



ICEM 2017
**4th International Conference Energy &
Meteorology**

Spatial modelling of wind farms expansion in northeastern Brazil

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Laboratory for Modelling and Studies of Renewable Energy Resources

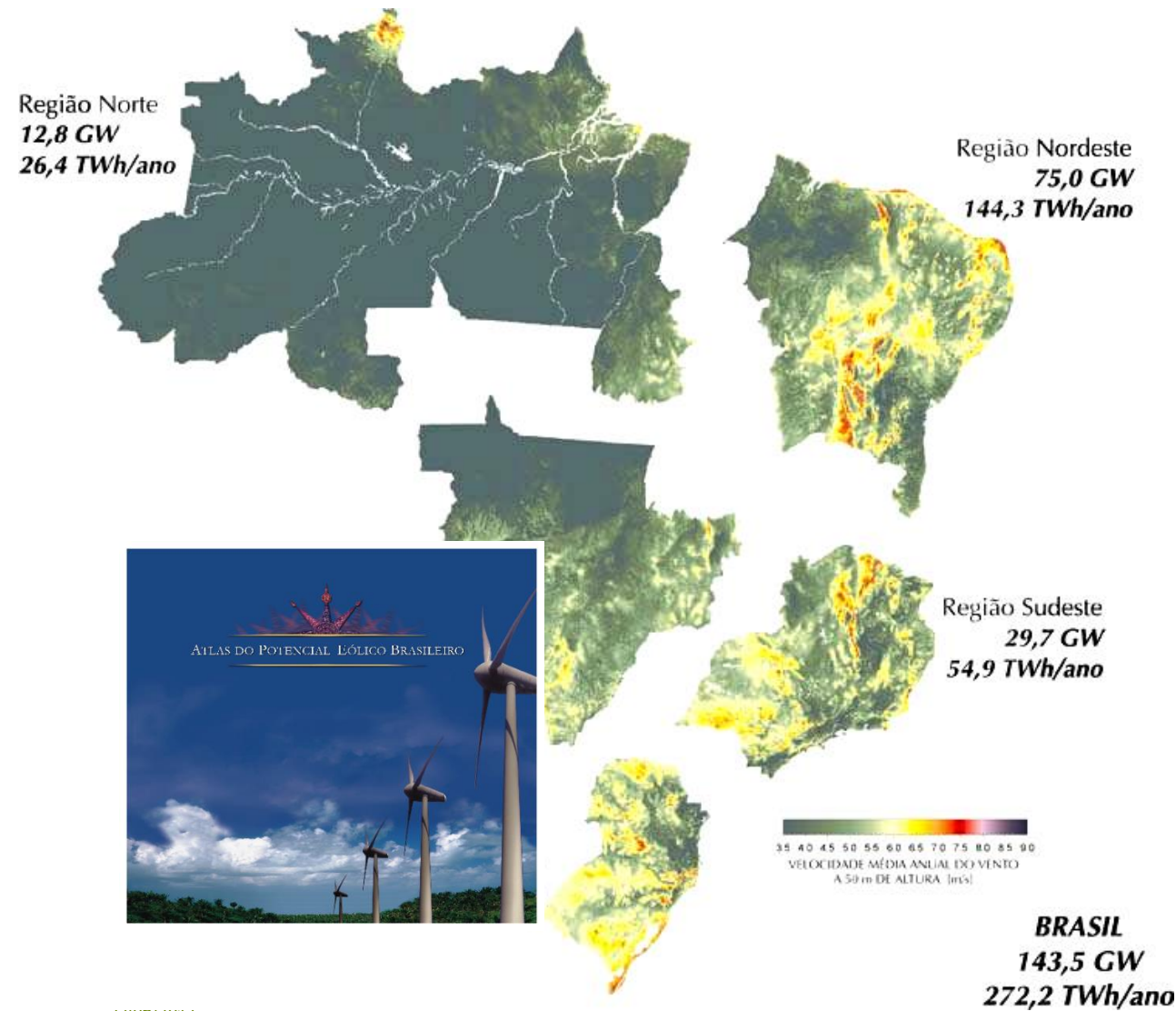
<http://labren.ccst.inpe.br>

The multidisciplinary laboratory LABREN-CCST-INPE, carries out research and teaching activities in energy meteorology and in the climate system influence on energy resources making use of satellite data, computational modelling and observational data.

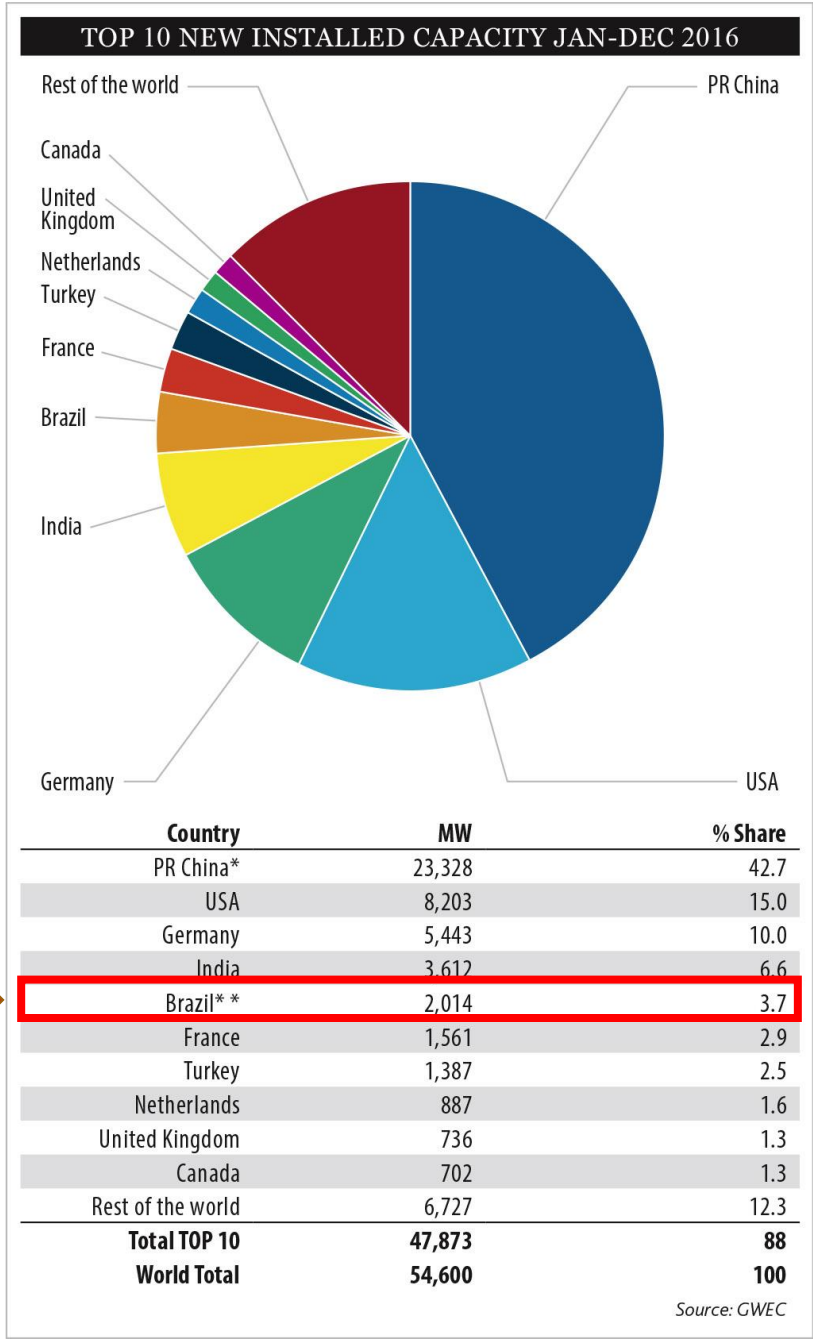
Research Topics:

- Assessment of solar and wind energy resources*
- Short and medium-term forecast of solar and wind generation*
- Energy and global climatic changes*
- Site-specific measurements, characterization and modelling of solar and wind resources*

Brazilian Wind Power Potential

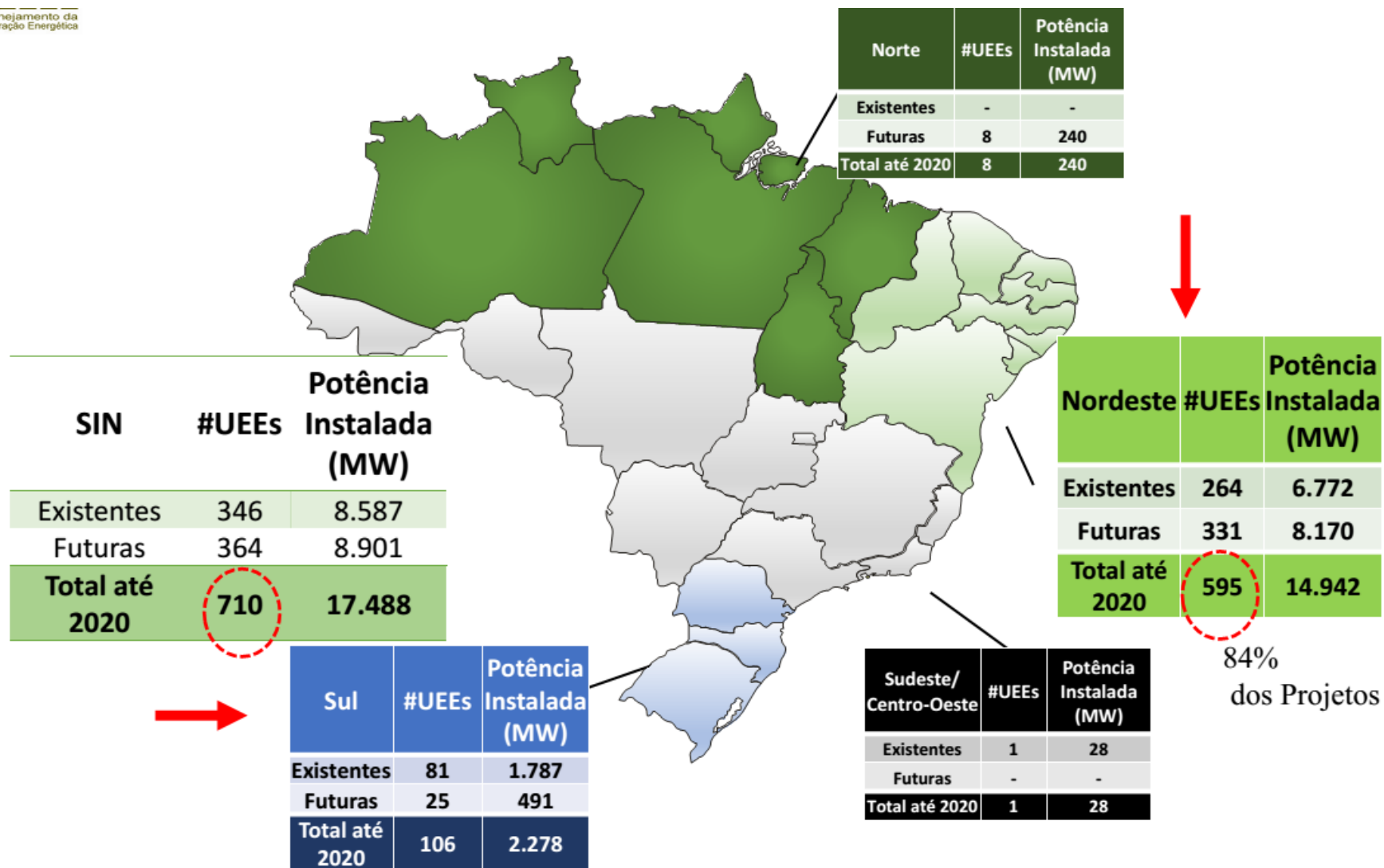


5°



Distribution of Wind Farms

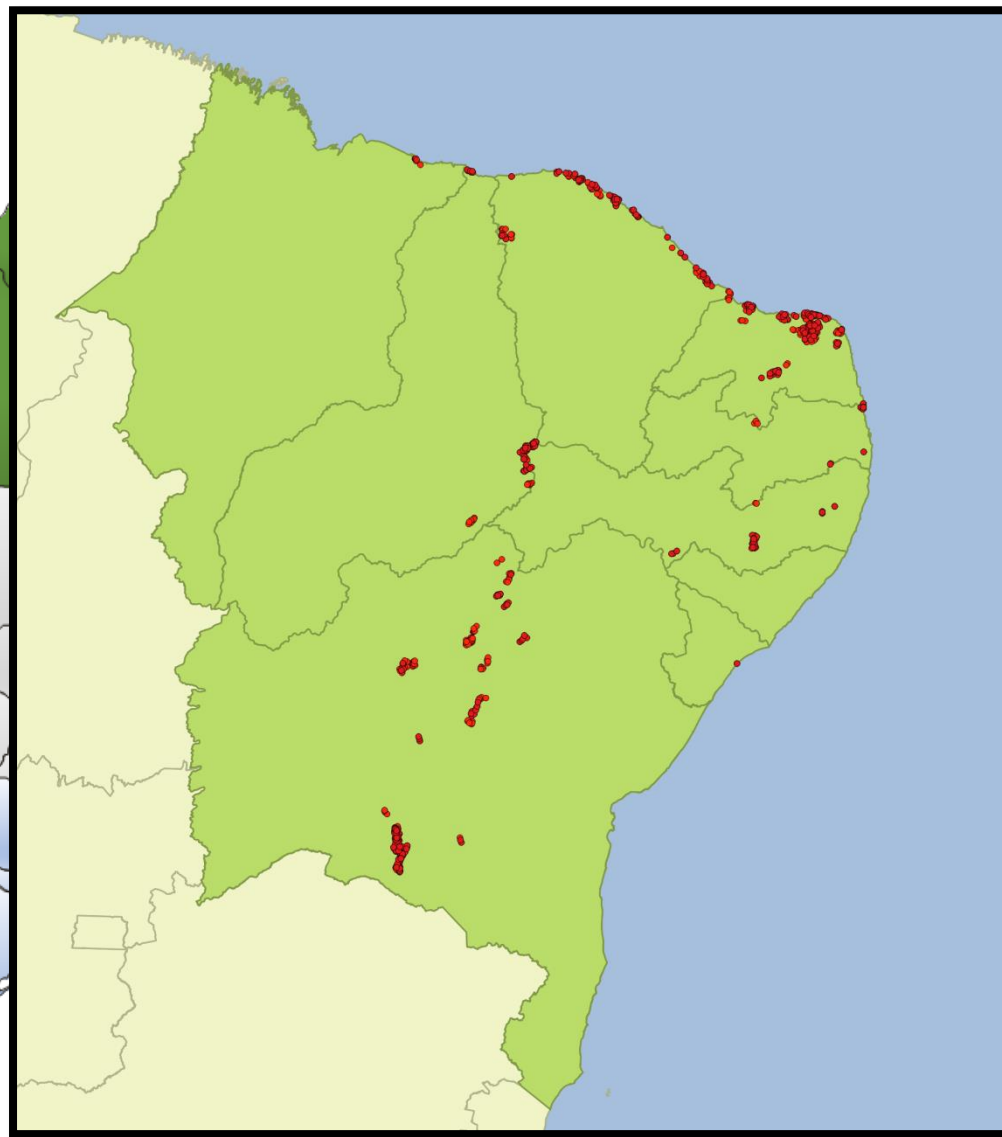
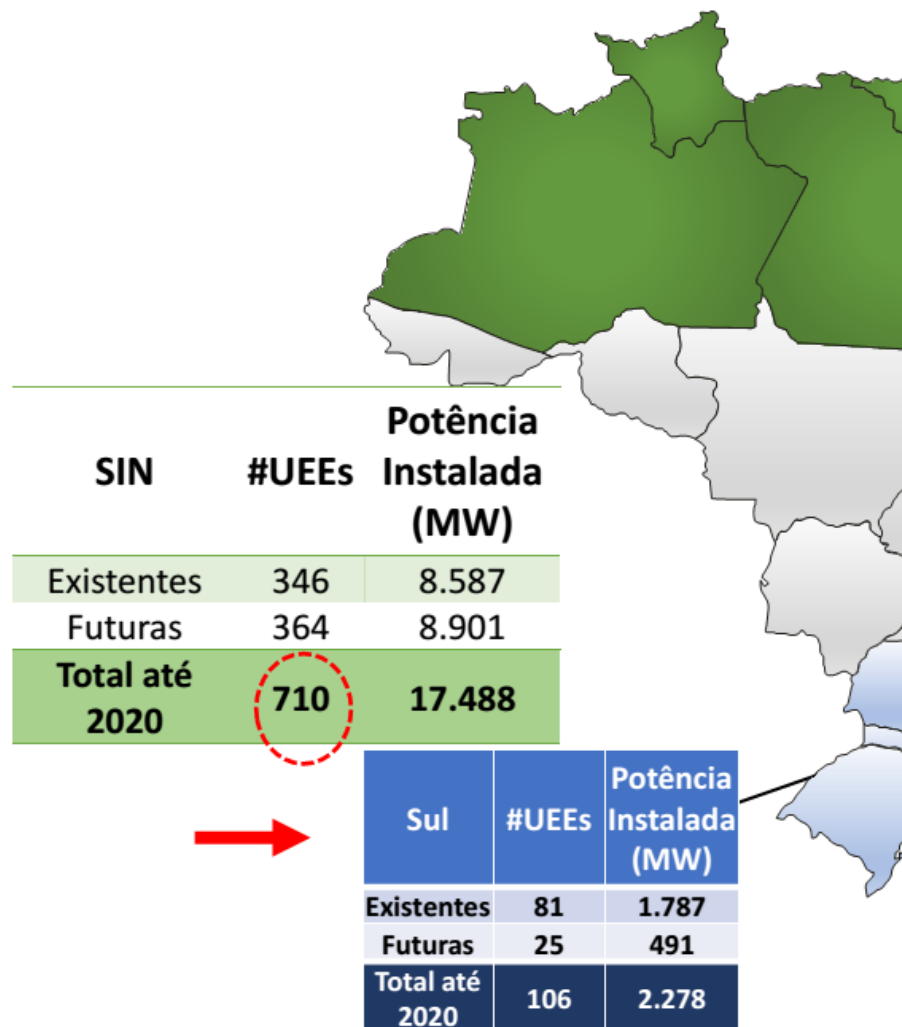
Planejamento da
Operação Energética



(ABEEOLICA, 2016)

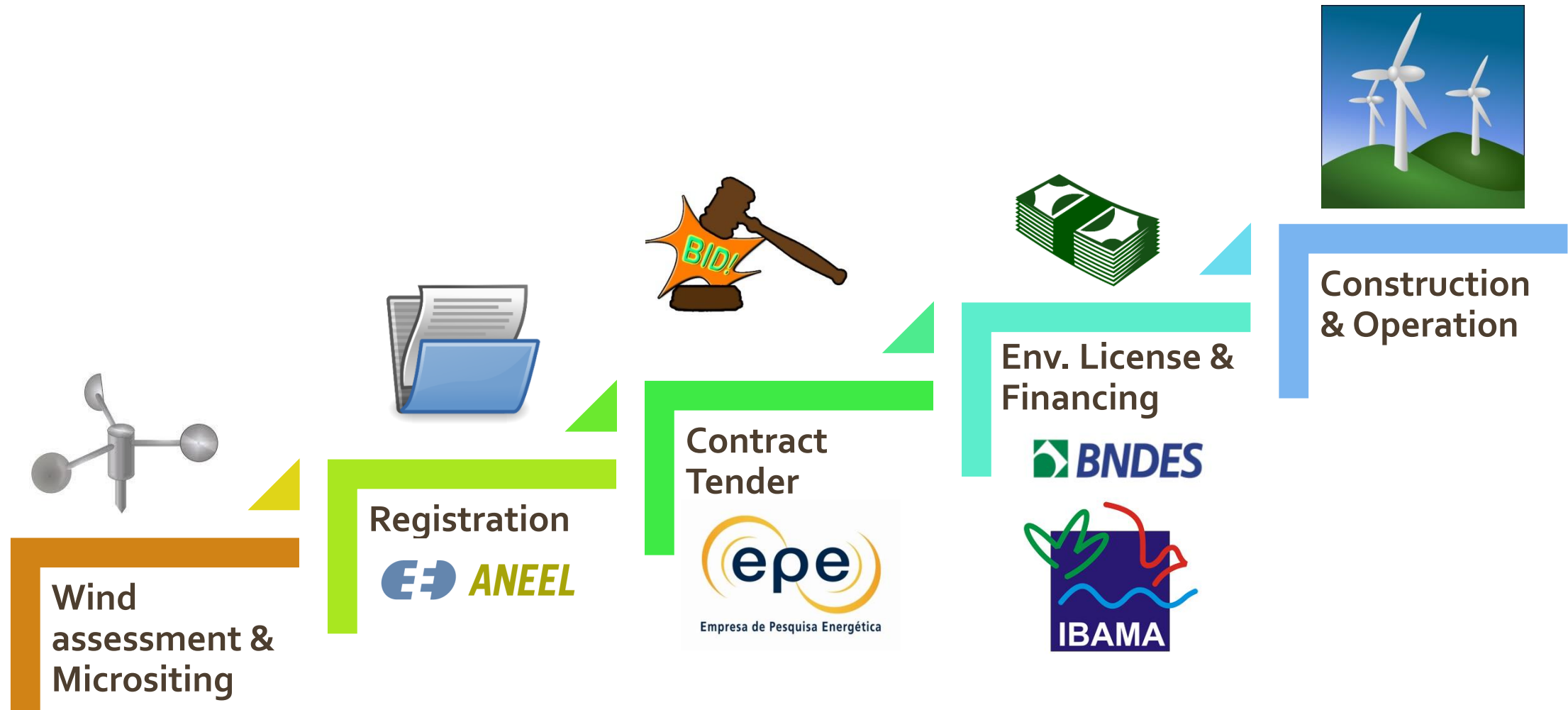
Distribution of Wind Farms

Planejamento da
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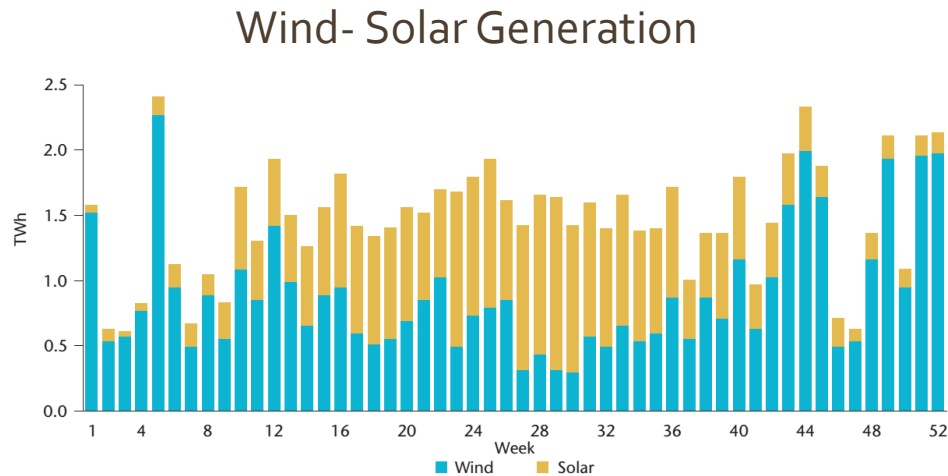
How wind farms are built in Brazil



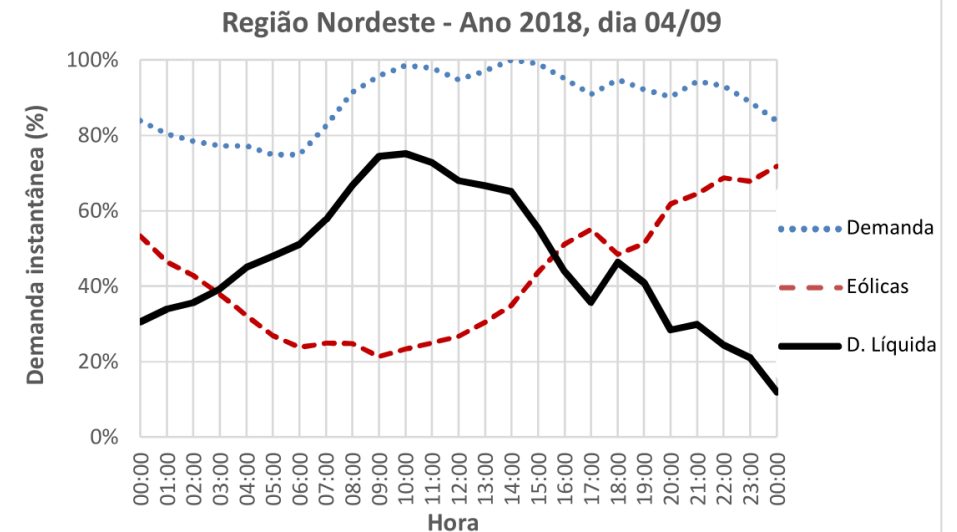
Why predict spatial distribution of wind power clusters?

Energy planning

- To assess complementarity between Solar-Wind-Hidro resources
- Predict grid expansion demands
- Risk assessment (energy security)
- Future impact on load curves



Estimated wind impact on load curve



(EPE, 2016)

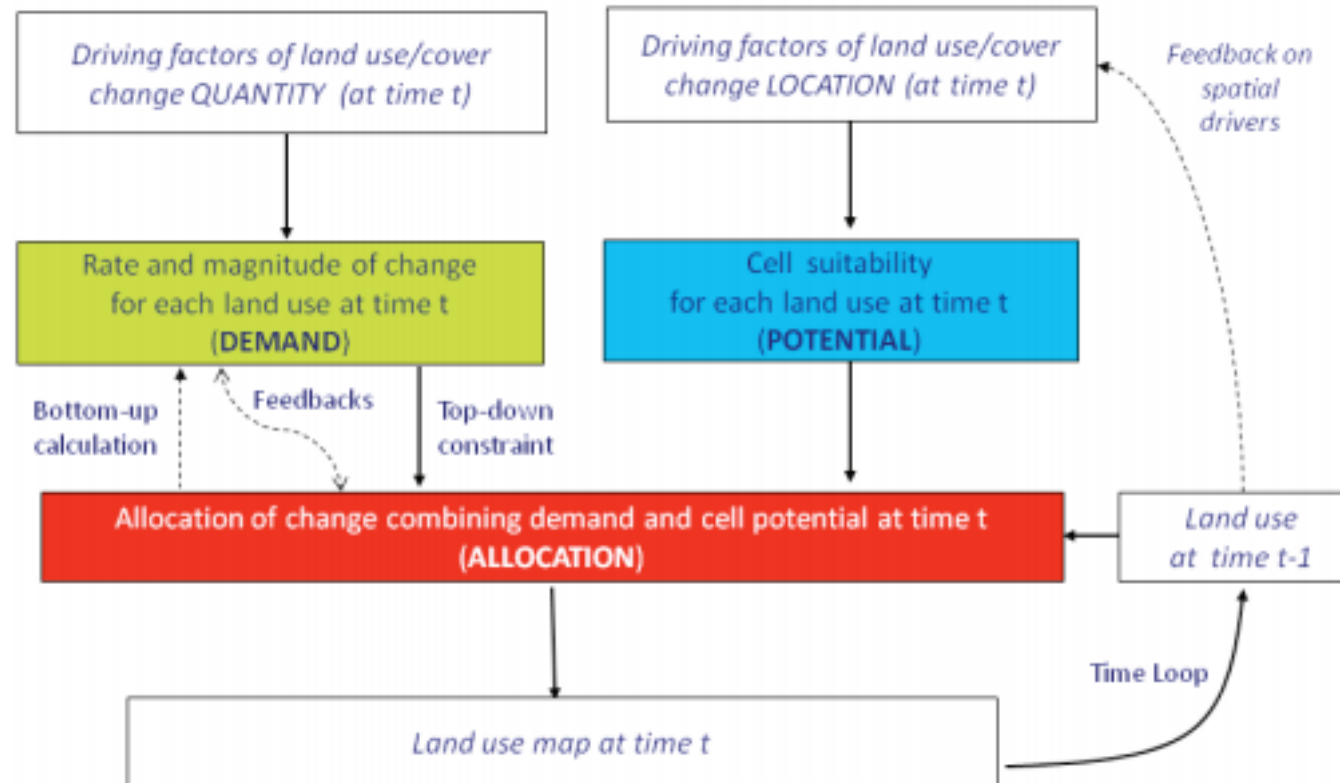
TerraME / LuccME model framework

- TerraME is a programming environment for spatial dynamical modelling developed at INPE



TerraME / LuccME model framework

- **LuccME** is an open-source framework for the development of spatially explicit land use and cover change models, built as an extension of the TerraME (Aguiar et al., 2012)



Model

- Discretized cells (~78 MW por célula)
- Study area: Northeast Brazil
- Resolution: 10 km x 10 km cells
- Timeframe: 2008-2012-2016
- Demand: Prescribed (contract tenders)
- Potential: Multiple Linear Regression
- Allocation Algorithm: ClueLike (Verburg et al 1999)
- Scenario: 2030 e 2050 (Government Planning and COP21 NDC)

Northeastern Brazil Domain



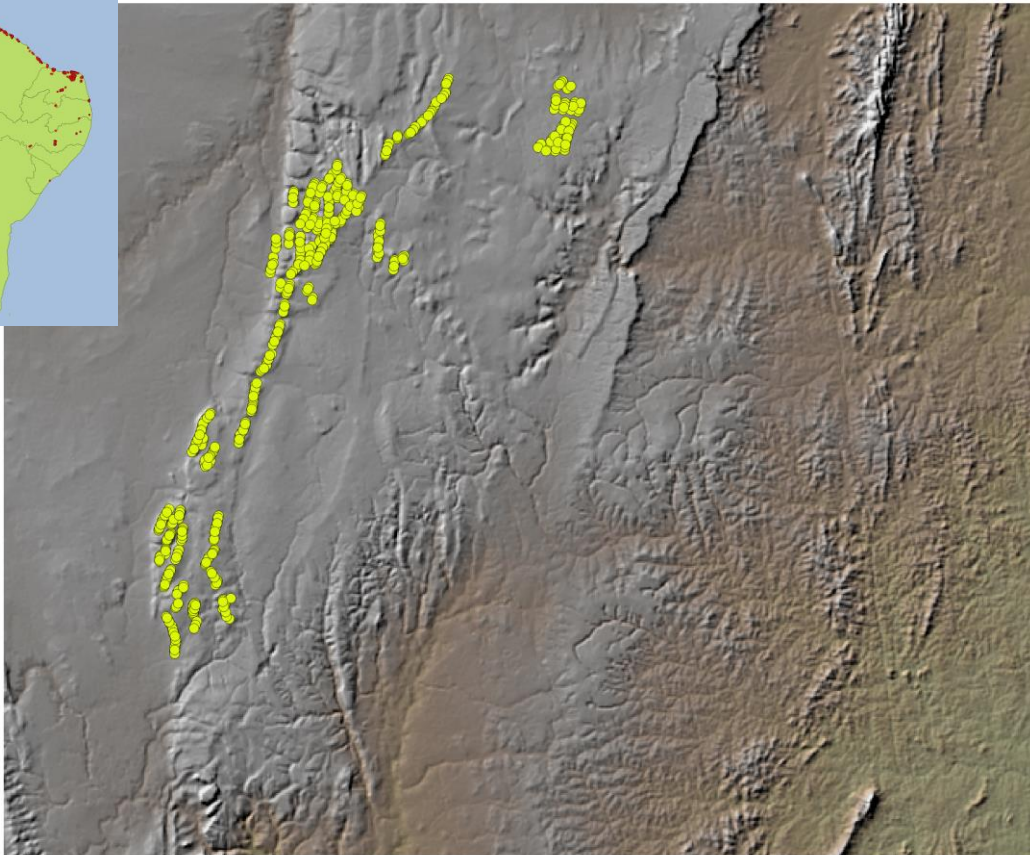
Distinct occupation patterns – Coastal plains

- Wind farms in Northeast RN

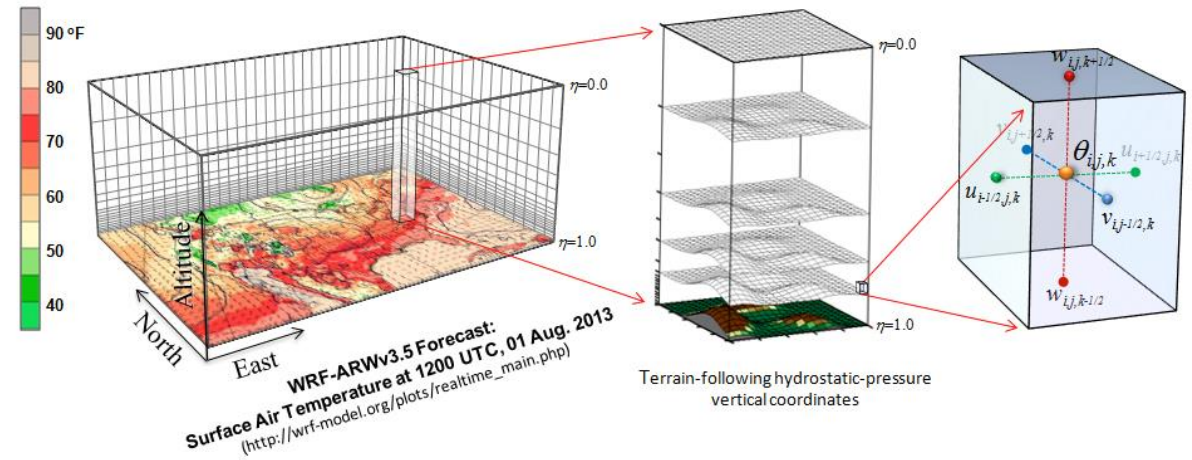
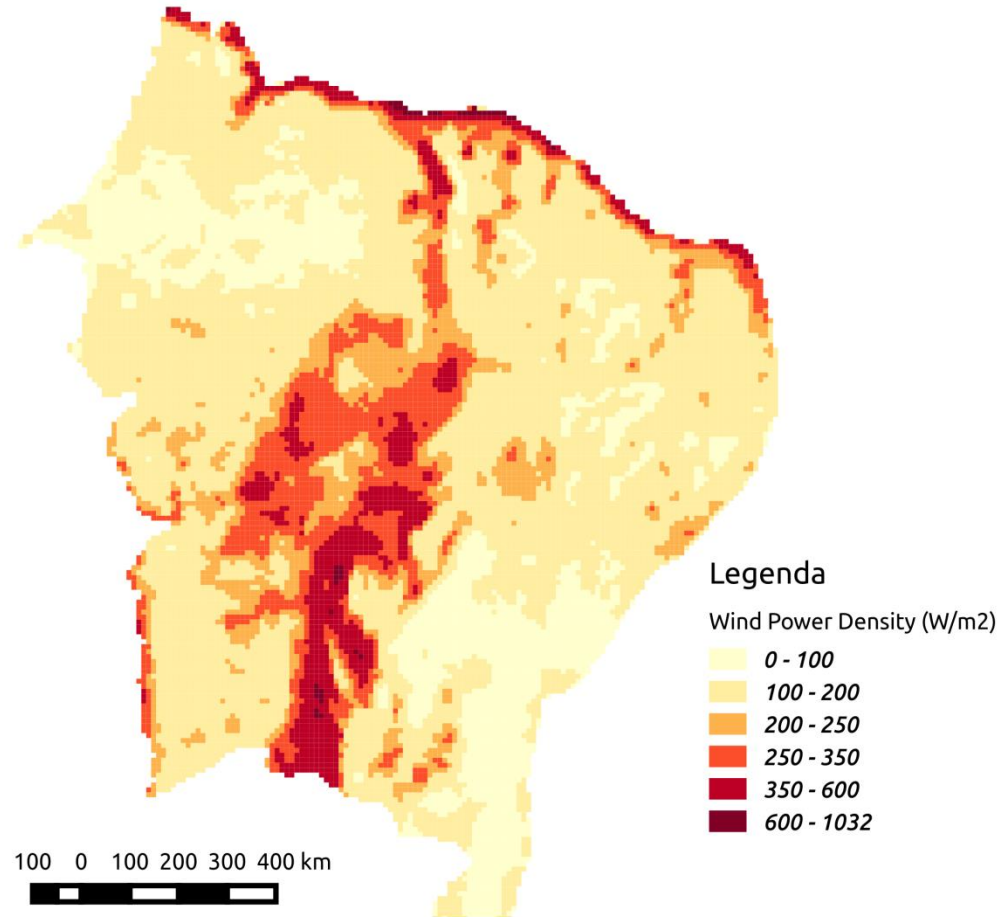


Distinct occupation patterns – Countryside hills

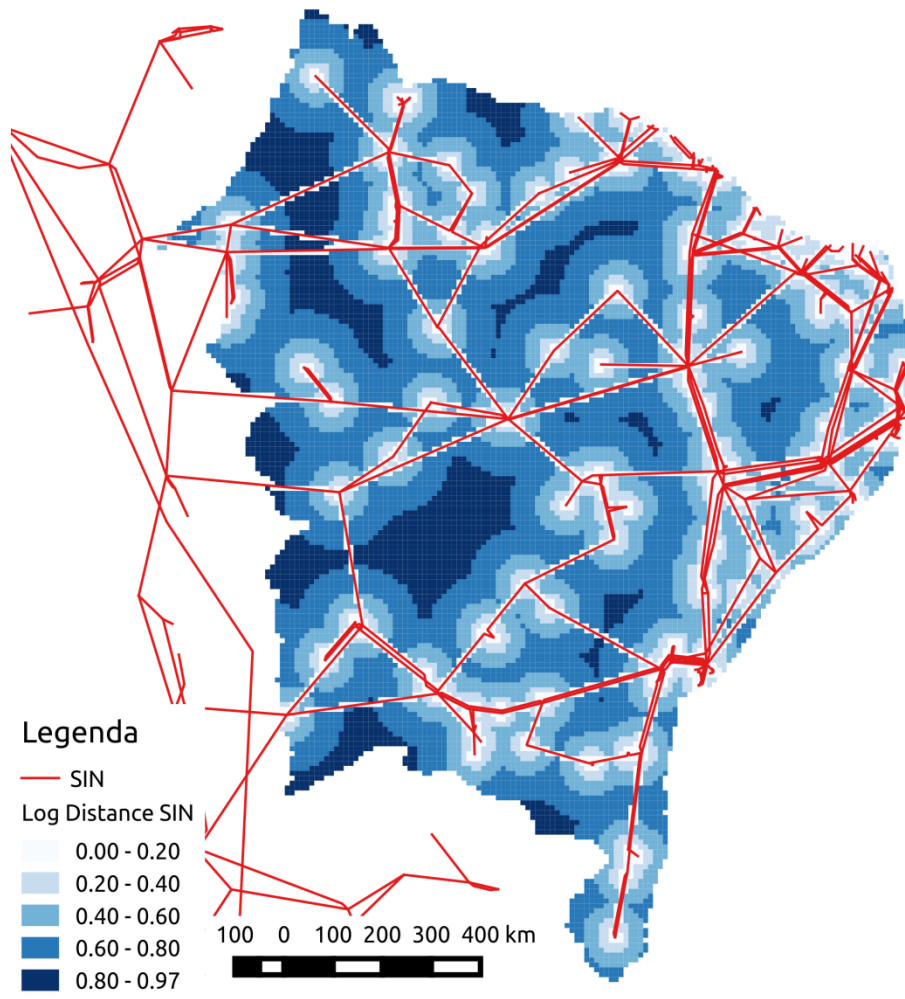
- Parques eólicos na Bahia



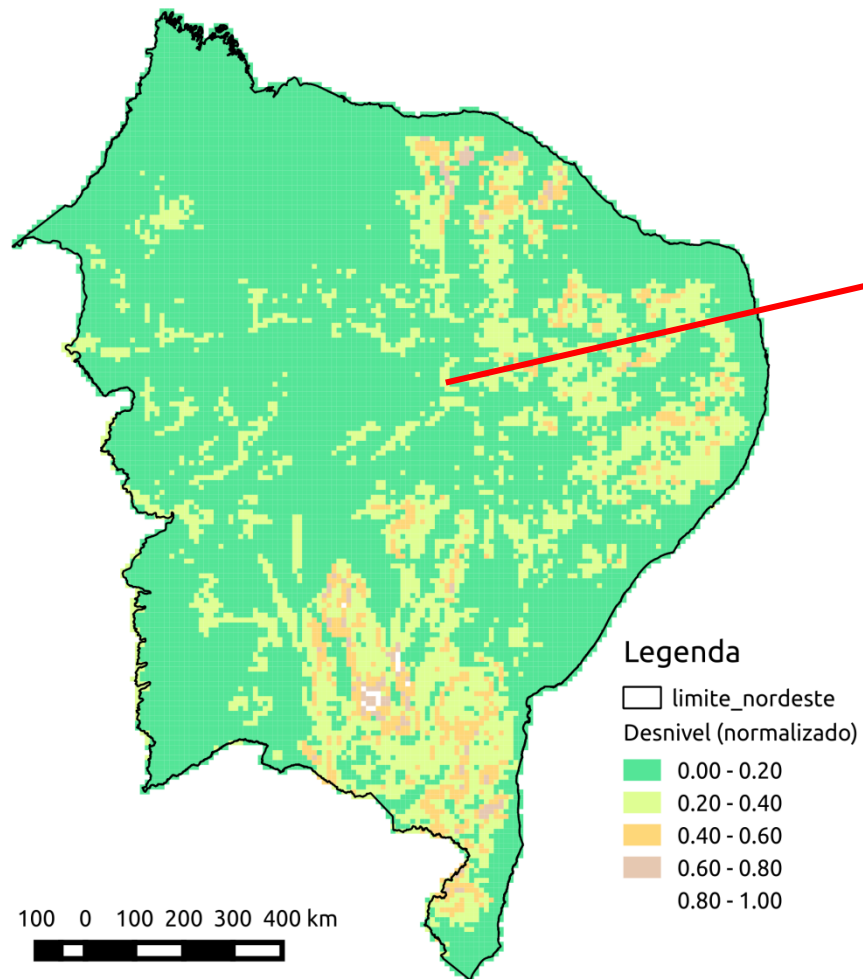
Explanatory factors: Wind Power Potential



Explanatory factors: Distance to Grid

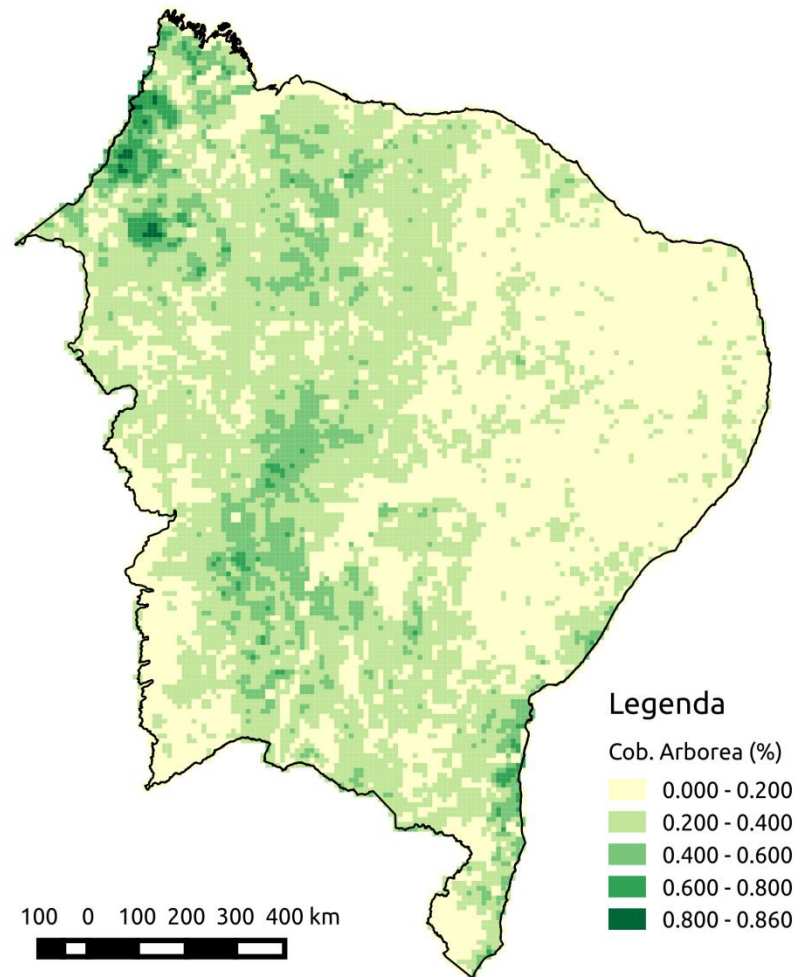


Explanatory factors: Local drop



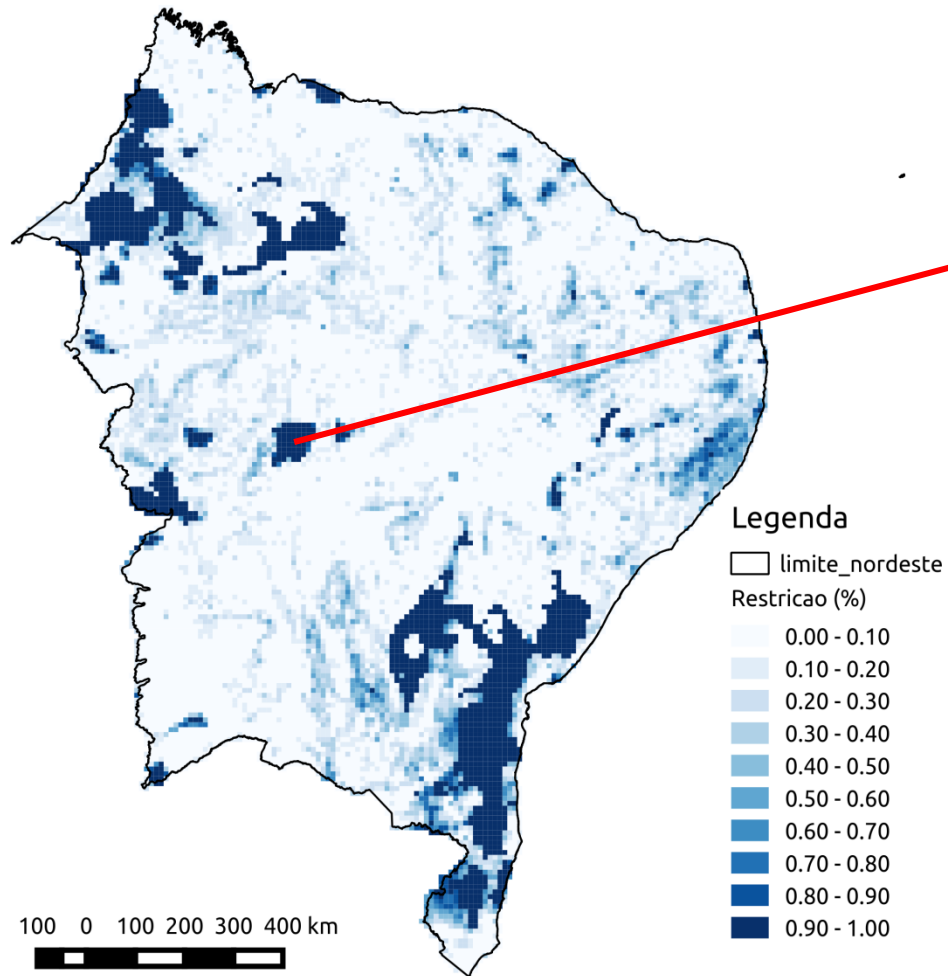
Chapada do Araripe, PI

Explanatory factors: Tree coverage



Restrictions: Terrain complexity, Noise Levels, Áreas Protected areas

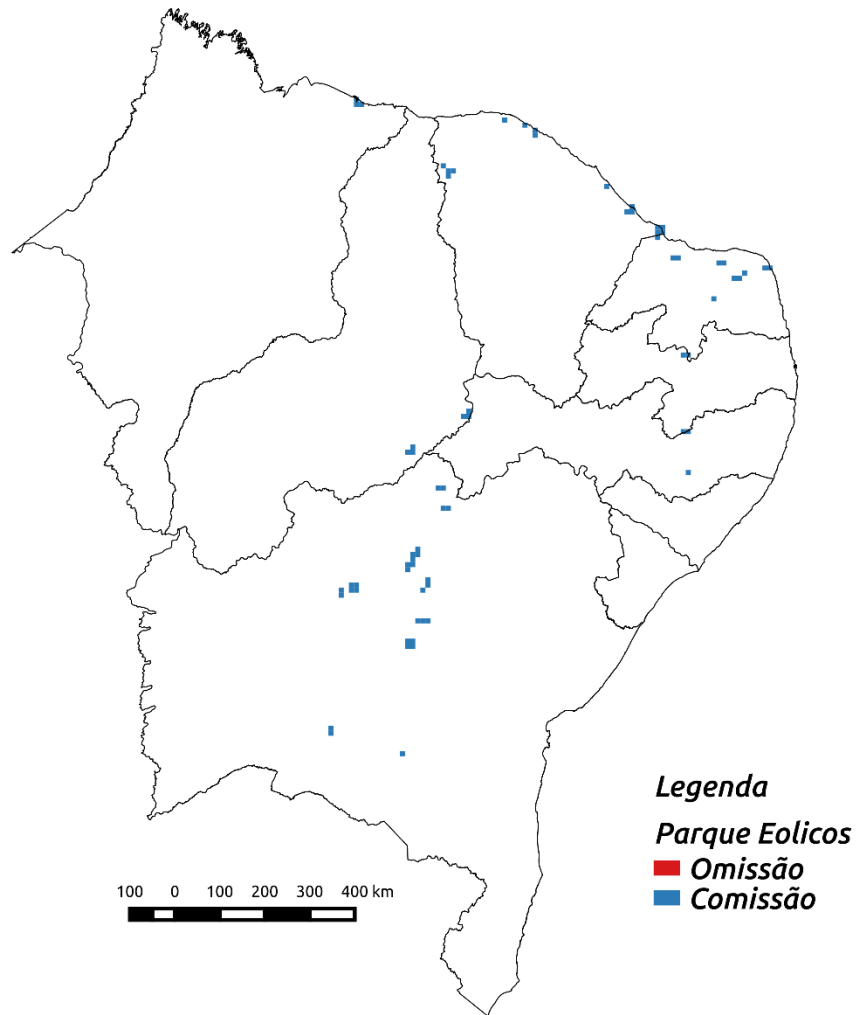
Restrictions



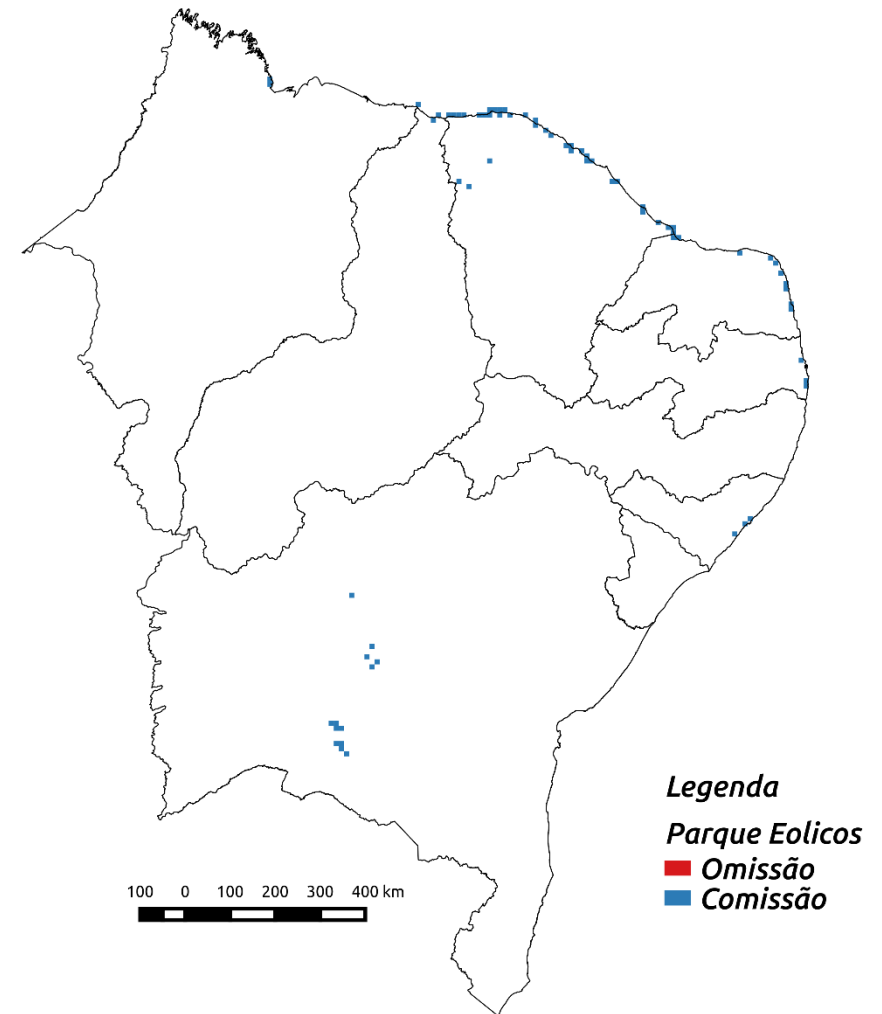
Serra das Confusões, PI

Validation: Real vs. Estimated change

Actual Change 2012-2016

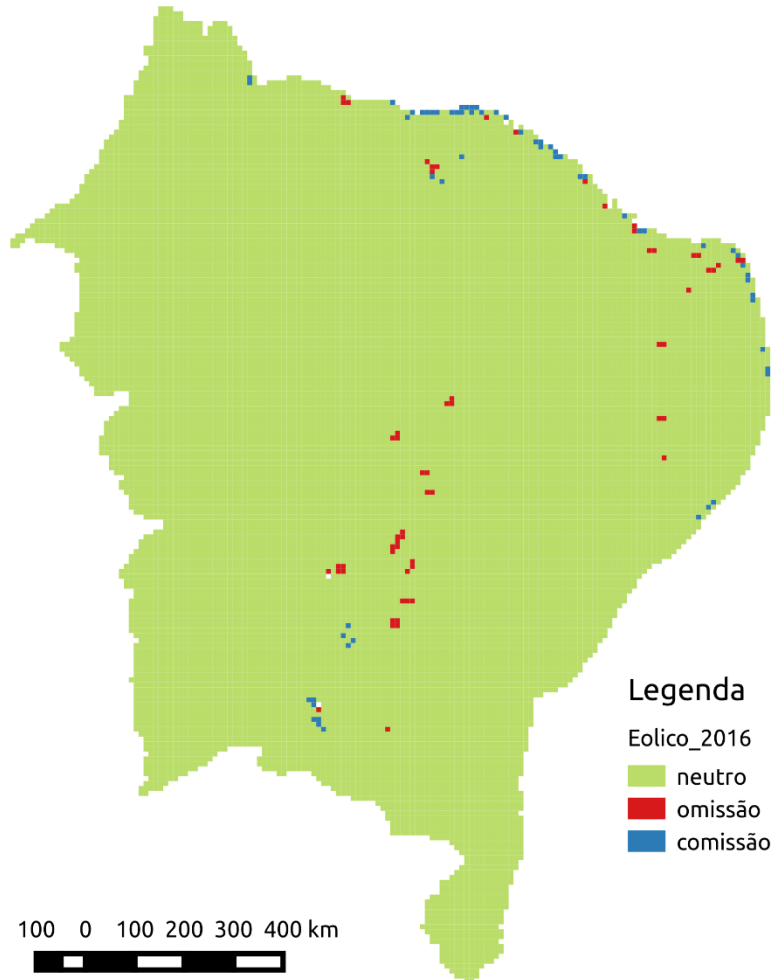


Estimated Change 2012-2016

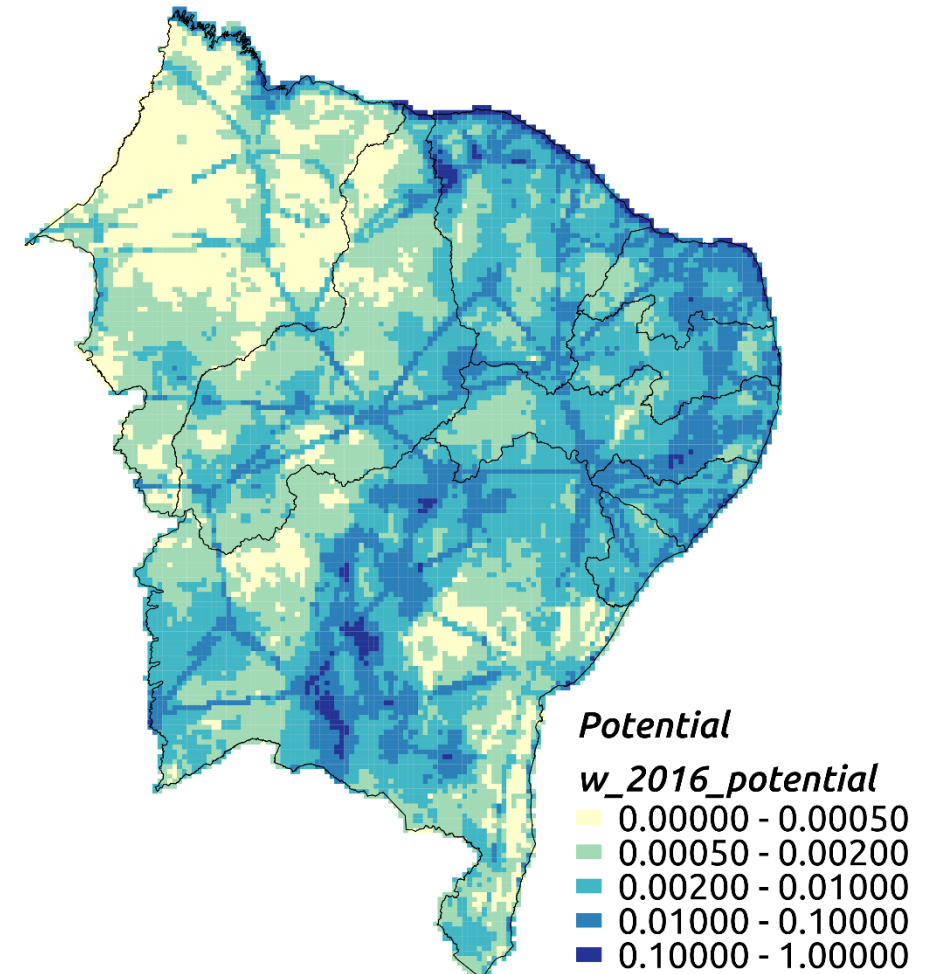


Validation: Real – Estimated change

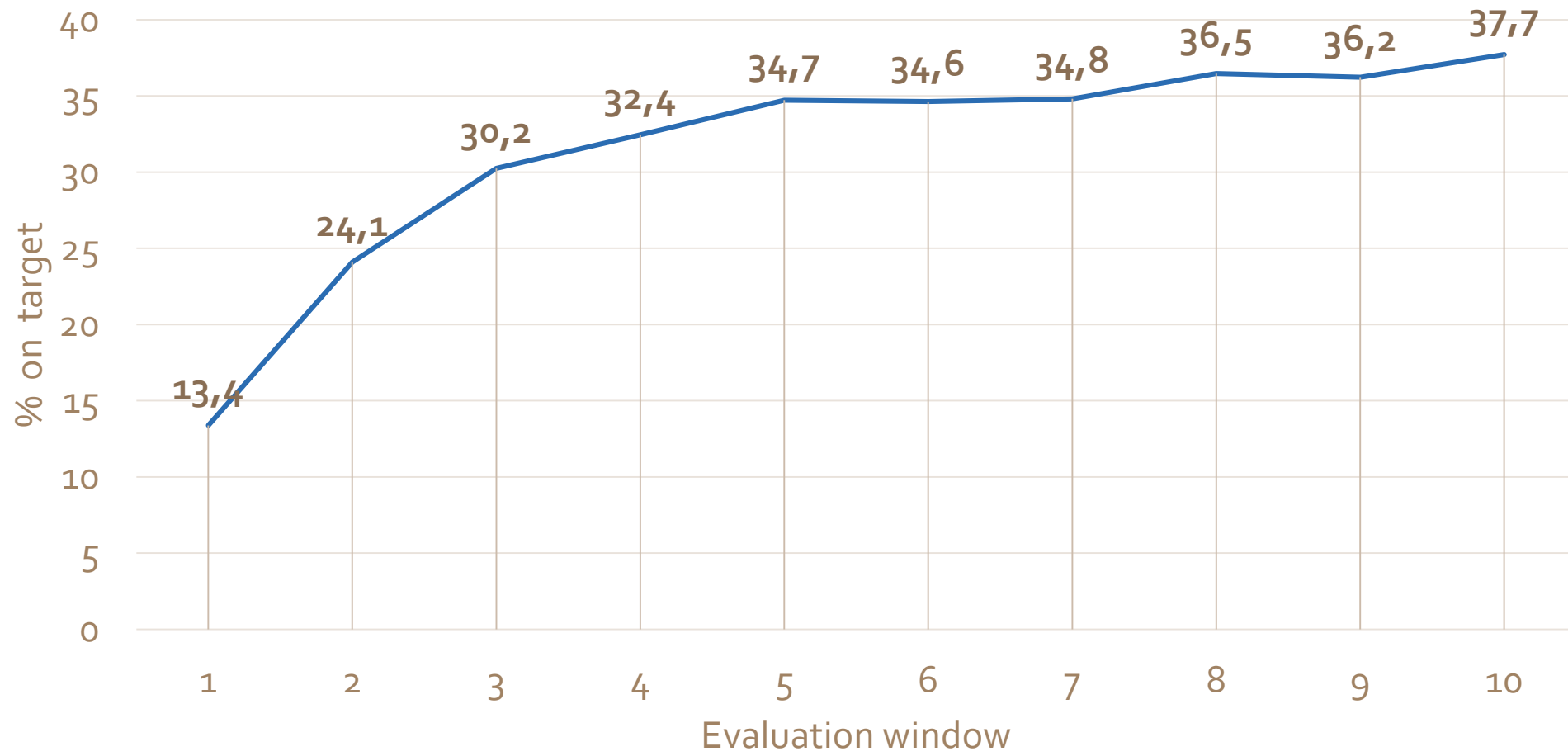
Diference Actual - Simulated



Land-Use Change Potential



Validation: Multiresolution Statistics



Wind power expansion scenario for Brazil

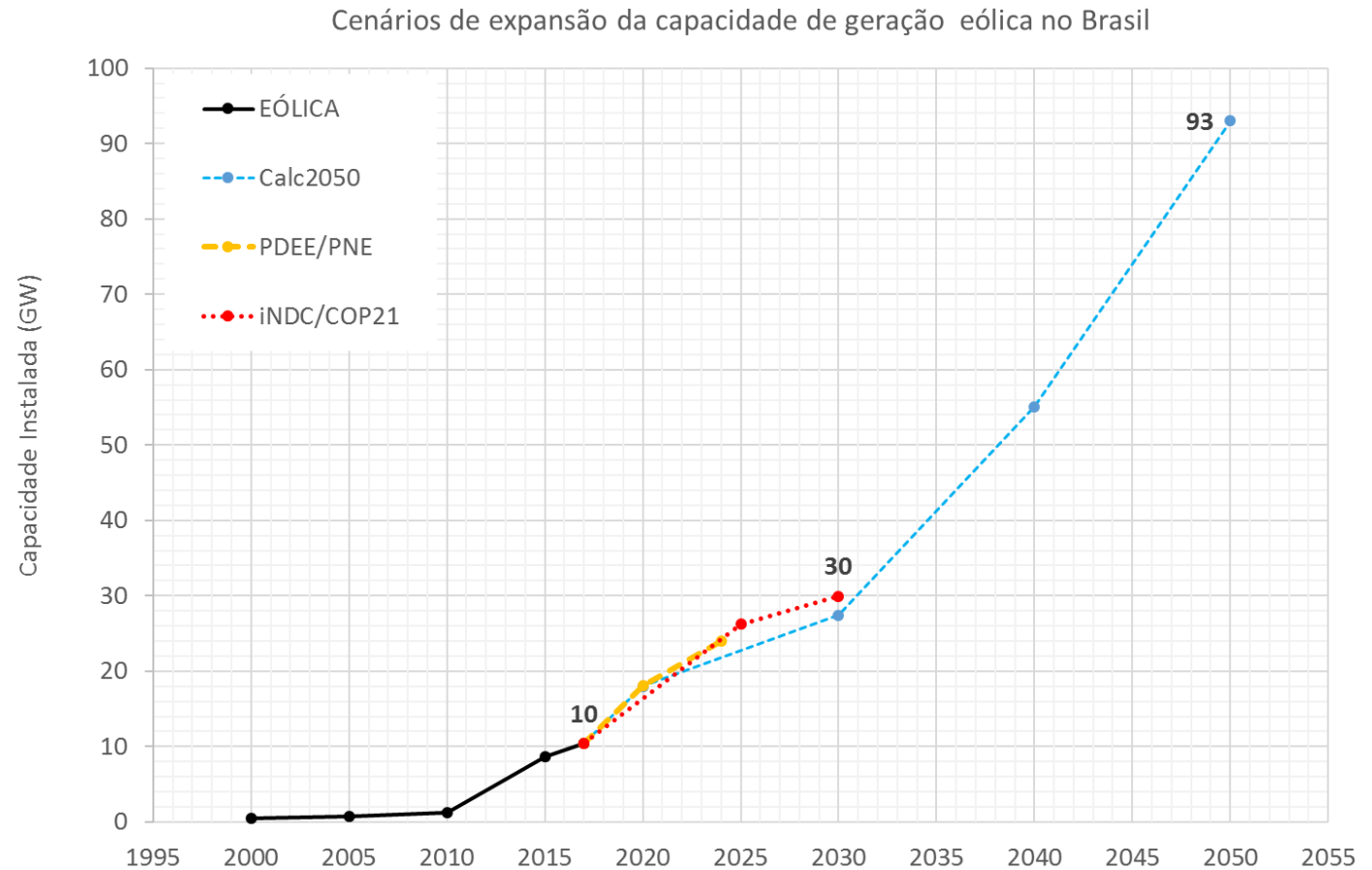
Wind Deployment Scenario

❖ PDEE iNDC /Paris

- +20 GW till 2030
- < 2 GW/year

❖ Calculadora2050

- 93 GW



Scenario: Estimated change 2030

Conclusions:

Deficient wind farm dispersion

Next steps:

- Divide regions: Coastal and Countryside
- Include Riverside Protected Areas
- Refine scenario for 2040 and 2050
- Include dynamical variable for grid expansion



Acknowledgements

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Thanks!



Laboratório de Modelagem e Estudos de
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