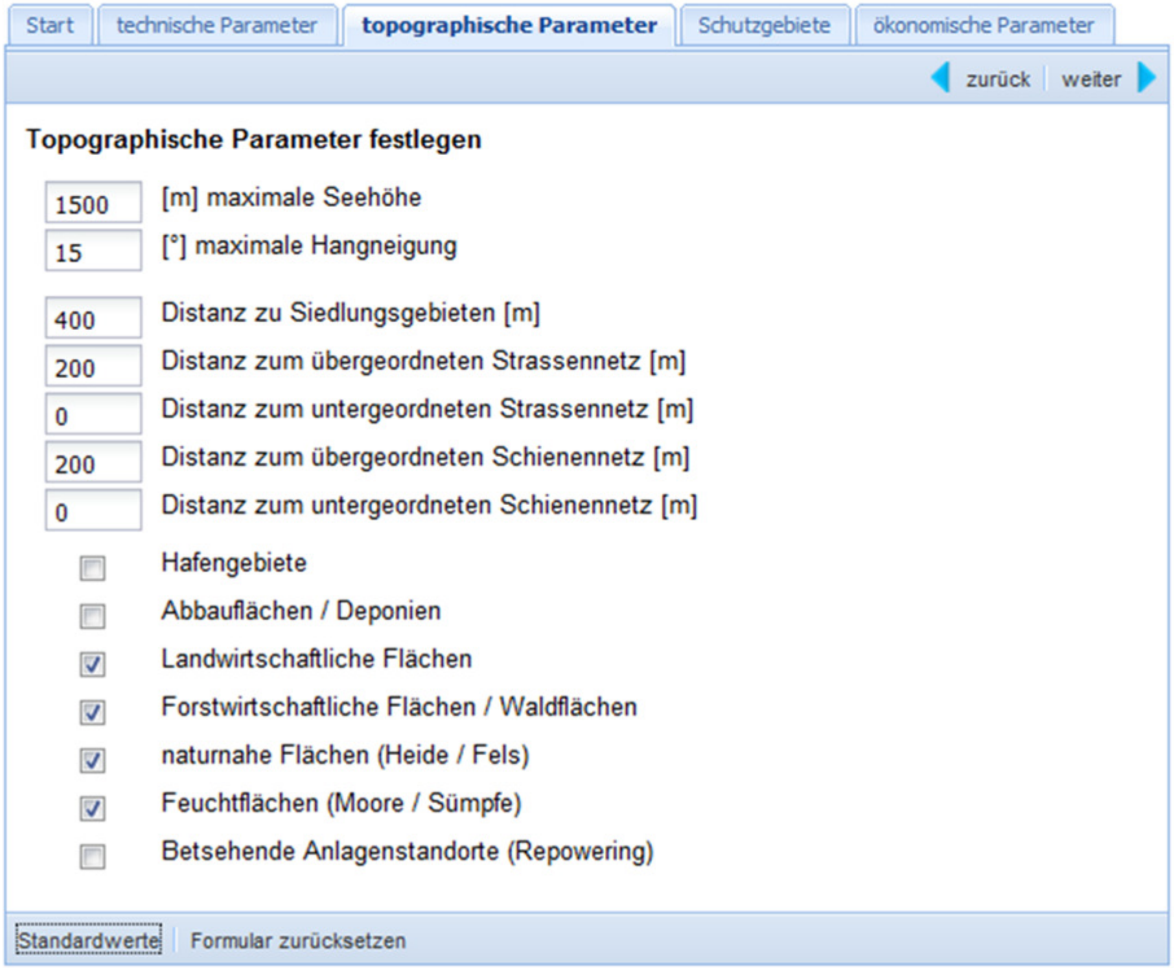


- Final adjustments ongoing
- Presentation of final results at Dissemination Workshop in Vienna (beginning of 2011)
- Publication of results on project homepage (www.windatlas.at) :

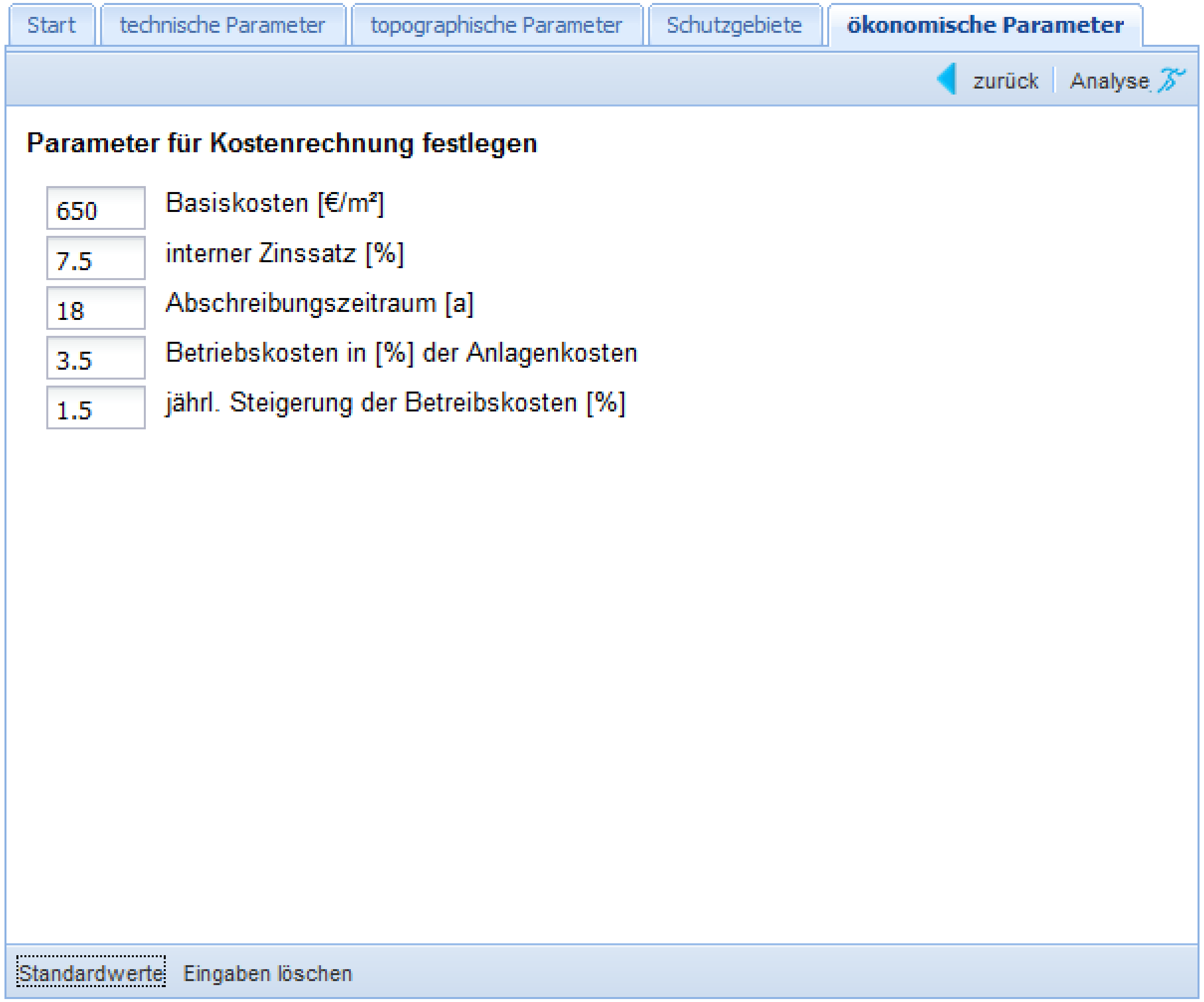
Web-GIS Application – Technical settings



Web-GIS Application - Topographic settings



Web-GIS Application – Economic constraints



Aggregation of realisable wind potential on district level

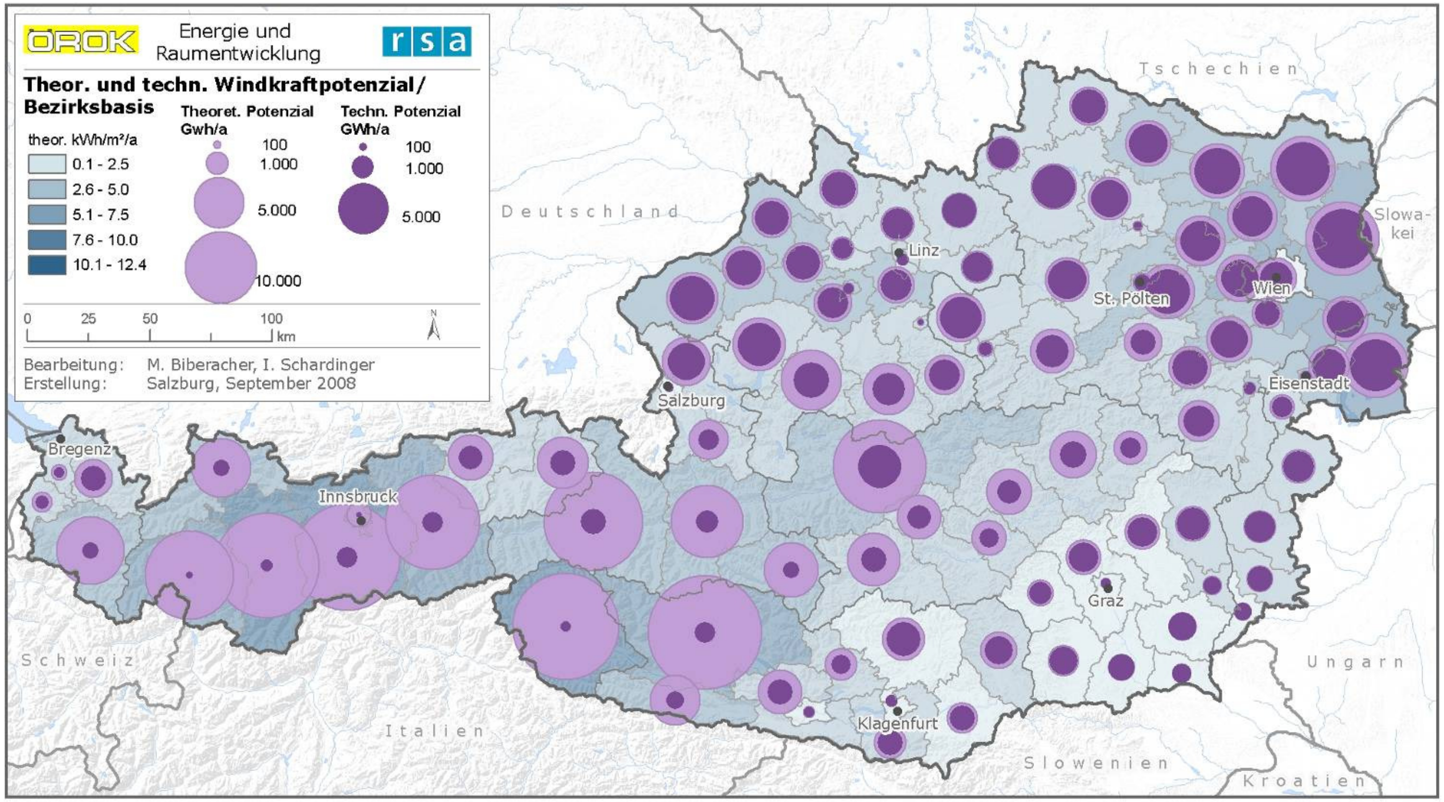
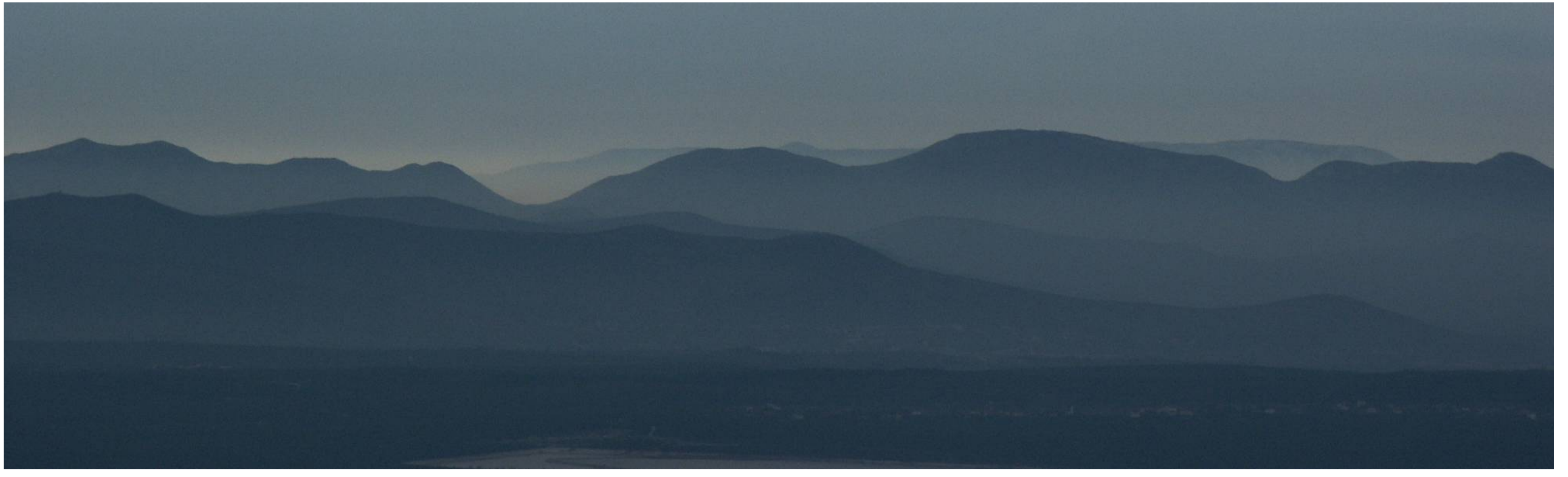


Fig.: Theoretic and realisable wind potential (Source: ÖROK Study, 2007)

No presentation of modelled eligible areas!

Austrian Wind Atlas and Wind Potential Analysis



Thanks for your attention!