Sustainable Wind Power Development

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Contents

Sustainable wind power development: project overview

- Which areas in the Lake Waging region are most suited to wind power development?
- Tasks
  - GIS-based suitability assessment
  - Visibility analysis
- Considerations
  - Wind energy potential
  - Physical constraints
  - Planning constraints

Pre-processing

- Problems
  - Data was in multiple projections (Gauss-Kruger zone 4, WGS 84, ETRS 1989, etc.)
  - Some data was on a state (Bavaria) or regional (Upper Bavaria) scale
  - Missing data (land use, railways, water bodies, rivers, power lines)
- Solutions
  - Reprojected data to Gauss-Kruger zone 4 to match data frame
  - Clipped data to fit study area
  - Downloaded additional data from Geofabrik

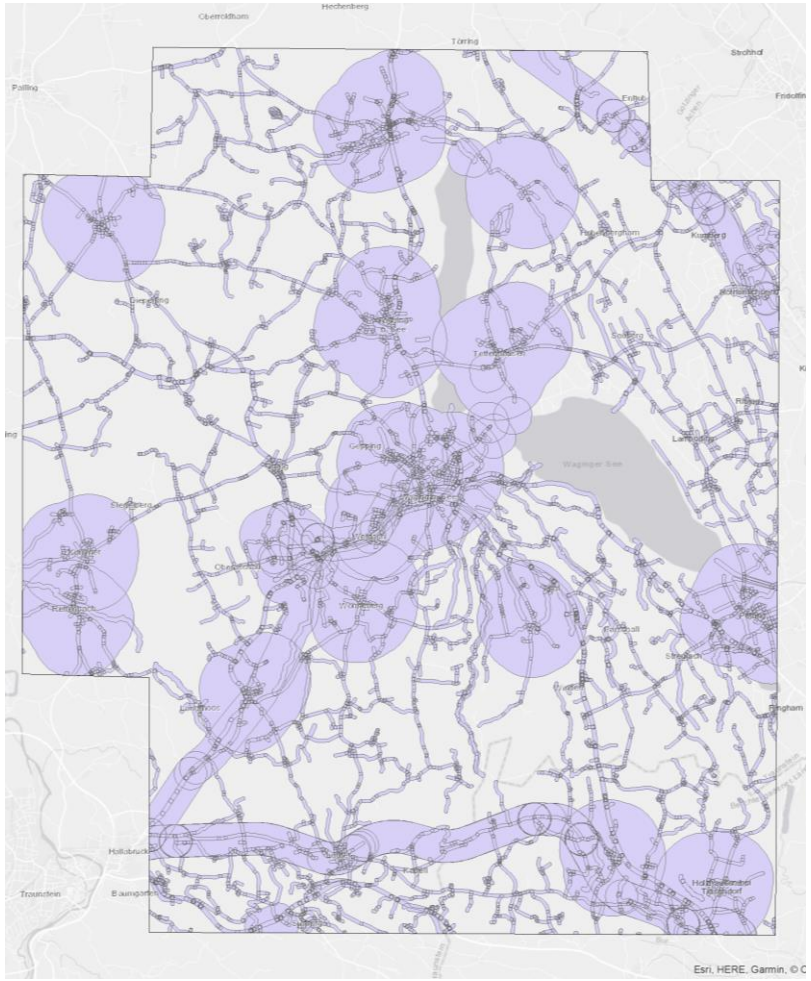
Analysis of constraints

- Physical and planning constraints
  - Residential areas
  - Dispersed buildings
  - Highways and streets
  - Industrial and commercial areas
  - Recreational areas
  - Railways
  - Waterways
  - Conservation areas
  - Slope

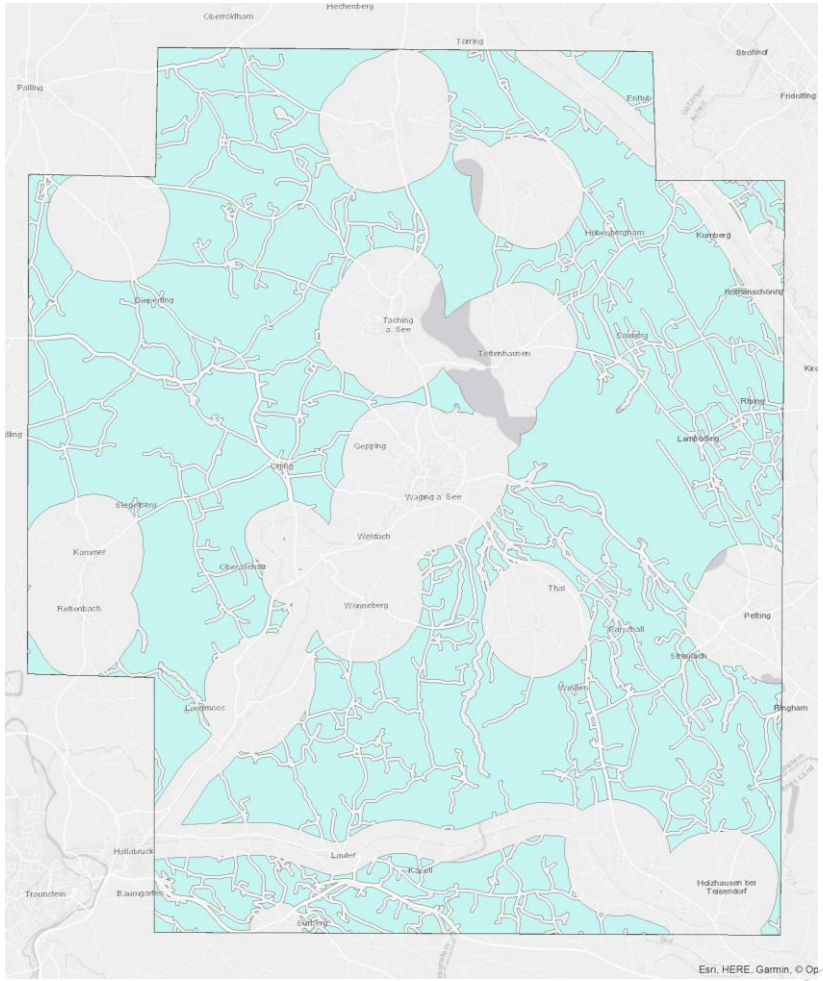
Buffer areas

- Buffers
  - Residential areas: 800 m
  - ~~Dispersed houses: 500 m~~
  - Industrial/commercial areas: 300 m
  - Leisure/sports facilities: 300 m
  - Railway lines: 300 m
  - ~~Power lines: 300 m~~
  - Rivers: 40 m
  - Major roads: 40 m
  - Minor roads: 30 m
- Combined all buffers into one using *union*

Exclusion and potential areas

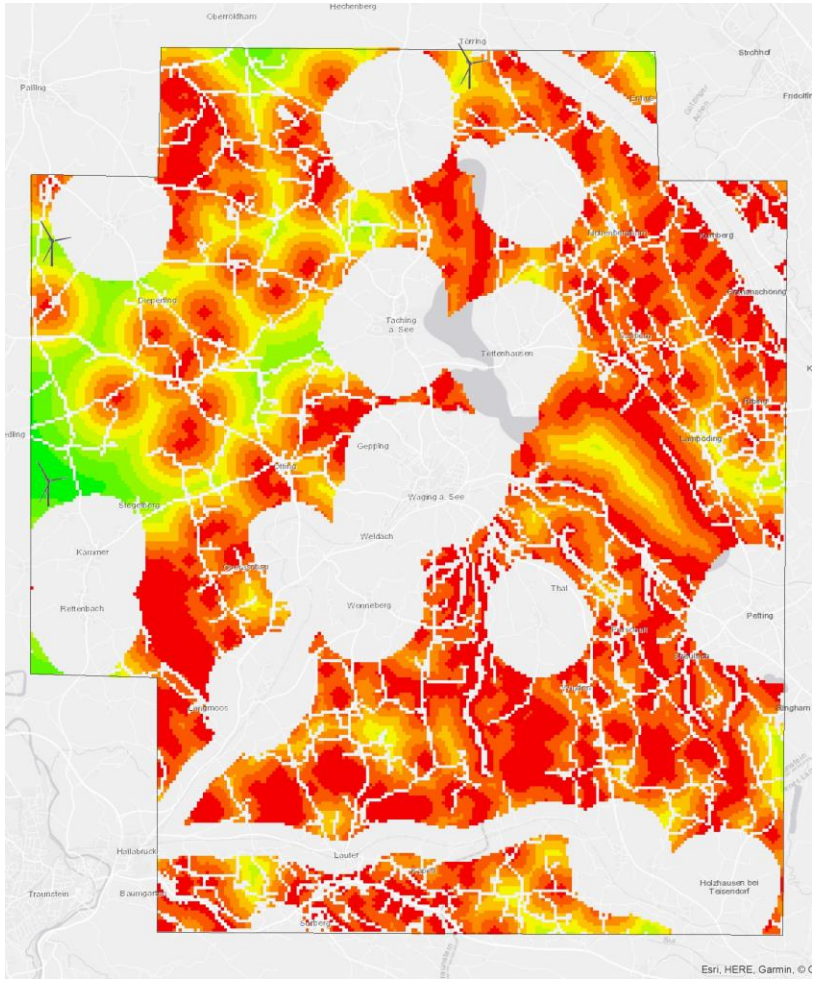


Exclusion areas (all buffers)

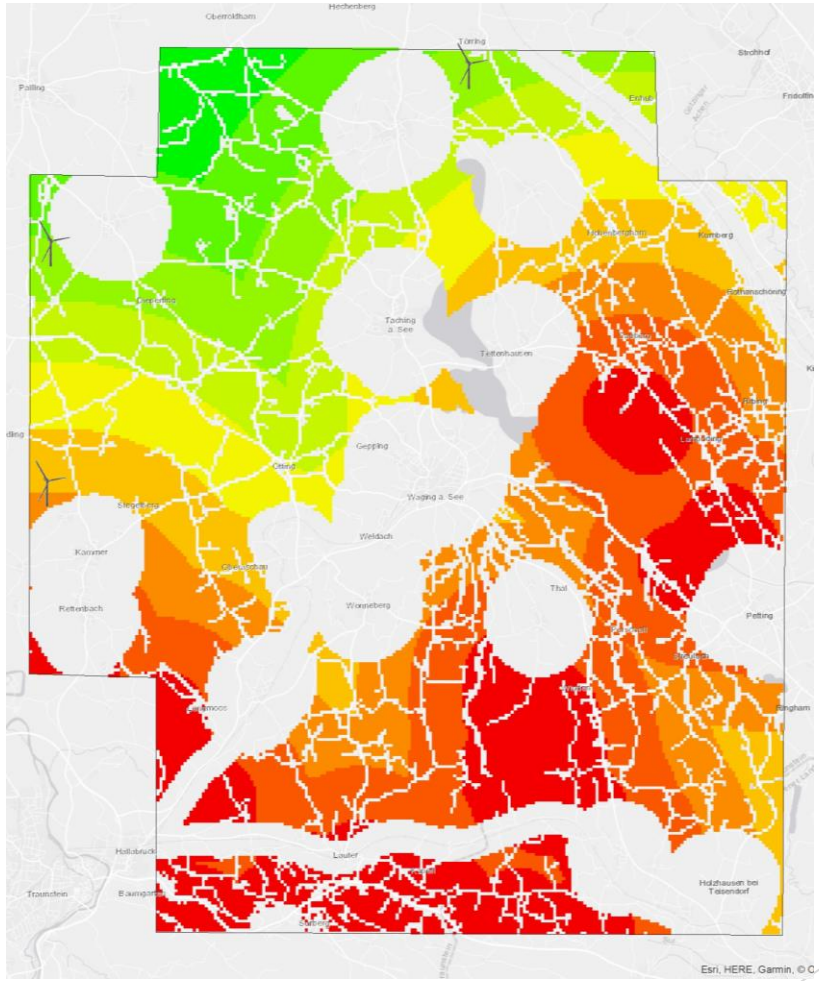


Potential areas for development, obtained using *erase*

Distance rasters

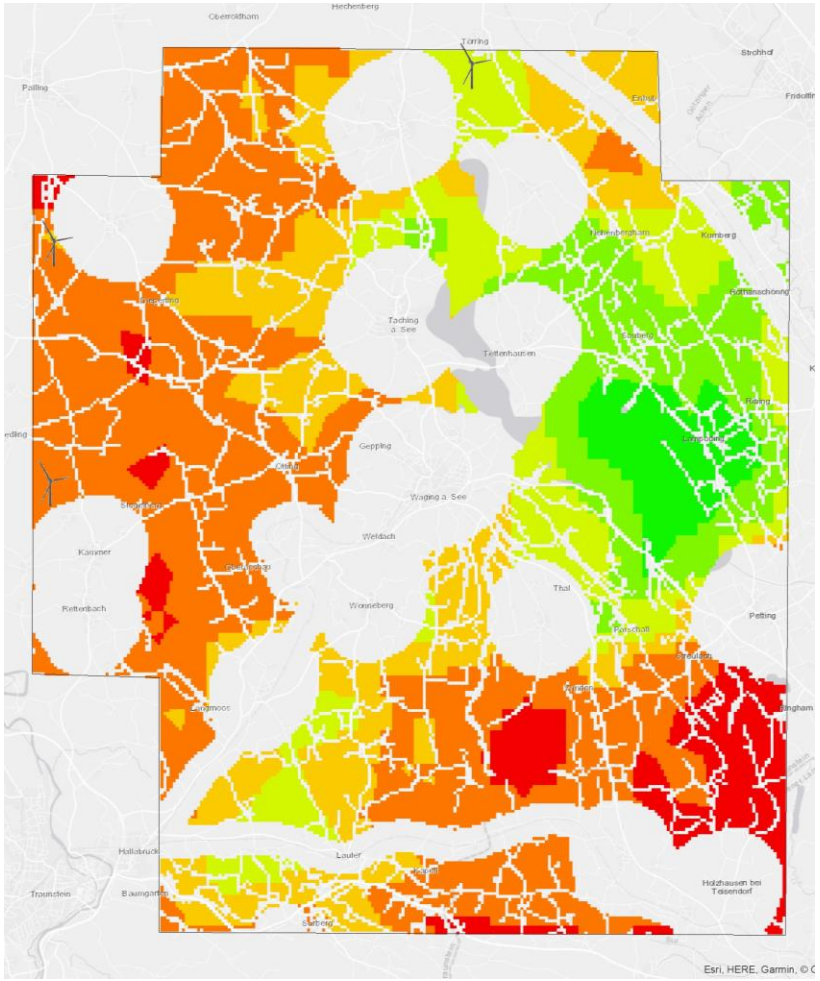


Distance raster for biotopes, obtained using *extract by mask* and *Euclidean distance*

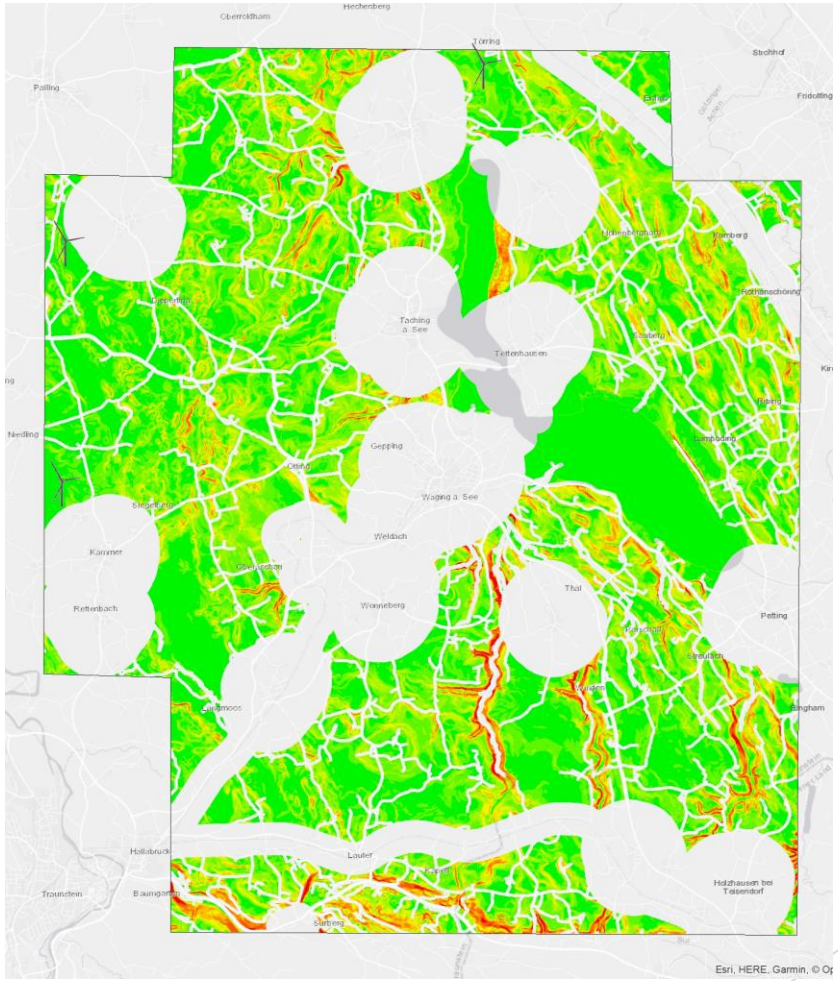


Distance raster for flora, fauna and habitat (FFH) protection areas

Wind speed and slope



Wind speed map, as provided

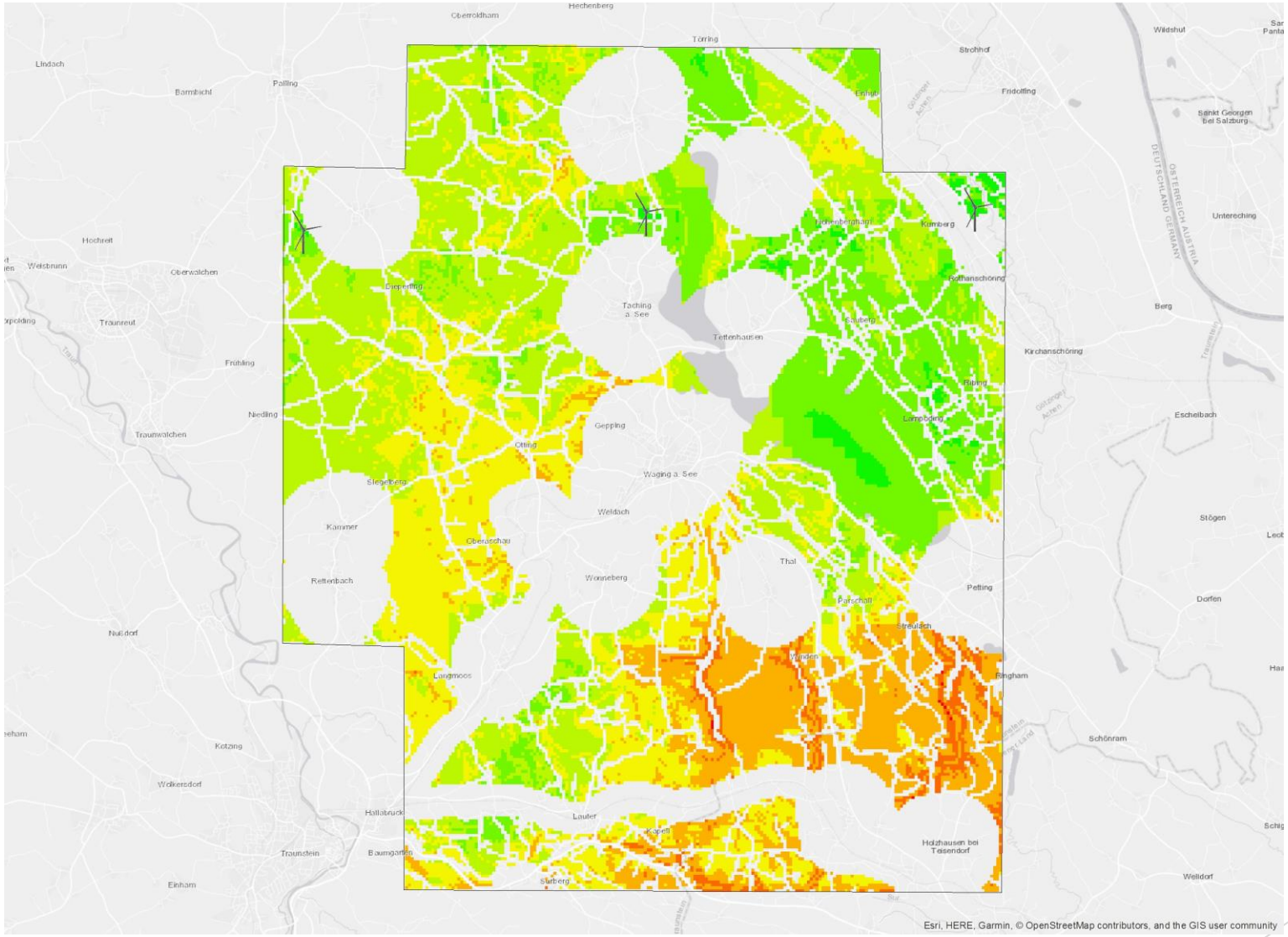


Slope raster, obtained from DEM

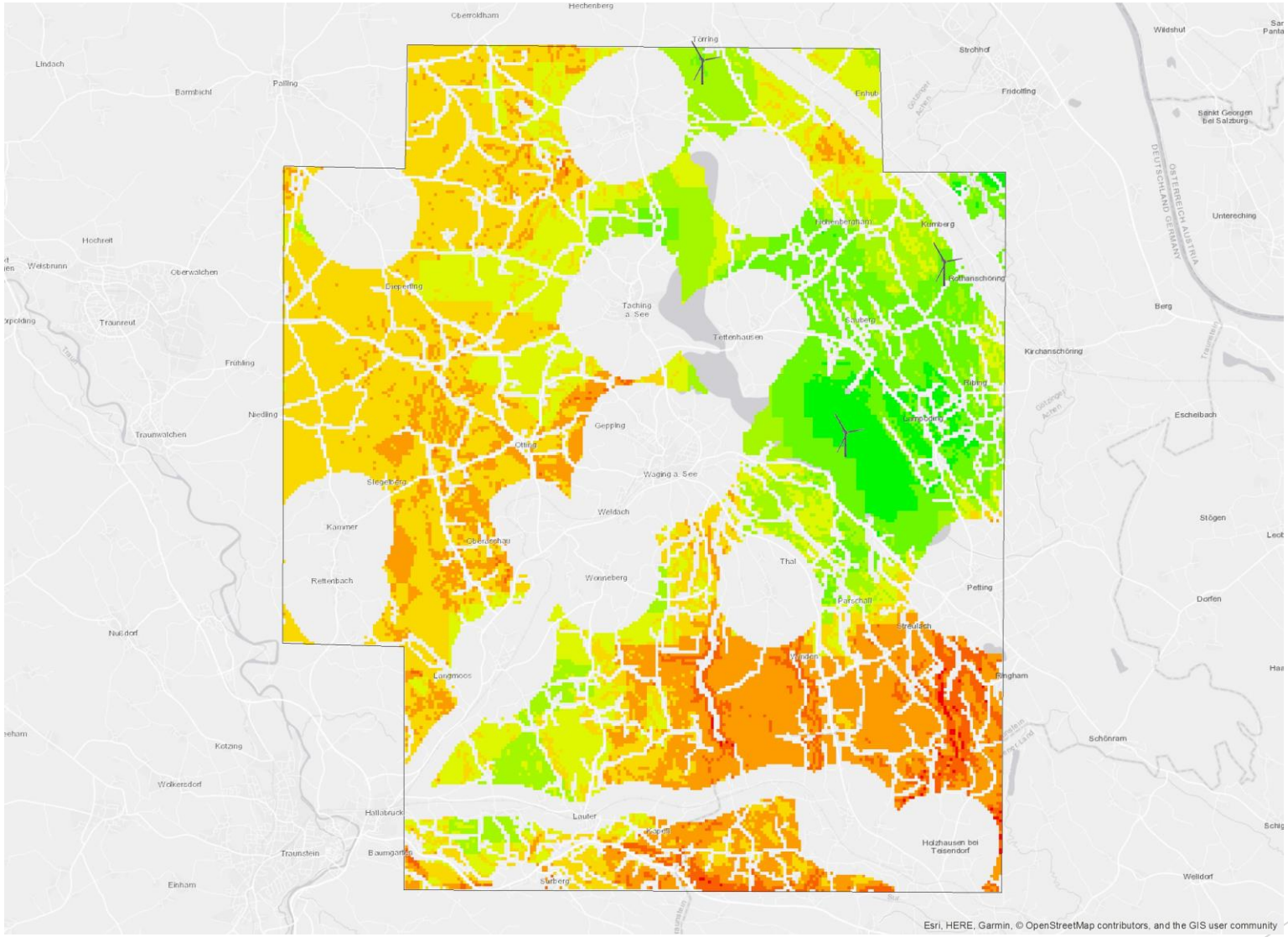
Weighting

- Scenario 1: equal weighting of wind energy potential and ecological factors
  - Wind energy potential: 40%
  - Slope: 20%
  - Biotopes/landscape/biosphere/FFH: 10% each = 40% total
- Scenario 2: wind energy potential prioritized
  - Wind energy potential: 60%
  - Slope: 20%
  - Biotopes/landscape/biosphere/FFH: 5% each = 20% total
- Scenario 3: ecological factors prioritized
  - Wind energy potential: 20%
  - Slope: 16%
  - Biotopes/landscape/biosphere/FFH: 16% each = 64% total
- Combined using *weighted overlay*
- Three sites selected in each scenario

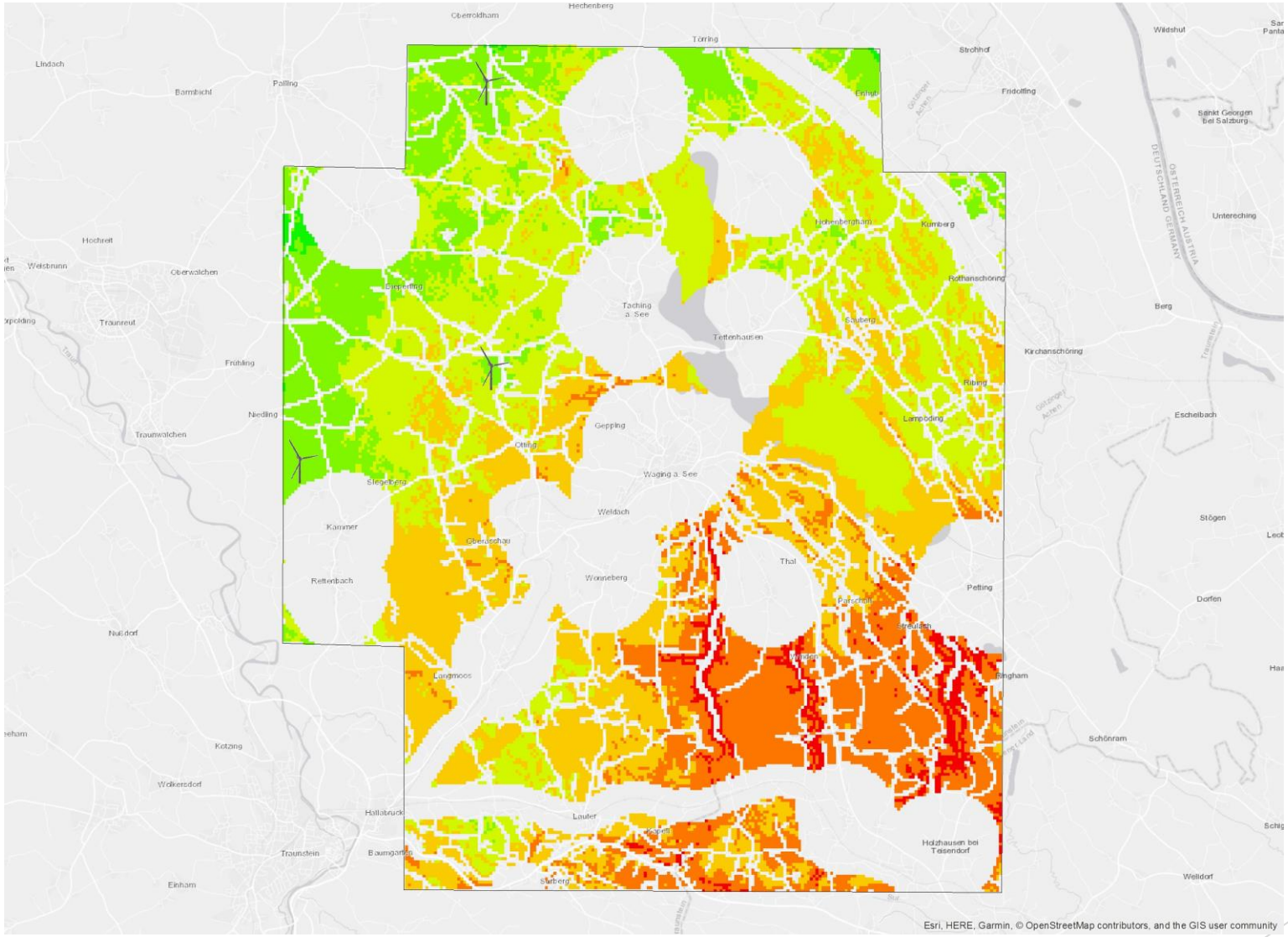
Scenario 1: equal weighting



Scenario 2: prioritizing wind energy



Scenario 3: prioritizing ecological factors



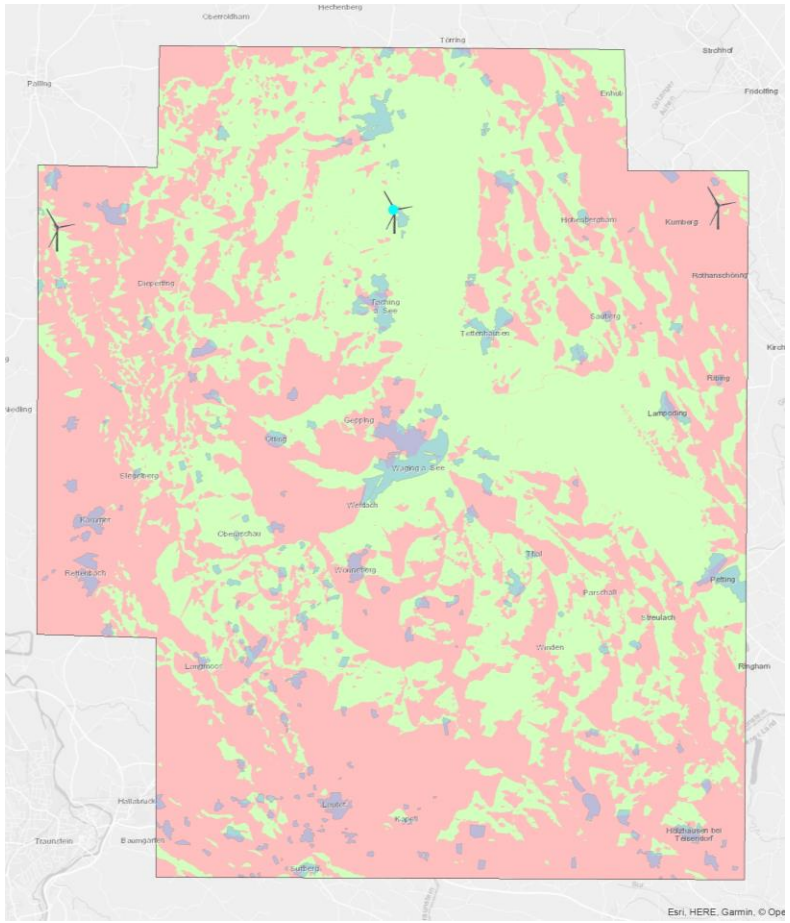
Visibility analysis

- How visible are the wind turbines from across the Lake Waging area?
- How can their visual intrusion be minimized?

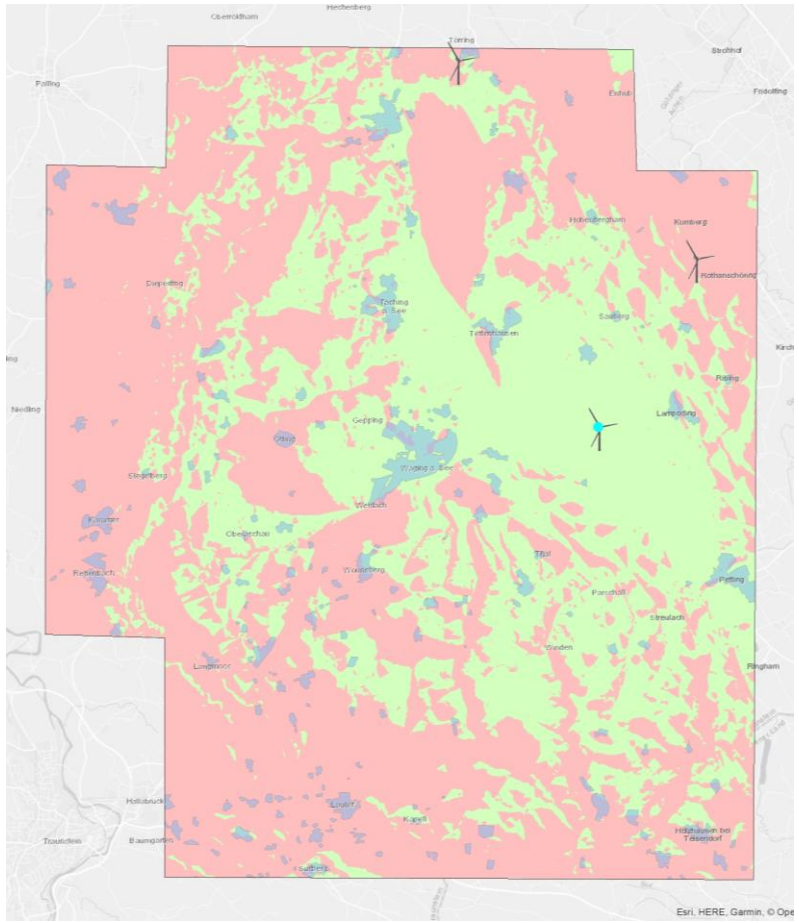
- Additional criteria for site selection: visual impact
  - For each site: *viewshed* at a height of 150 m above ground
  - DEM used to provide elevation data
  - Best site chosen from each scenario based on visual impact

http://www.windhoist.co.uk/wp-content/uploads/sites/102/2017/12/20171219_110053-e1513850416934.jpg

Unsuitable sites



Site 1, from scenario 1 (north of Taching am See)

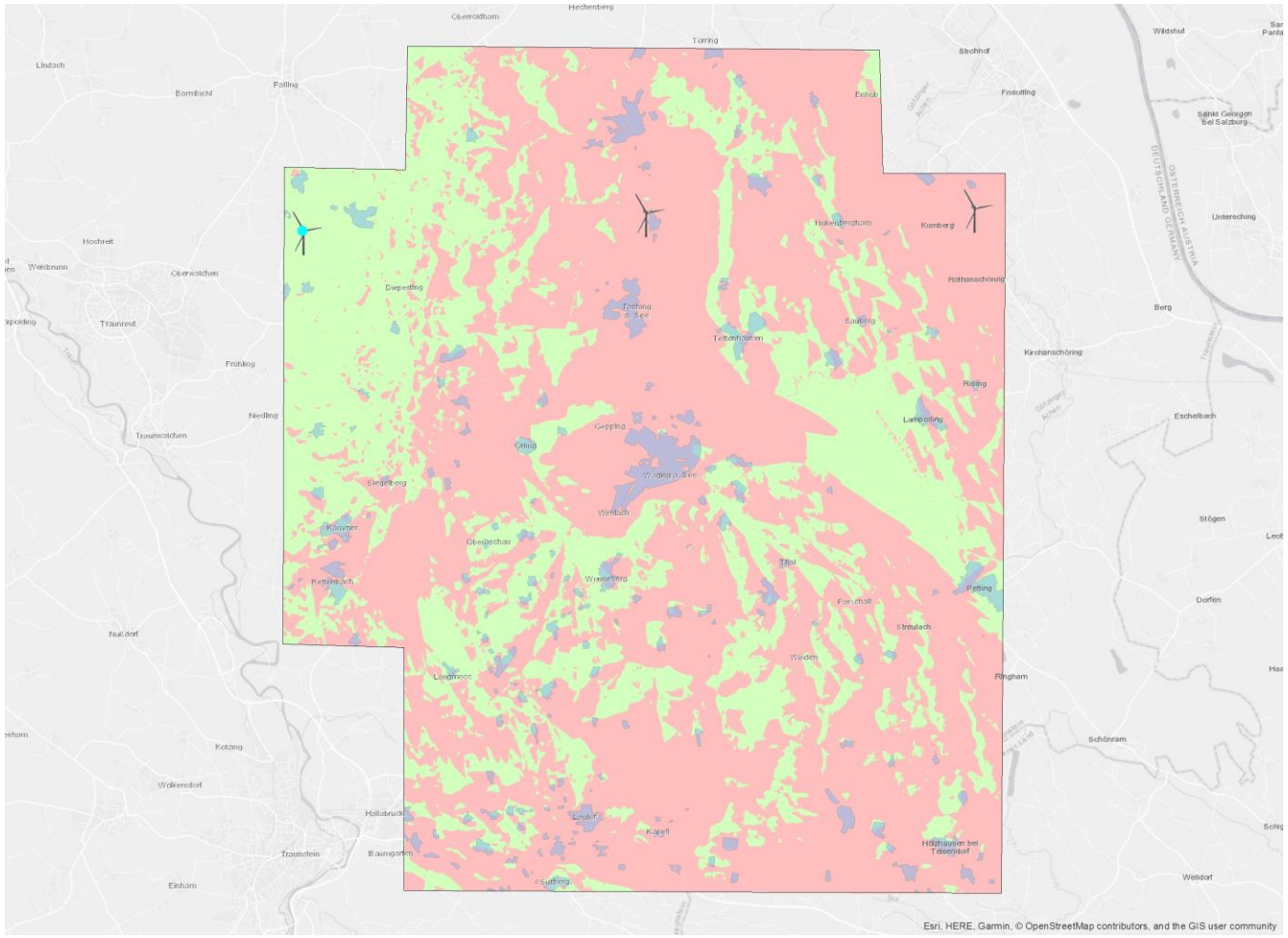


Site 5, from scenario 2 (offshore in Lake Waging)

Visible

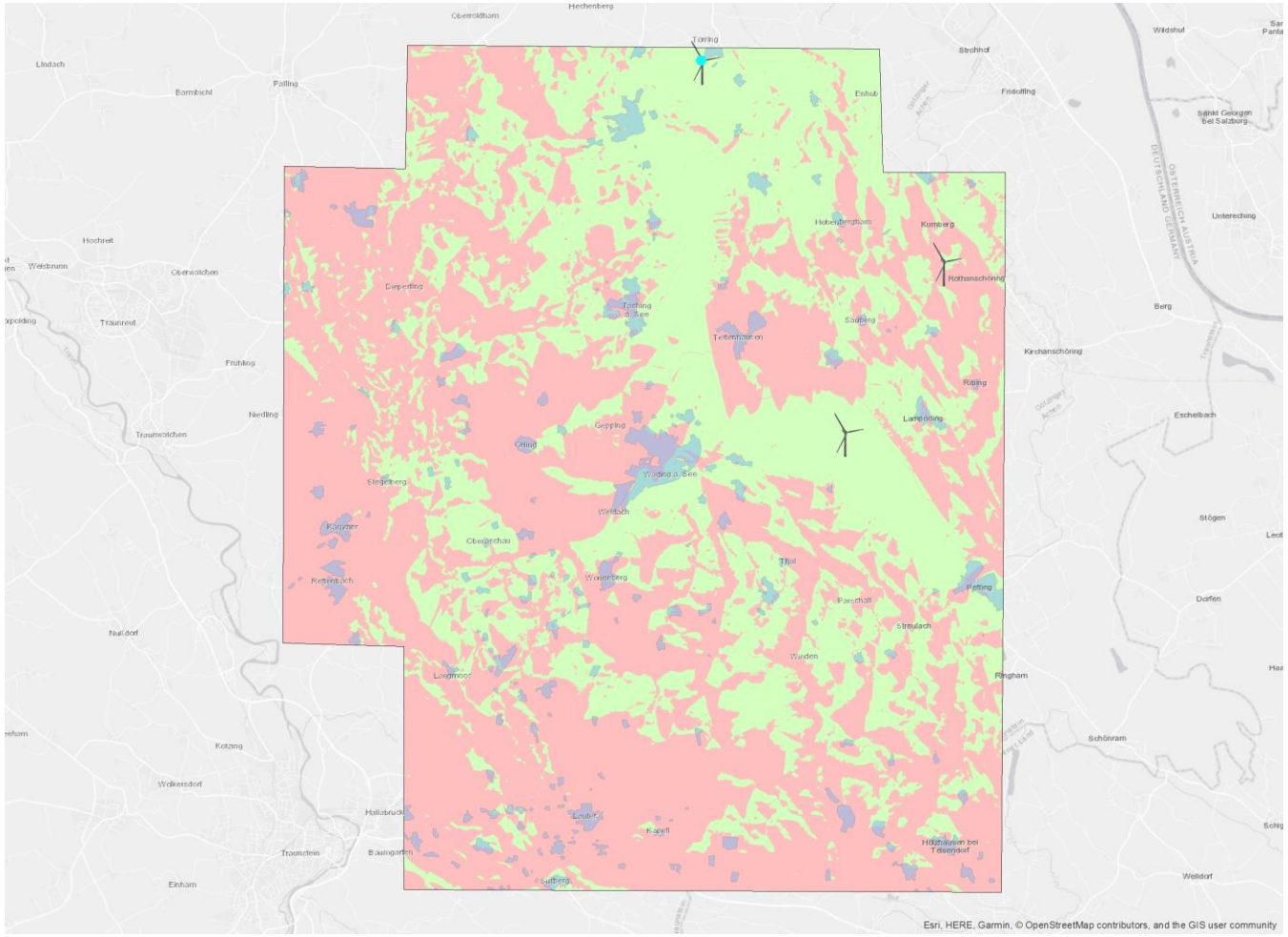
Not visible

Suitable sites: scenario 1



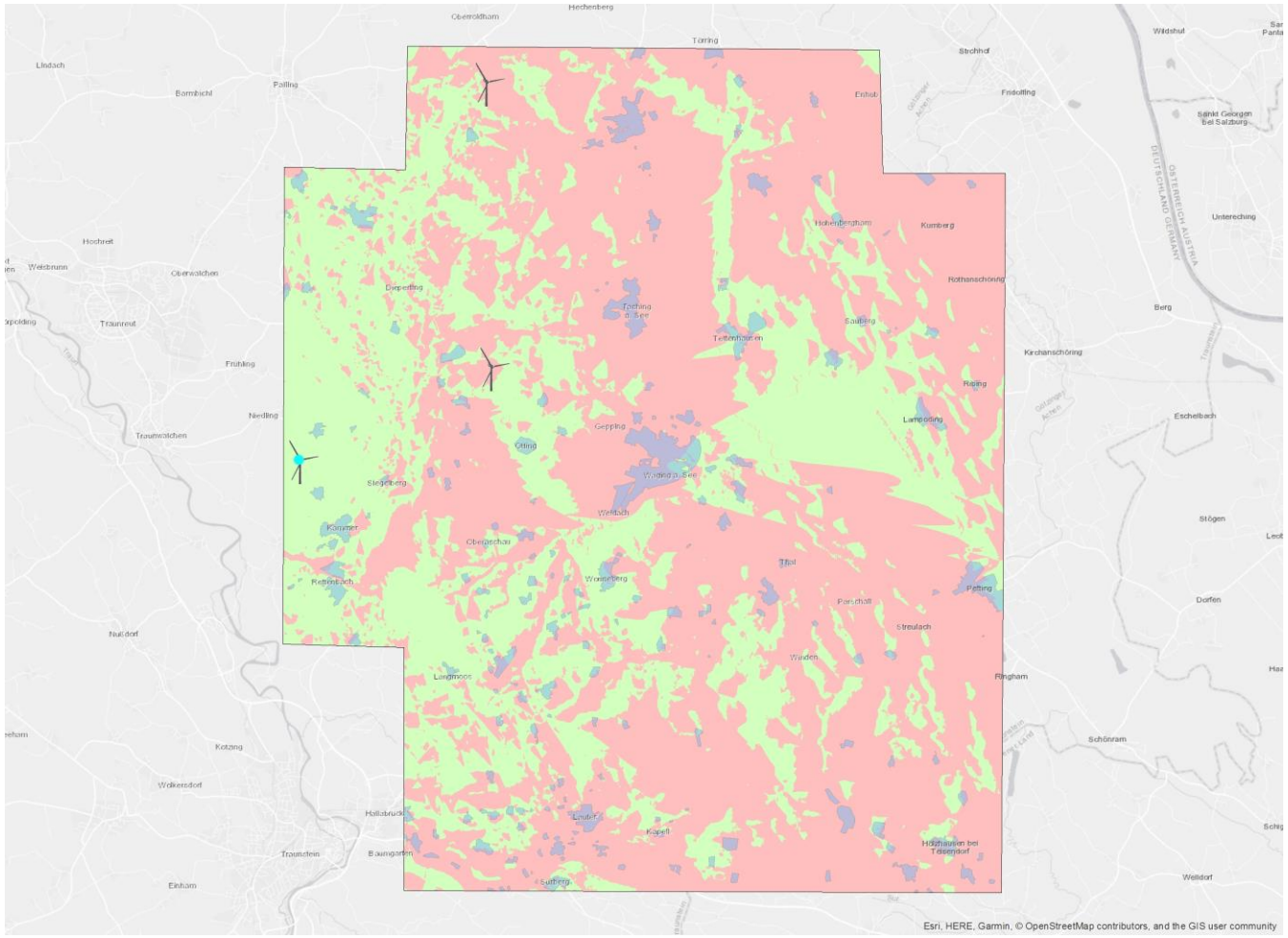
Site 2: the most suitable site that balances power generation and ecological considerations

Suitable sites: scenario 2



Site 4: the most suitable site that prioritizes wind power generation

Suitable sites: scenario 3

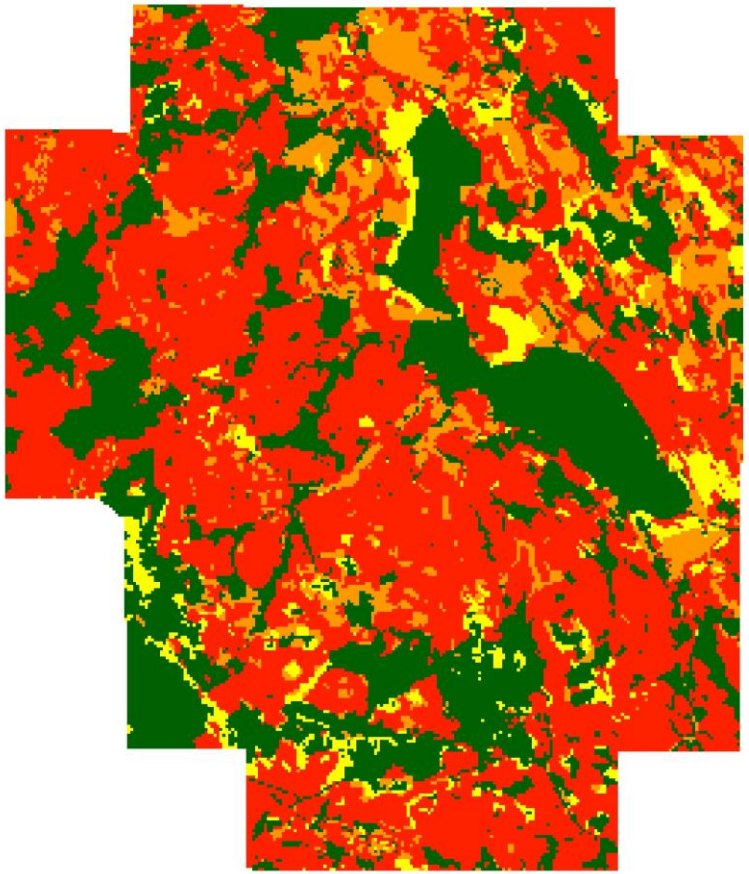


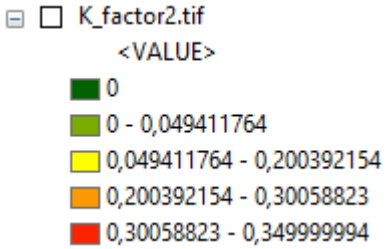
Site 8: the most suitable site that prioritizes ecological considerations

Soil erosion risk

- Universal soil loss equation (USLE): mathematical model for calculating soil erosion risk
  - USLE = K × C × R × S × L (× P)
  - Assumed P = 1
- K-factor: soil erodability factor
- C-factor: crop/vegetation factor
- R-factor: rainfall and runoff factor
- S-factor: slope factor
- L-factor: slope length factor
- ~~P-factor: support practice factor~~

K-factor




K_factor2.tif
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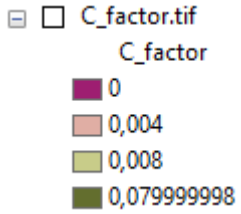
0,049411764 - 0,200392154
0,200392154 - 0,30058823
0,30058823 - 0,349999994

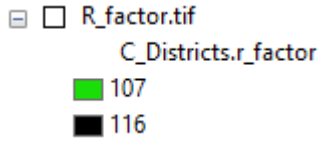
C-factor



Water bodies: 0
Urban areas: 0
Industrial/commercial areas: 0
Sport/leisure facilities: 0
Forests: 0.004
Grasslands: 0.008
Agricultural land: 0.08

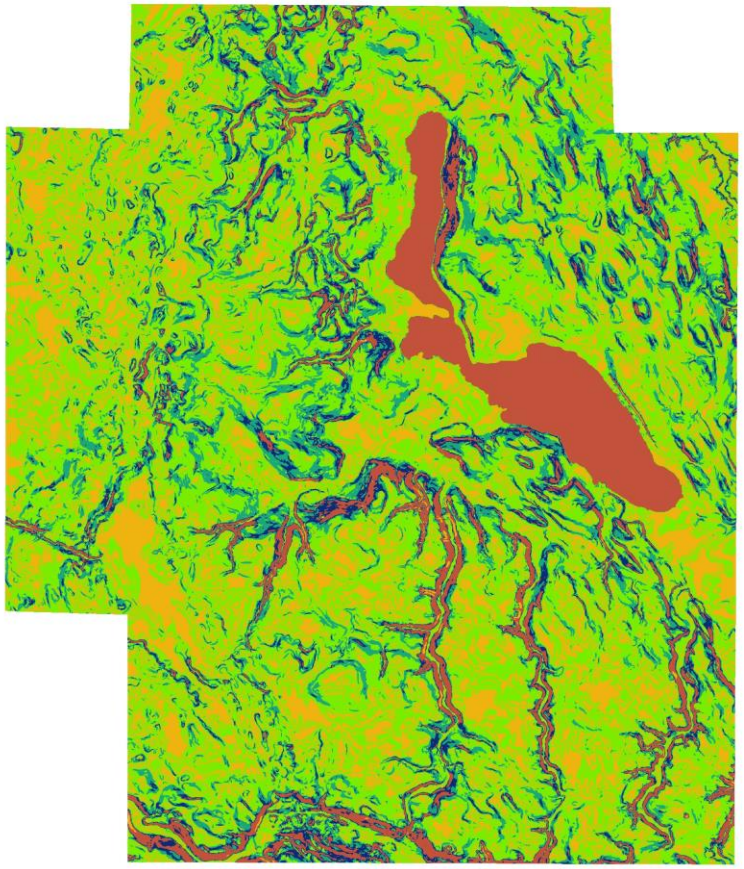
Based on Corine land cover data

R-factor



Traunstein: 107
Berchtesgadener Land: 116

S-factor



S_factor_2.tif
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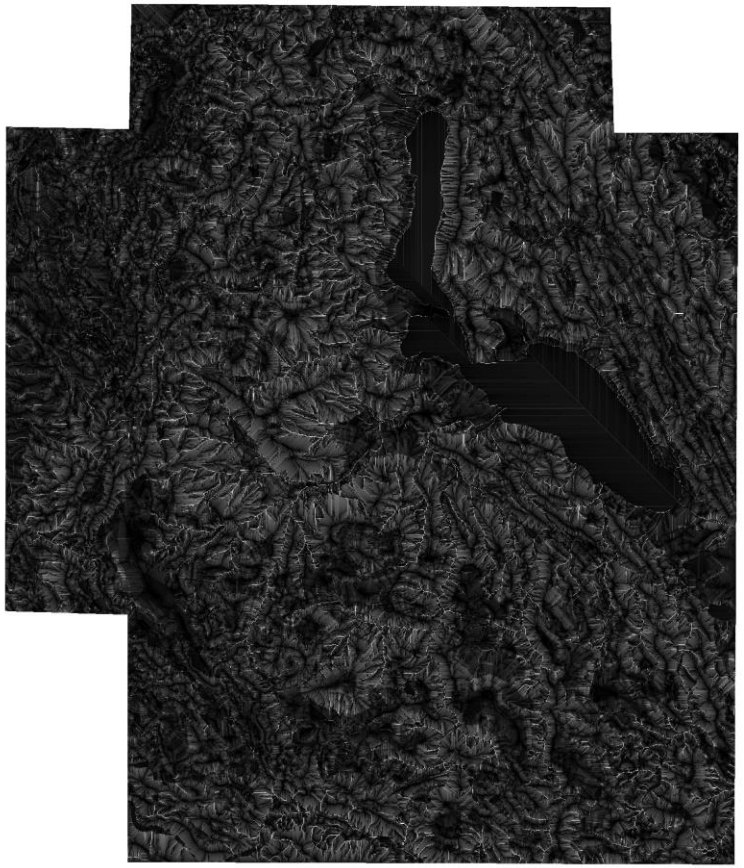
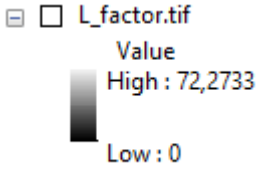
0,039341177 - 0,290070589
0,290070589 - 2,295905883
2,295905884 - 4,113694118
4,113694119 - 8

Slope based on filled DEM

L-factor

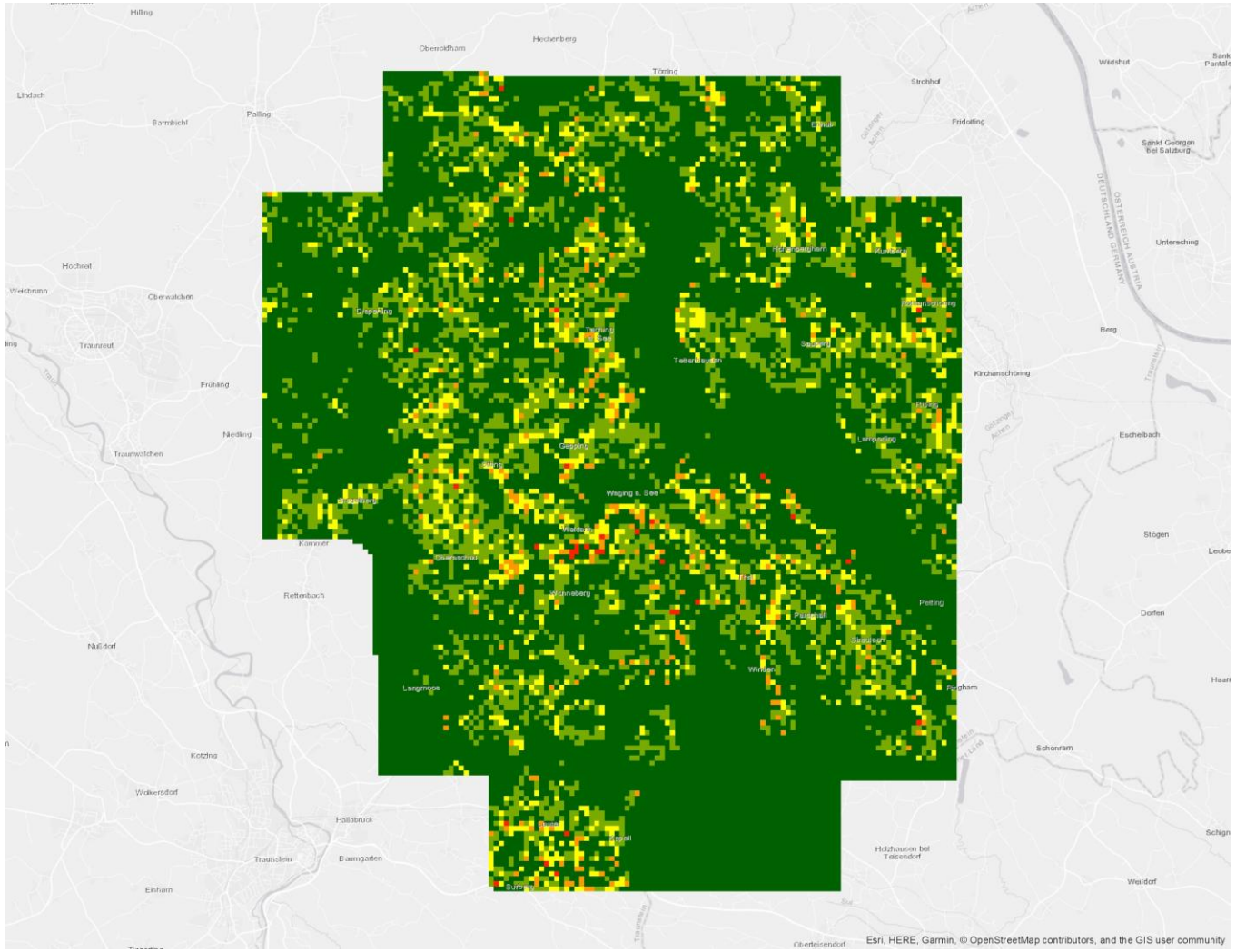




$L = (\lambda / 22.1)^m$

Calculated based on flow direction, flow accumulation and slope

Final USLE



USLE.tif

<VALUE>

0 - 155,3079504

155,3079505 - 582,4048139

582,404814 - 1.281,290591

1.281,290592 - 2.640,235156

2.640,235157 - 9.900,881836

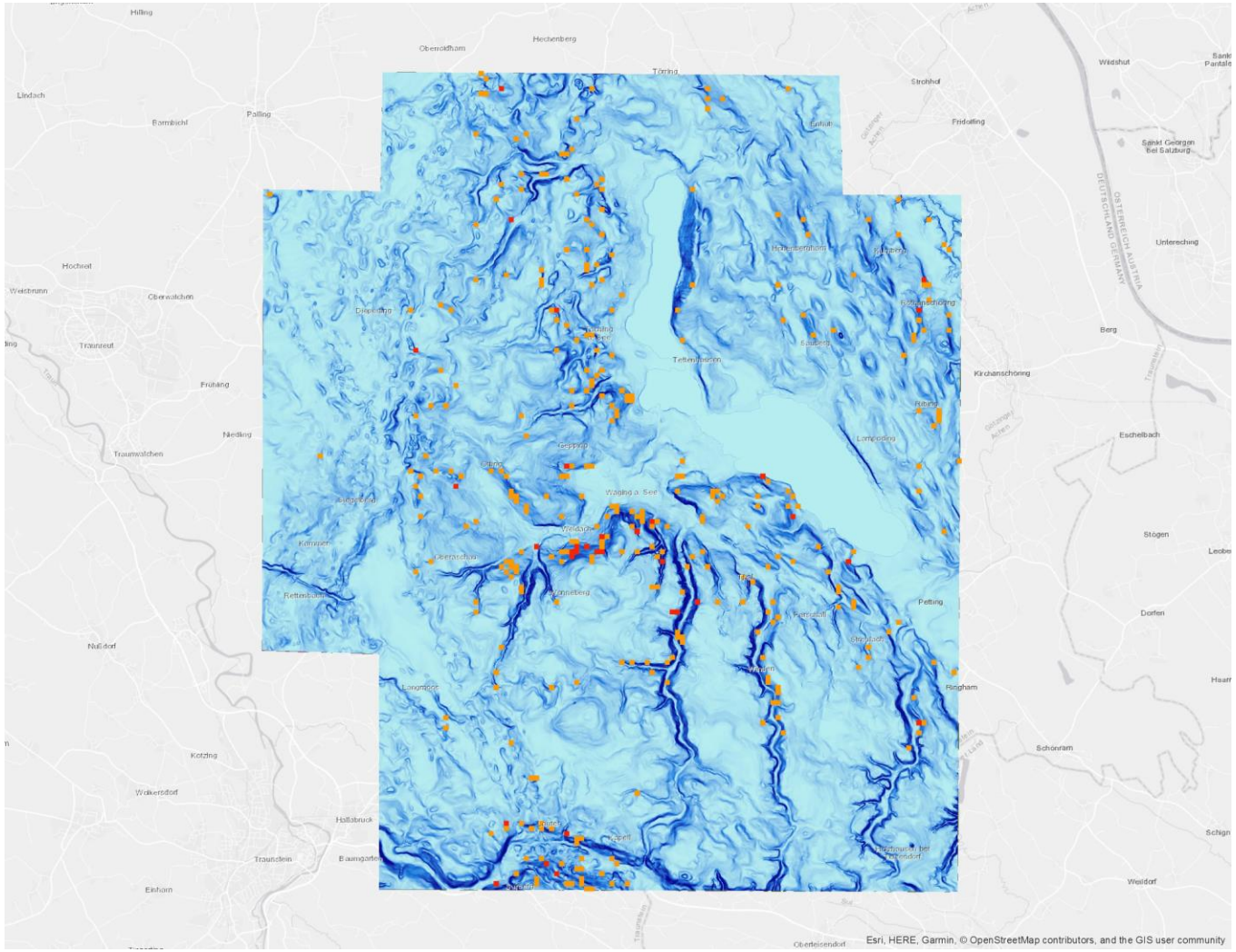
USLE overlaying land cover map

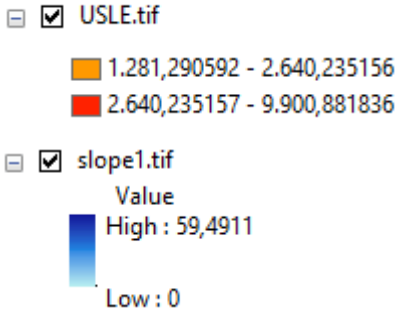
USLE.tif

1.281,290592 - 2.640,235156

2.640,235157 - 9.900,881836

USLE overlaying slope raster





Observations and recommendations

- Observations
  - Almost all high-risk areas are heavily inclined, particularly south of Waging am See and in the Lauter/Surberg area
  - Some high-risk areas are close to residential areas and on the edges of forests, with a few inside the forests
  - Very few high-risk areas around the lakes, except around the forest to the south of Lake Waging
- Recommendations
  - Keep soil covered as much as possible
    - Plant grass and shrubs to hold the soil in place with roots
    - Add mulch to limit runoff
  - Stabilize heavily eroded slopes
    - Build retaining walls
    - Plant trees to prevent landslides on steep slopes
  - Use agricultural practices that prevent erosion
    - Crop rotation
    - Conservation tillage (low-till or no-till planting)
    - Contour farming
    - Strip farming

THANK YOU FOR YOUR ATTENTION!