Hochschule für
Wirtschaft und Umwelt
Nürtingen-Geislingen

Nürtingen-Geislingen University
Institute für Landscape and Environment

Assessing visual landscape sensitivity towards wind turbines with a distance decay effect: An exploration of different GIS approaches

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Research Team

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Preconditions

Political goal	Transition towards renewable energy
Planning authority	Select sites for wind energy development
Research	Visual sensitivity data to compare different sites

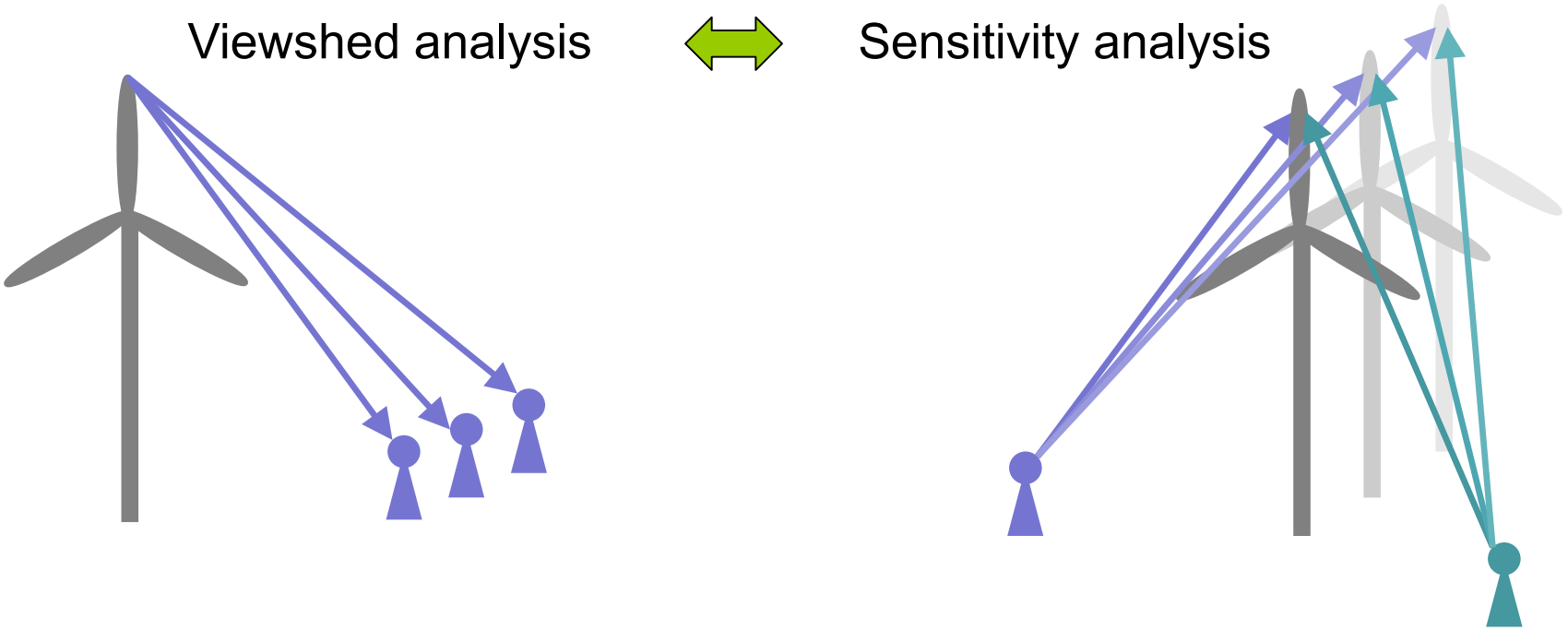
Overview

Background	Perceived visual impacts of wind turbines decrease with distance from observer
Research gap	Influence of distance decay effect on visual landscape sensitivity
Overall goal	Inclusion of distance decay effect into the sensitivity assessment towards wind turbines
Approach	Exploratory approach
Method	Development and comparison of five GIS approaches
Investigation area	20 x 20 km tile within the German federal state of Thuringia

Settings

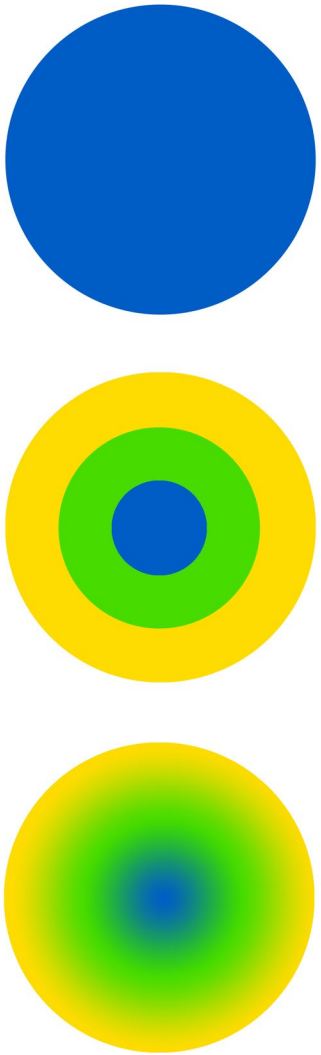
- Visual landscape sensitivity
  - Potentially impacted area if a project is realized at a certain location
  - Study focus solely on visibility

Viewshed analysis ⟺ Sensitivity analysis



Settings

- Exemplary project
  - Wind turbines
  - 200 m blade tip height
- Distance decay effect
  - No distance decay effect (no distance weights)
  - Stepwise distance decay effect (stepwise discrete distance weights)
  - Continuous distance decay effect (continuous distance weights) Linear!



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Uniform distance decay effect

Uniform Analysis
3 km
(after Breuer 2001)

Uniform Analysis
10 km
(after Fischer & Roth 2020)

Stepwise distance decay effect

Stepwise Analysis
10 km
(after Nohl 1993)

Continuous distance decay effect

Observer Viewshed
10 km

QGIS Interpolation
10 km

Analysis distance 3 km

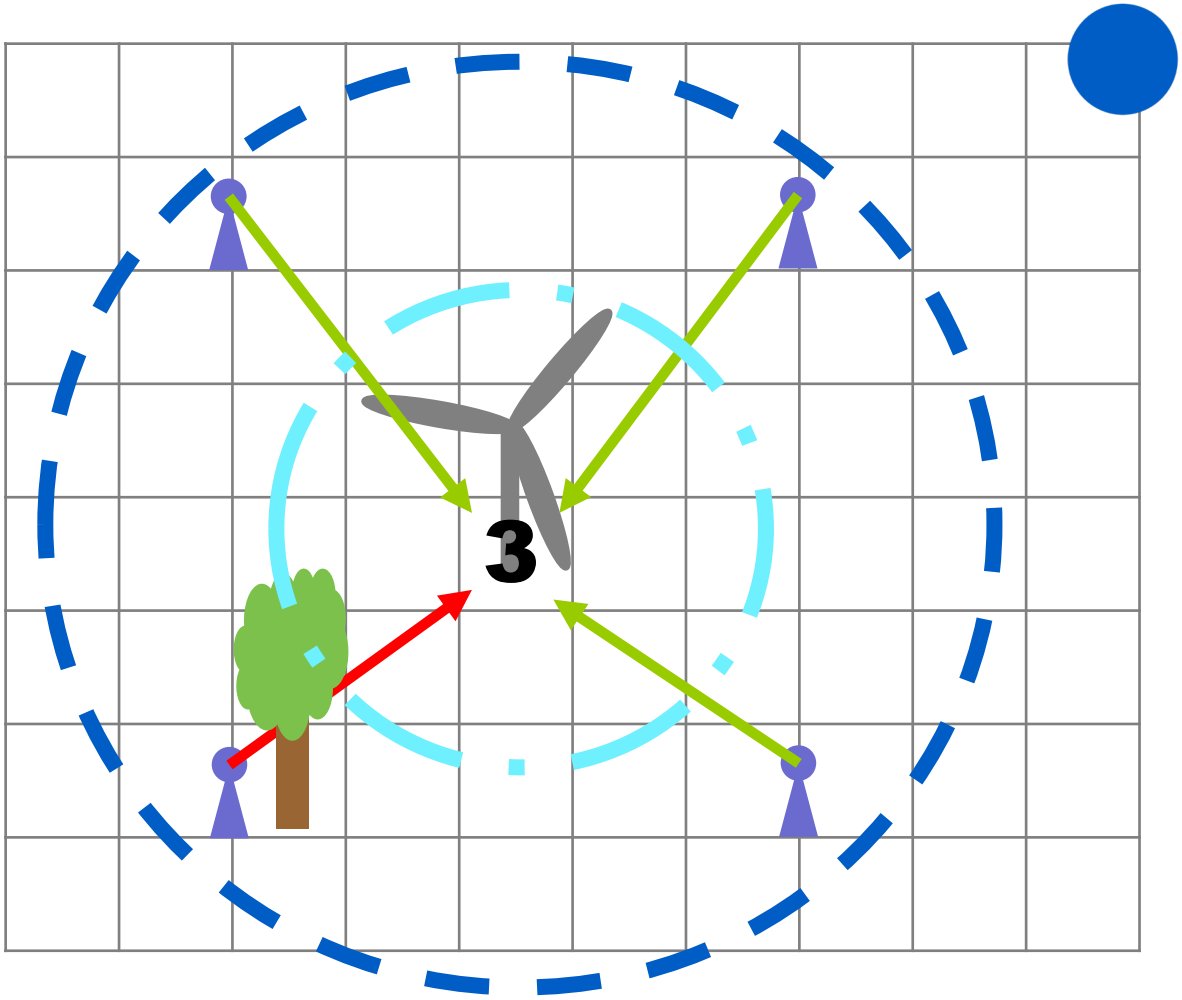
Analysis distance 10 km

Program ArcMap

Program QGIS

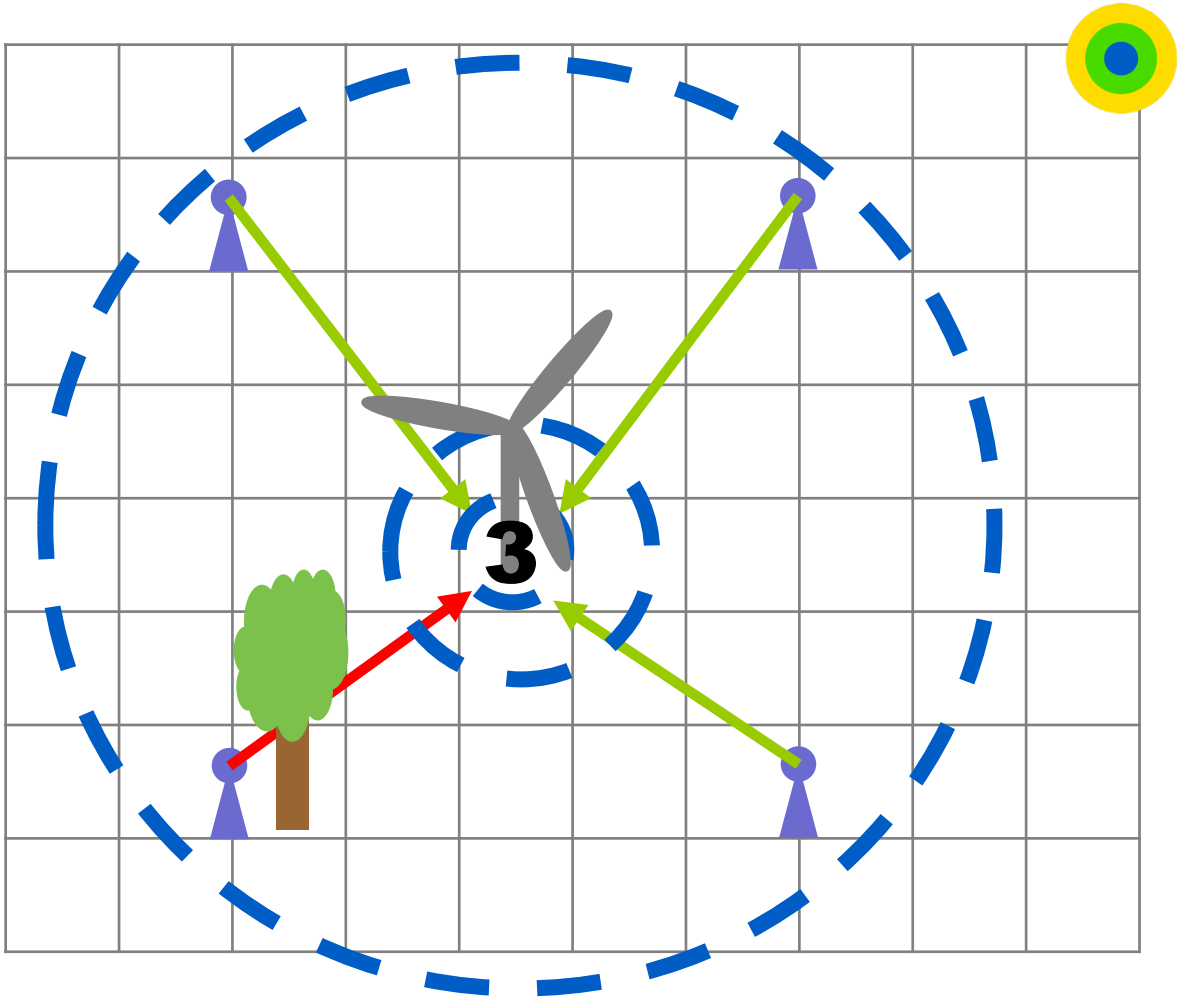
Uniform Analysis

- Regularly distributed fictive observer points
- Digital surface model
- Adaptation for land use height



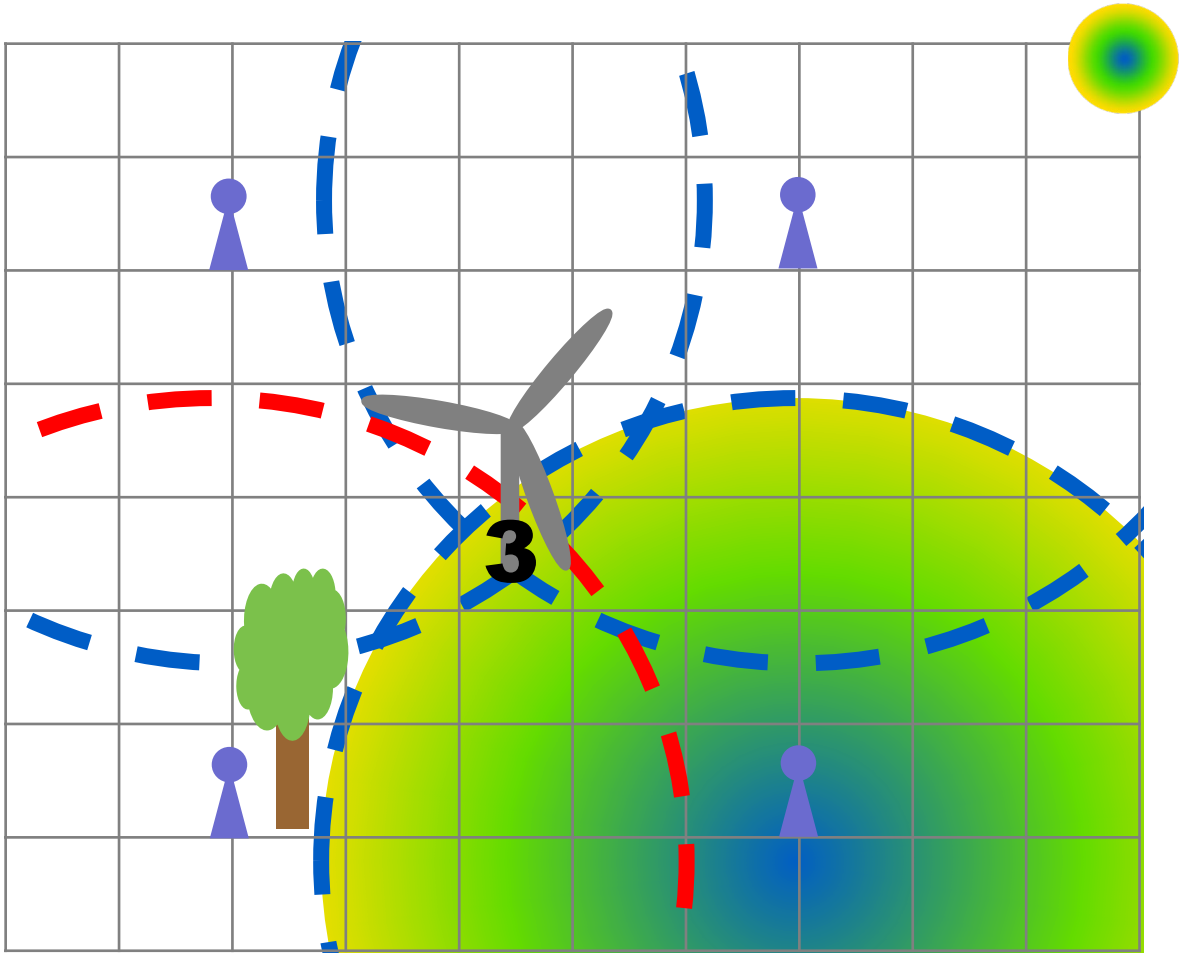
Stepwise Analysis

- Sensitivity analysis separately for different zones
- Multiplication with distance weight per zone
- Sum



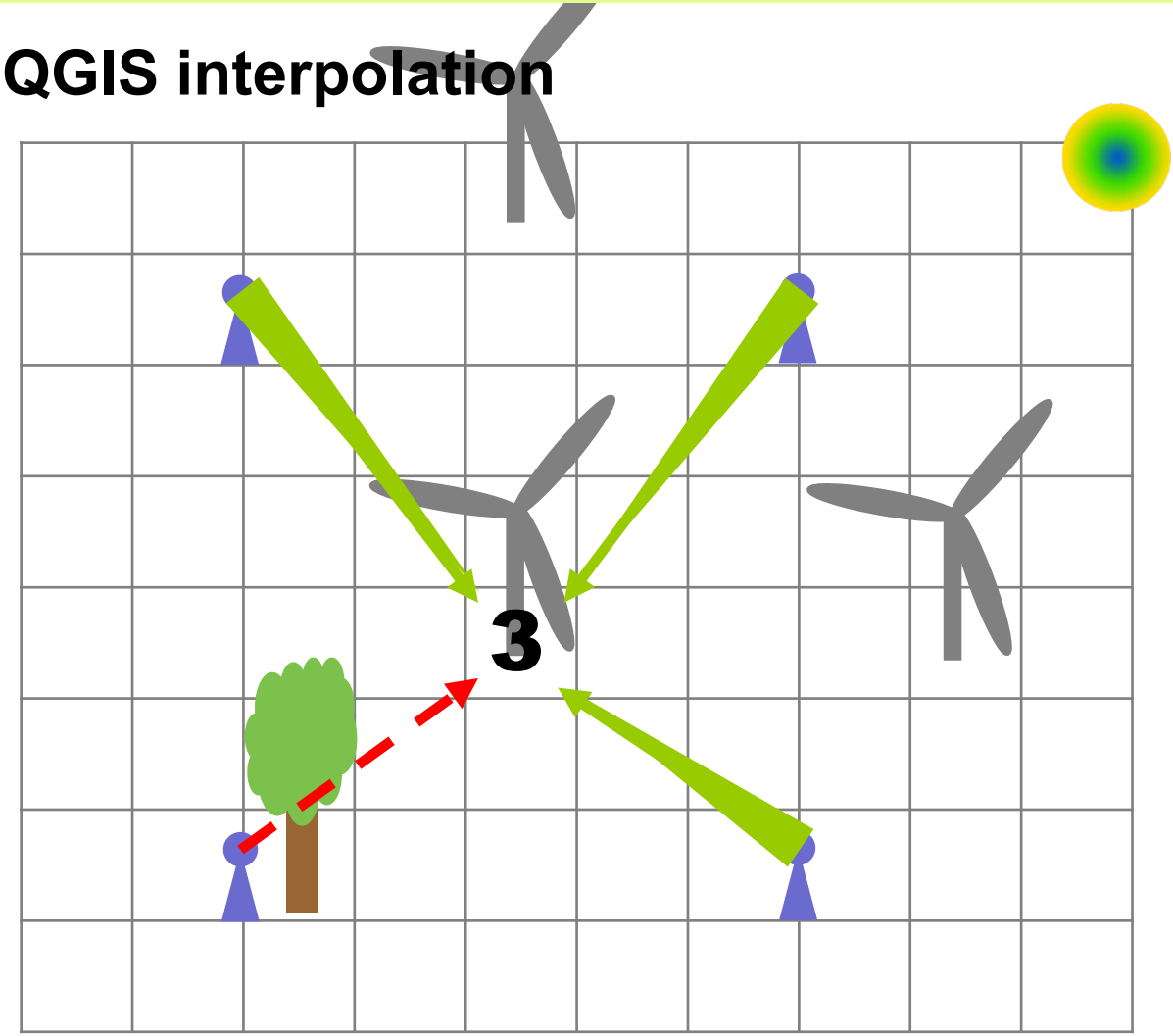
Continuous Analysis: Observer Viewshed

- Viewshed Analysis from every observer point
- Adaptation for land use height
- Intersection of visible area with inverted and normalized Euclidean Distance
- Sum over all raster



Continuous analysis: QGIS interpolation

- Tool „Intervisibility network“ CUCKOVIC (2016)
- Points representing fictive turbines
- Adaptation for land use height
- Lines of sight between each observer and turbine point
- Weight: Inversion, Normalization of length
- Sum of all lines per turbine point
- Interpolation



CUCKOVIC, Z. (2016), Advanced viewshed analysis: a Quantum GIS plug-in for the analysis of visual landscapes. Journal of Open Source Software, 1 (4), 32.

Results

- Very strong correlations for visibility indices except from Uniform Analysis (3 km) ($p \leq 0.001$)

Method	Computational Time
Uniform Analysis (3 km)	12 hours
Uniform Analysis (10 km)	28 hours
Stepwise Analysis	40 hours
Observer Viewshed	177 hours (> 7 days)
QGIS Interpolation	13 hours

Conclusion

- Possible integration of distance decay effect into sensitivity analyses
- Two new approaches for the continuous distance decay effect
- Scalable to larger areas
- Uniform analysis (10 km) most efficient method (full resolution, time)
- Intervisibility network (QGIS interpolation) most flexible integration

Future challenges

- Maximum distance
- Different distance decay functions
- Interplay with visual landscape quality

Thank you for your attention

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