Use of GPS for the analyses of movements of visitors flow in nature areas

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Context

- Geographic Privacy aware Knowledge Discovery and Delivery (GeoPKDD)
- People in Motion (PIM)

- devising methods for representing, storing and managing moving objects, which change their position in time, and possibly also their shape or other features, together with their trajectories, with varying levels of accuracy and certainty,
- devising spatio-temporal knowledge discovery and data mining methods and algorithms for moving objects and their trajectories,
- devising native techniques to make methods and algorithms intrinsically privacy-preserving, as data source typically contains personal location-aware sensitive data.

Goals

- Explore the use of spatial-temporal recordings to analyzing movement behavior of visitors in nature areas
- Apply techniques from the field of GIS, visual-analyses and data-mining
- Relate patterns of movement to environmental characteristics.
- Evaluate the usability of GPS for analyzing movement behavior

Representation of movements

- Spatial Temporal Sequences
  - Set of spatial temporal recordings

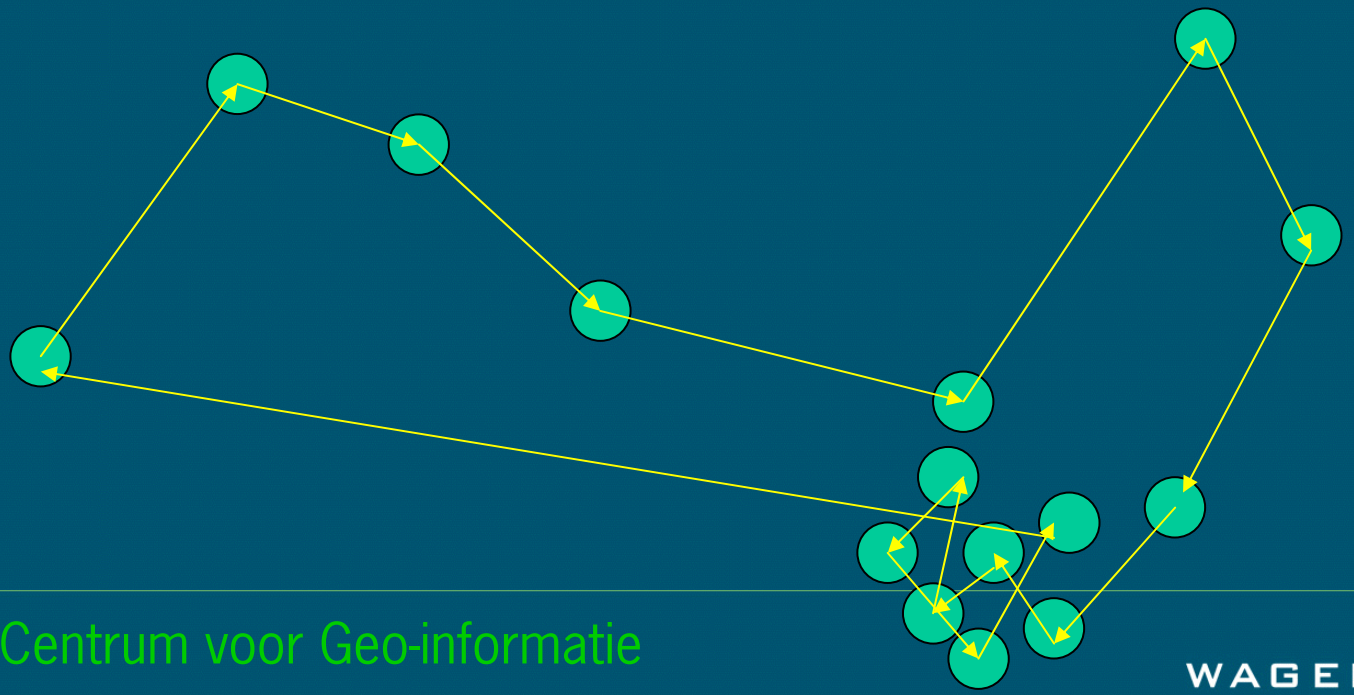
$$STS = s_0 \xrightarrow{a_1} s_1 \xrightarrow{a_2} \ldots \xrightarrow{a_n} s_n$$

  - Recorded in triples: $STS = \langle (x_0,y_0,t_0),\ldots,(x_k,y_k,t_k) \rangle$

Generated by:
- GPS
- Mobile phones
- RFID
- …

Trajectories

- Begin and End?
- Start and Stops?
- Scale?
- Interactions?



Characteristics of movement

- Single movements:
  - Speed
  - Acceleration
  - Shape
- Compound/multiple movements:
  - Density
  - Interactions in space an time

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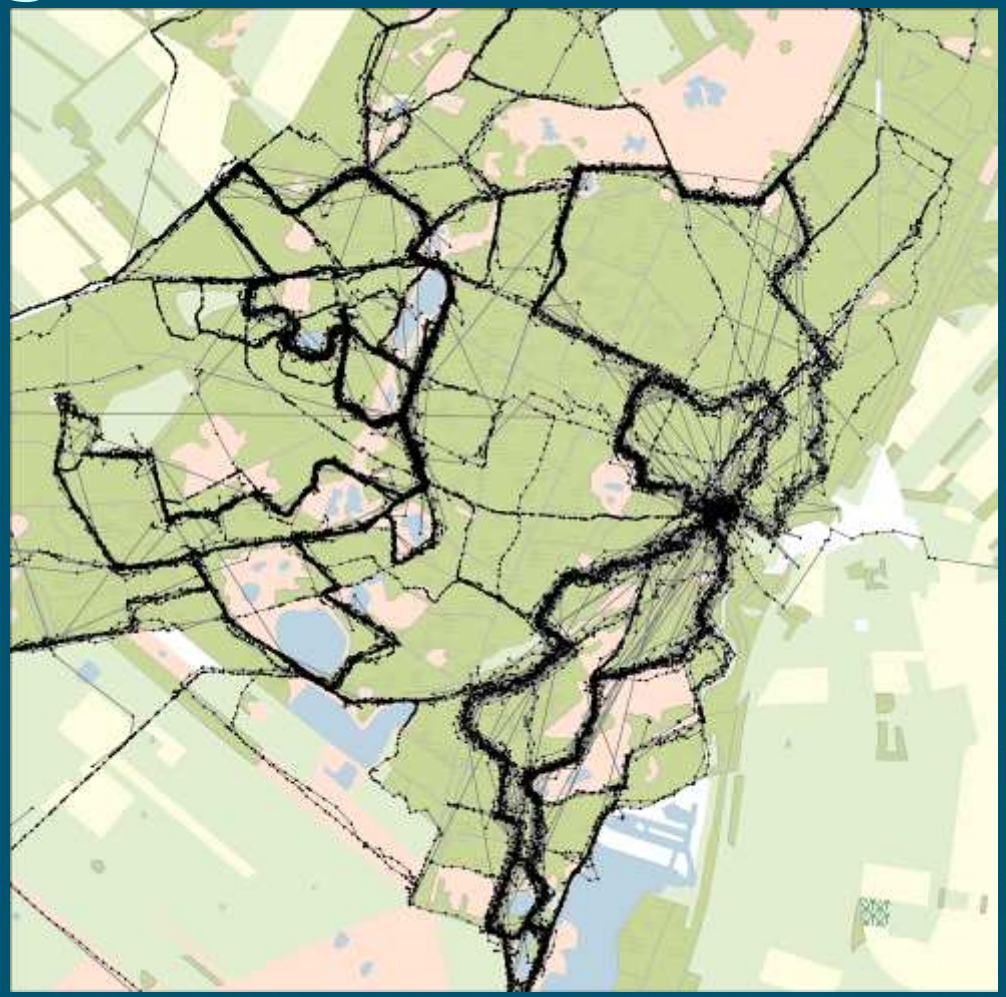
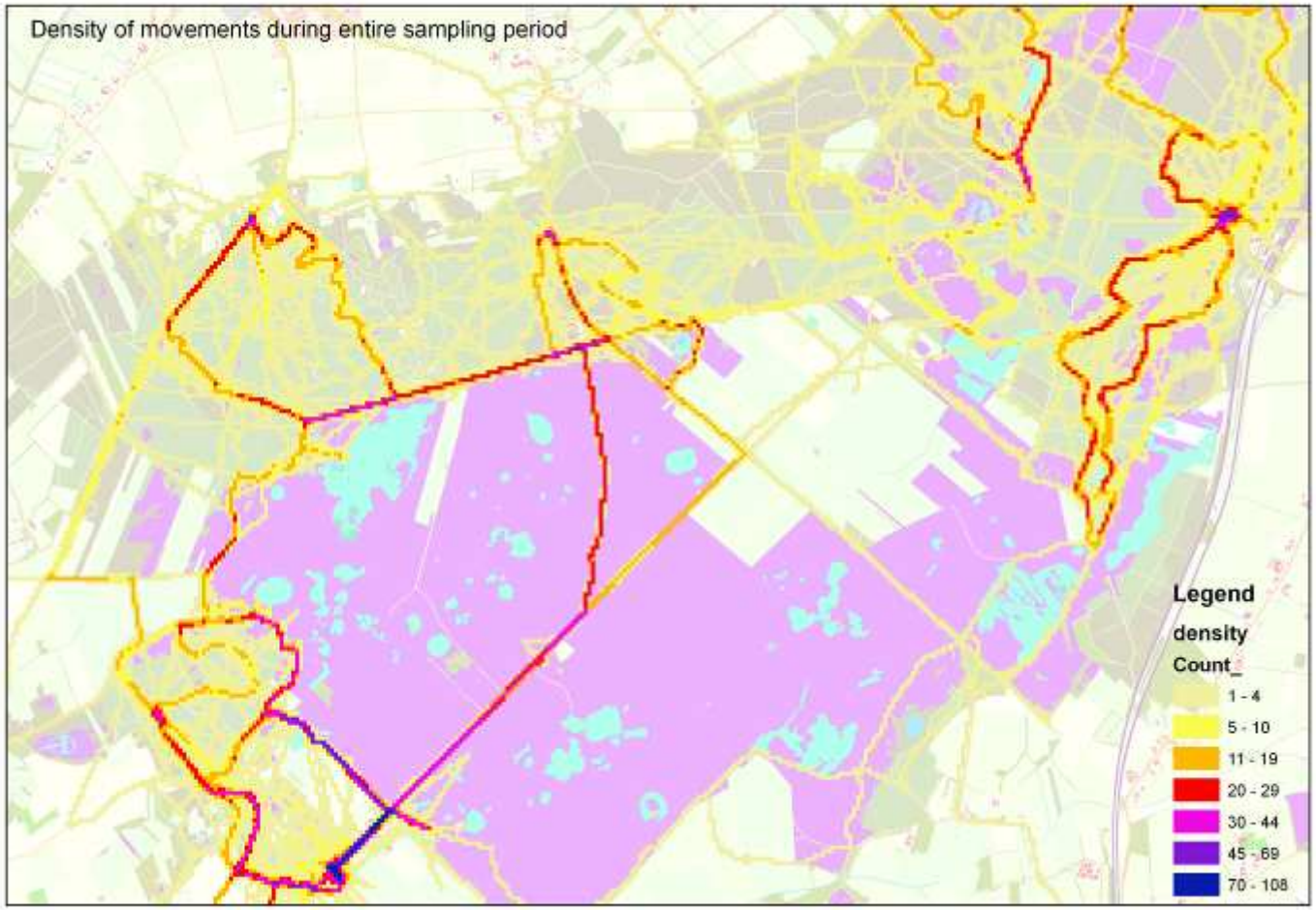
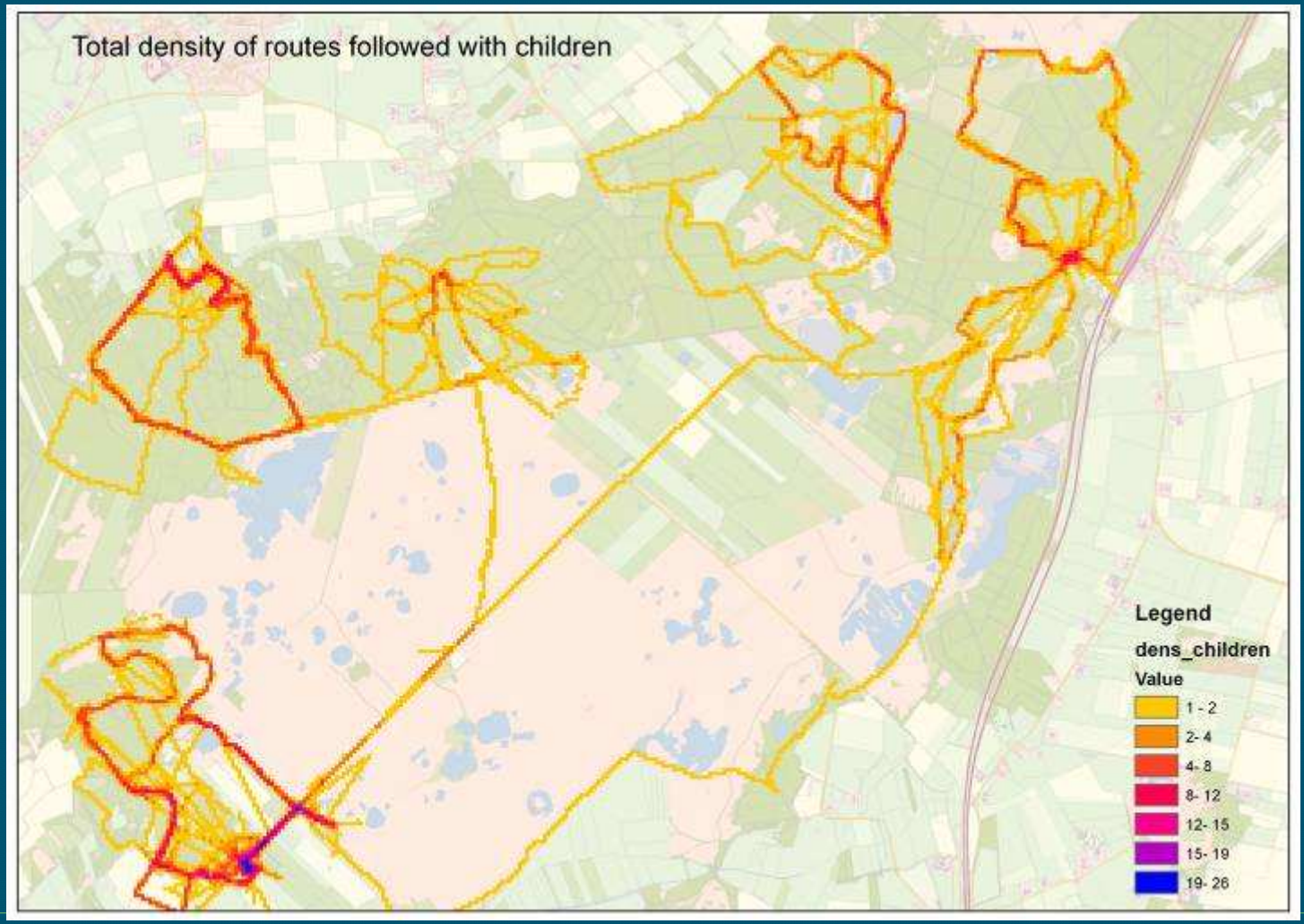
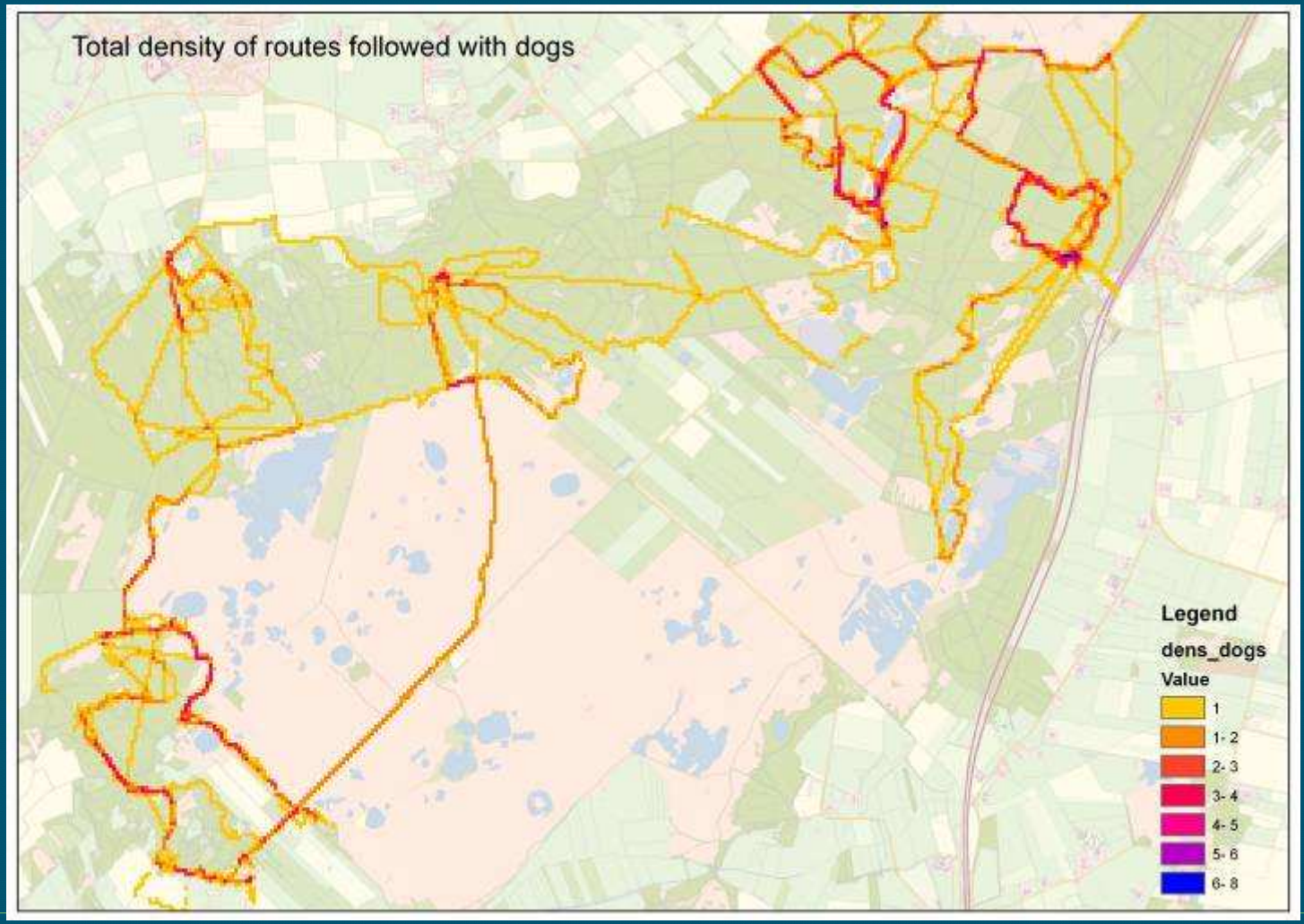
- Explorations
  - Density
  - Walking speed in relation to openness of the landscape
  - Start and Stops
  - Similarities amongst various trajectories
- Tracks of 399 visitors
- 142000 TAS

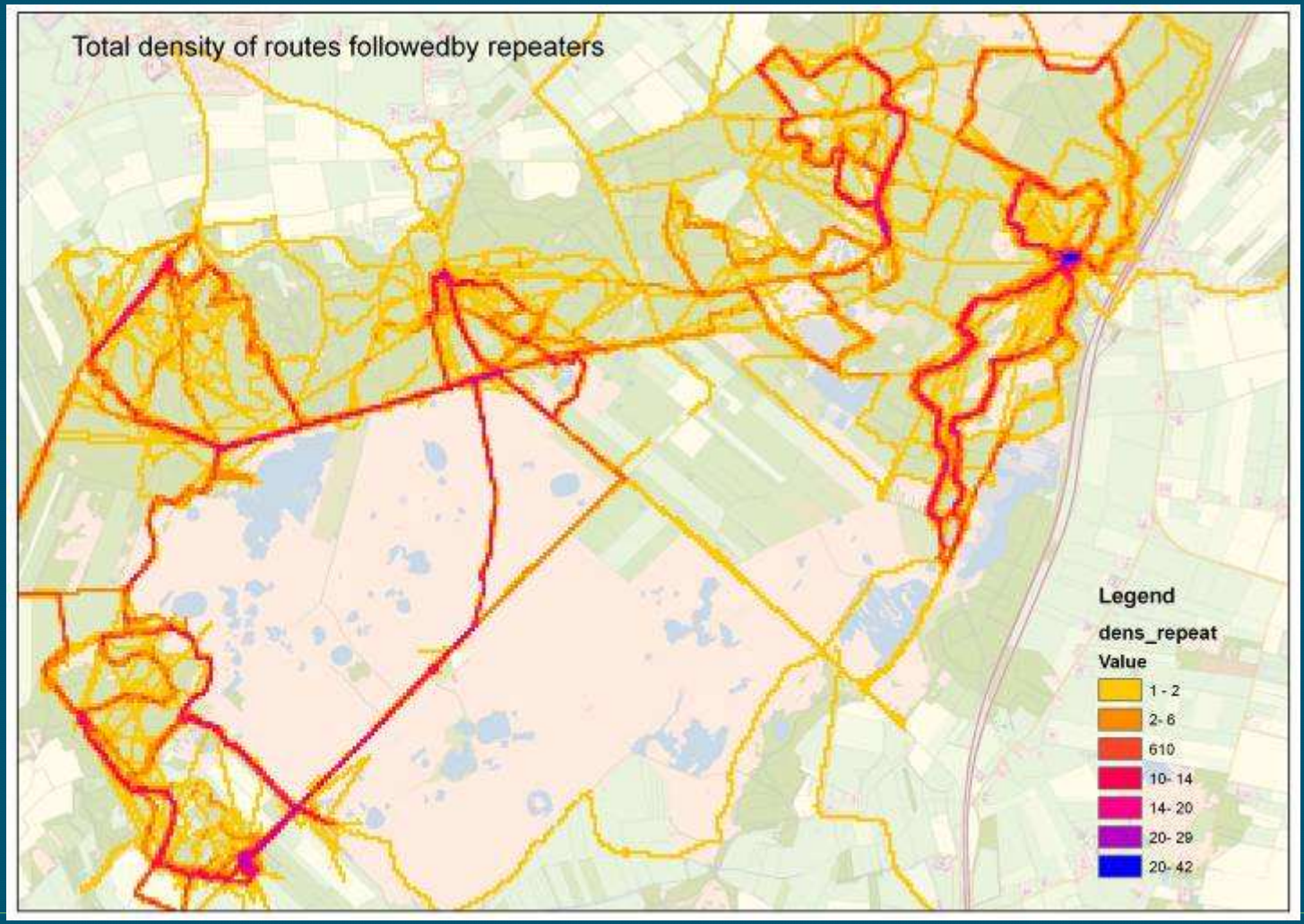


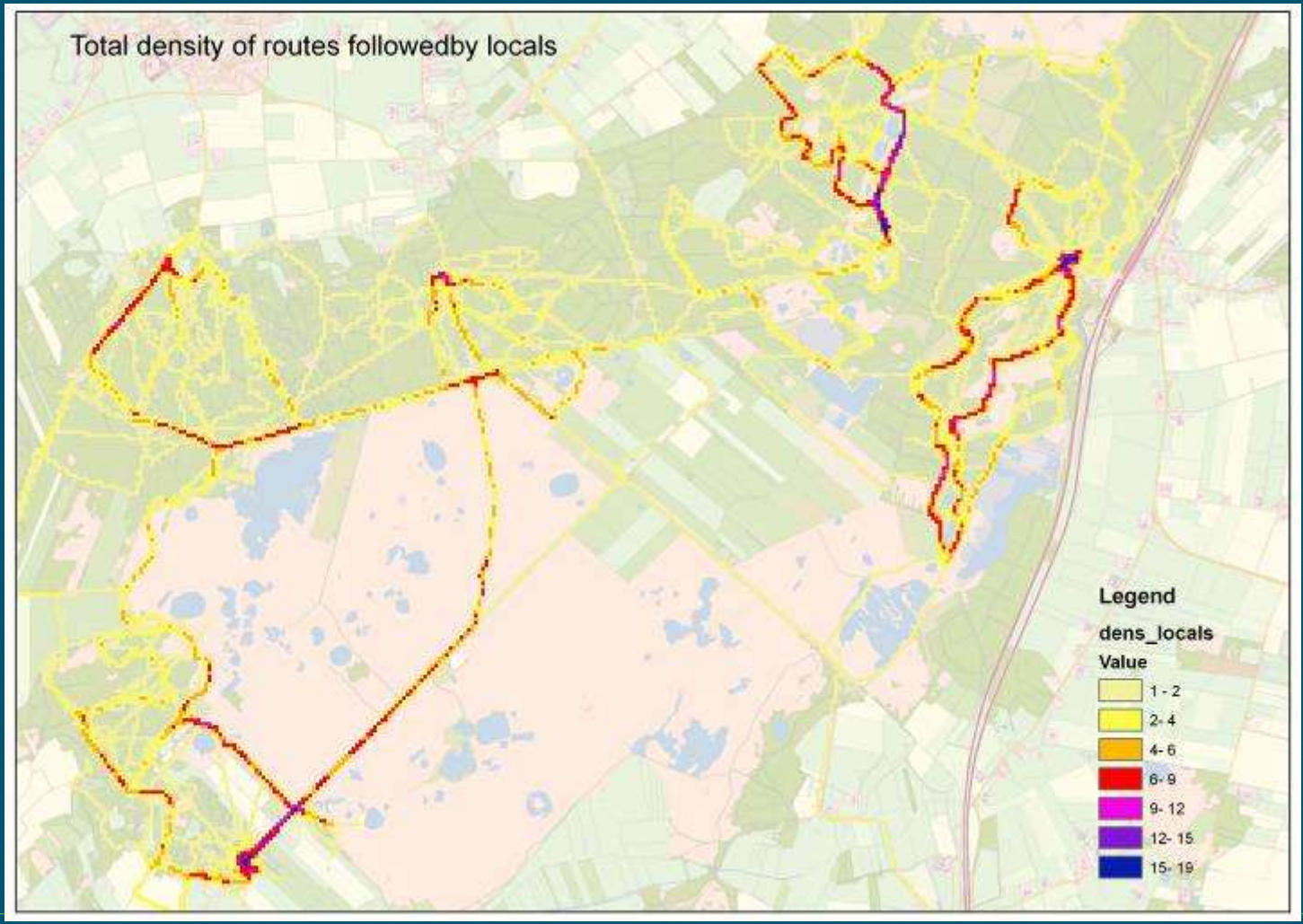
Density


Density of movements during entire sampling period
Legend
density
Count_
1 - 4
5 - 10
11 - 19
20 - 29
30 - 44
45 - 69
70 - 108


Total density of routes followed with children
Legend
dens_children
Value
1 - 2
2- 4
4- 8
8- 12
12- 15
15- 19
19- 26

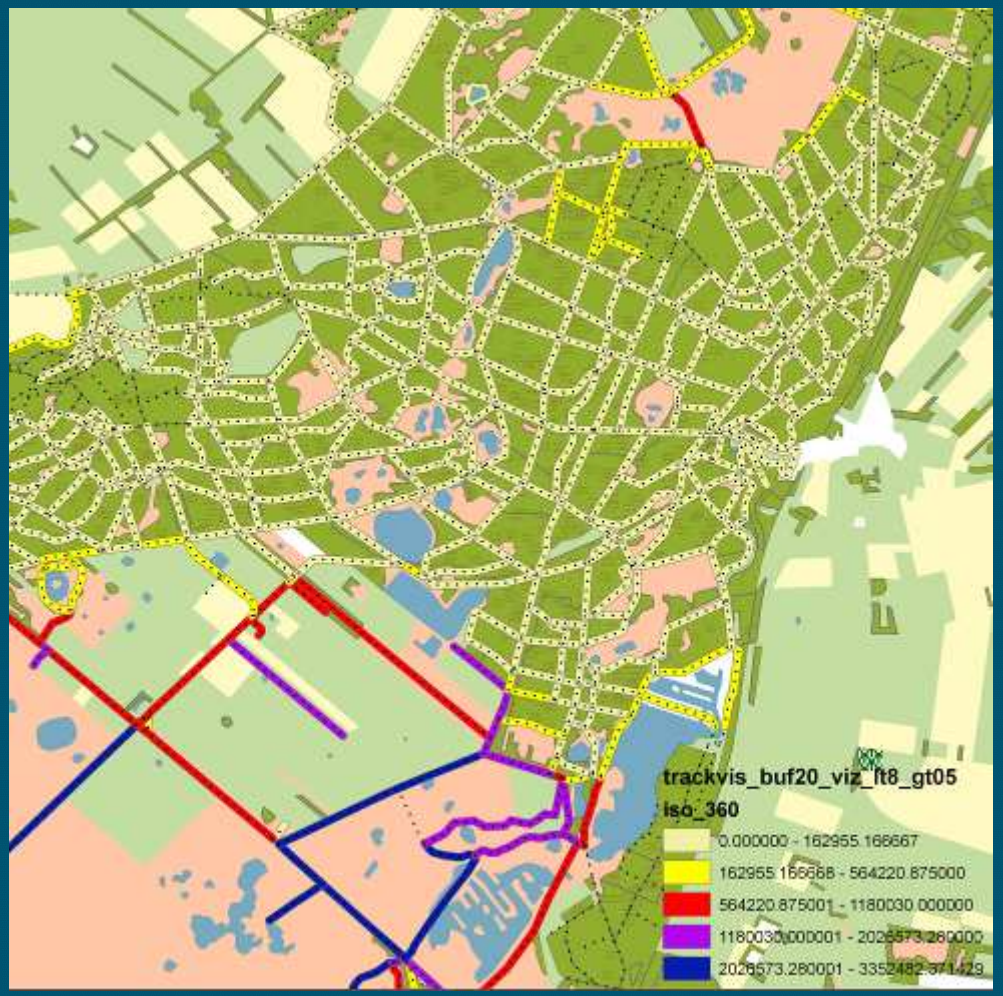

Total density of routes followed with dogs
Legend
dens_dogs
Value
1
1- 2
2- 3
3- 4
4- 5
5- 6
6- 8


Total density of routes followedby repeaters
Legend
dens_repeat
Value
1 - 2
2- 6
610
10- 14
14- 20
20- 29
20- 42


Total density of routes followedby locals
Legend
dens_locals
Value
1 - 2
2- 4
4- 6
6- 9
9- 12
12- 15
15- 19

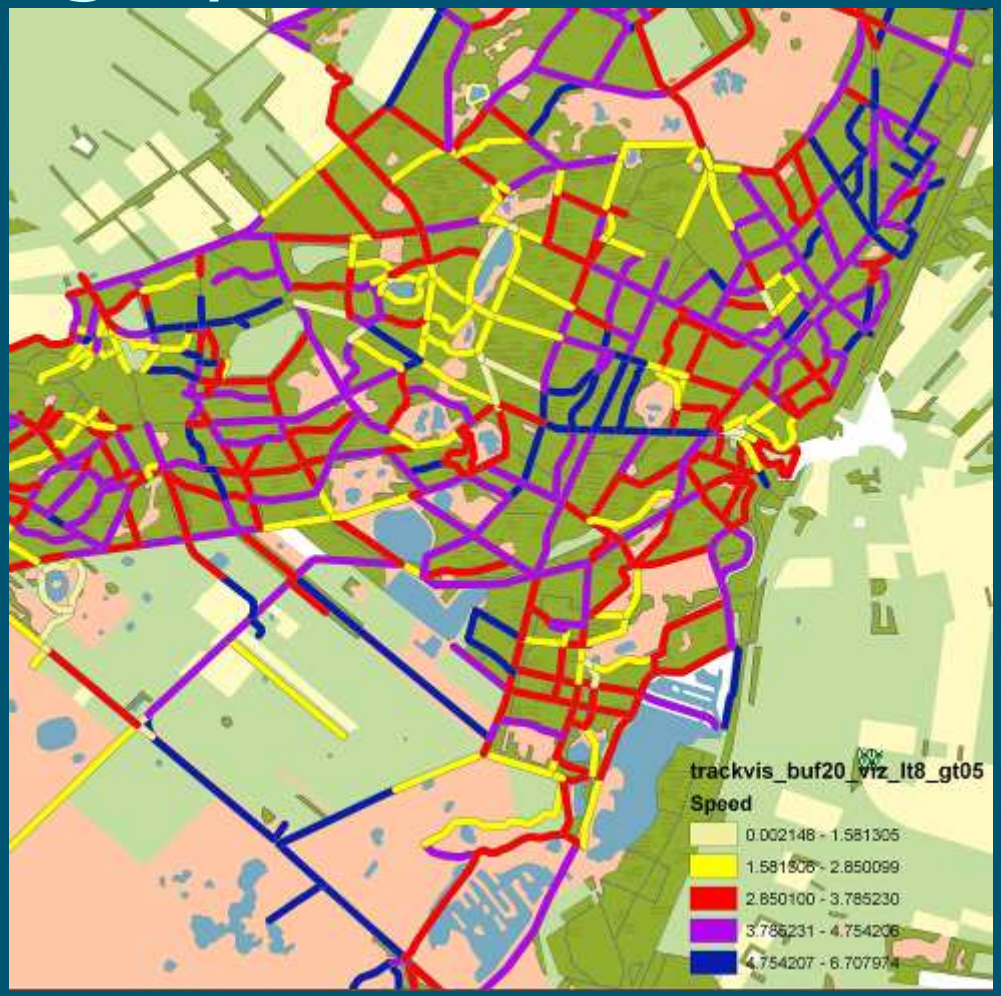
Openness

- Viewpoints along the road
- Calculate openness using Isovist analyst
- Based on classified topographical map

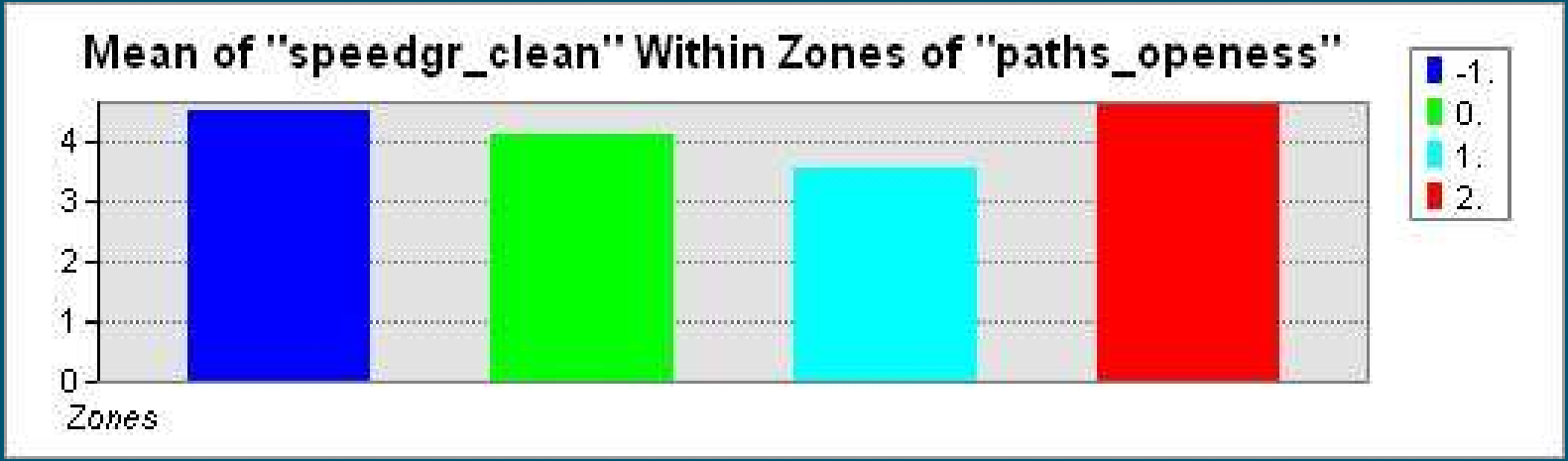


Walking speed

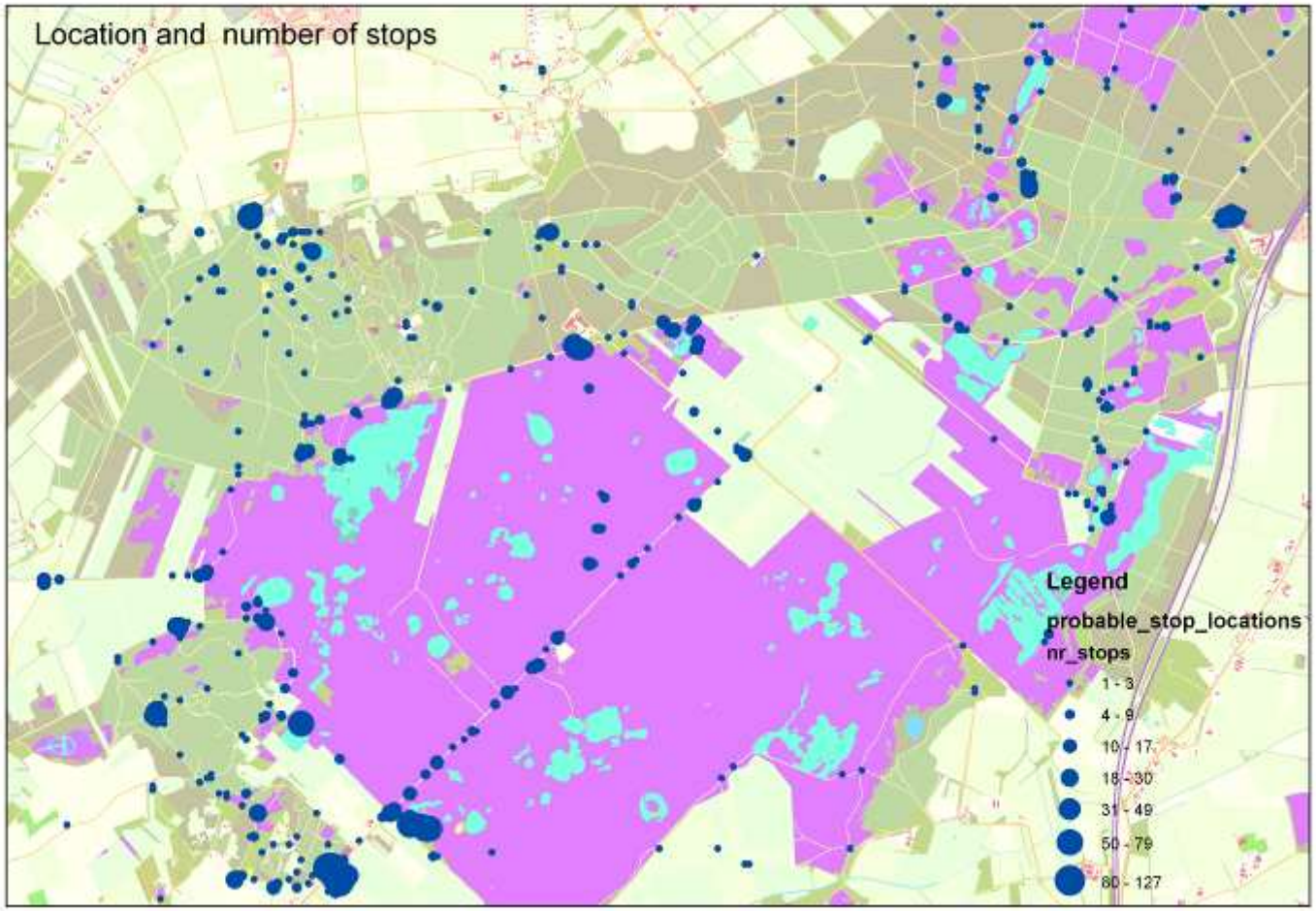
- 65% of the visitors followed marked trails
- Effect of openness on walking speed
- Four openness classes
  - Open
  - Closed
  - Boundary
  - Mixed



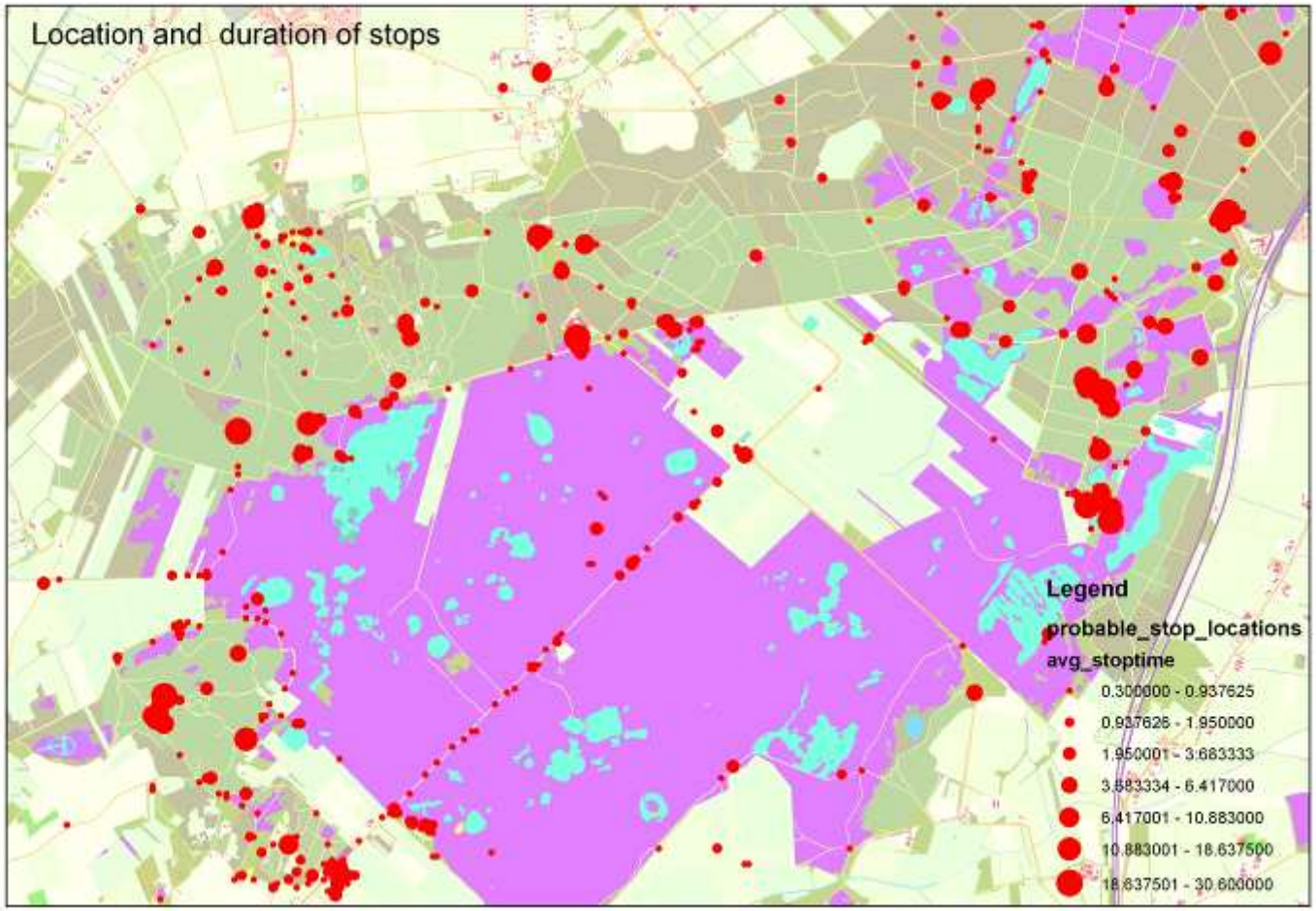
Relation openness-speed



Stops (density)



Stops (duration)



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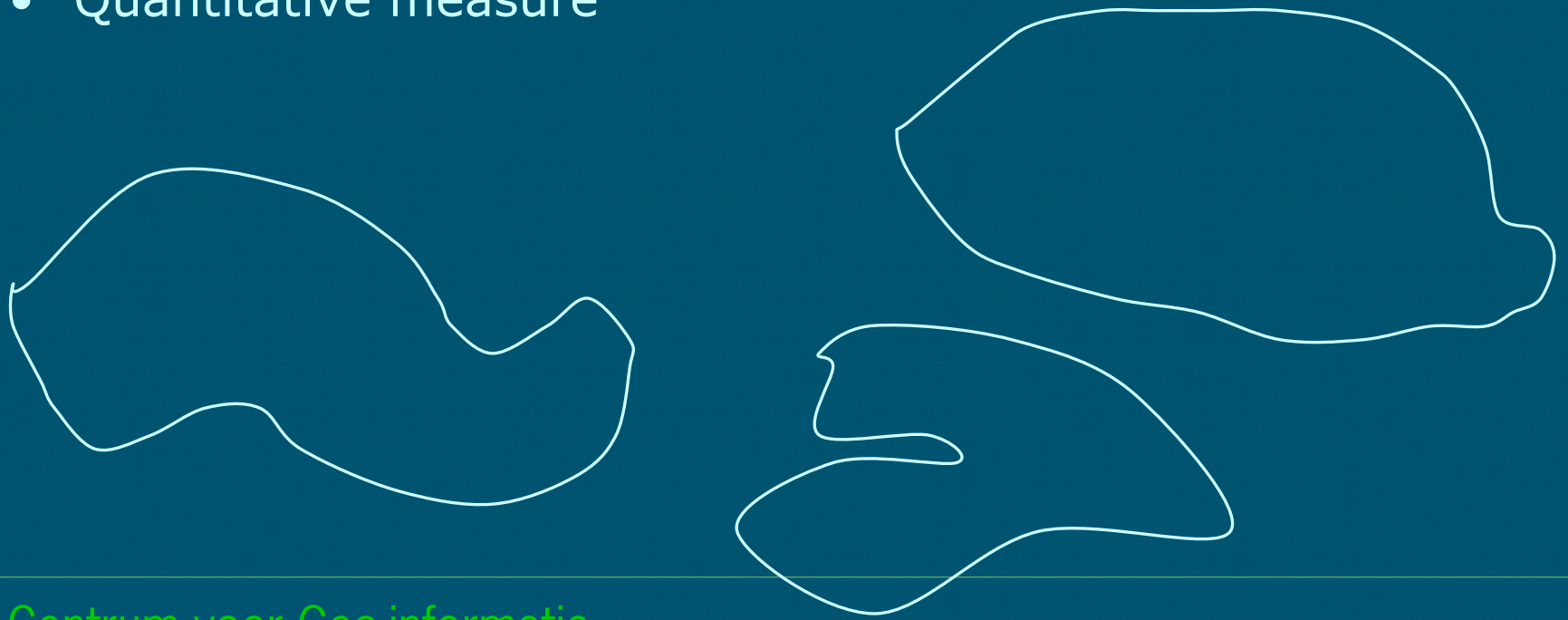
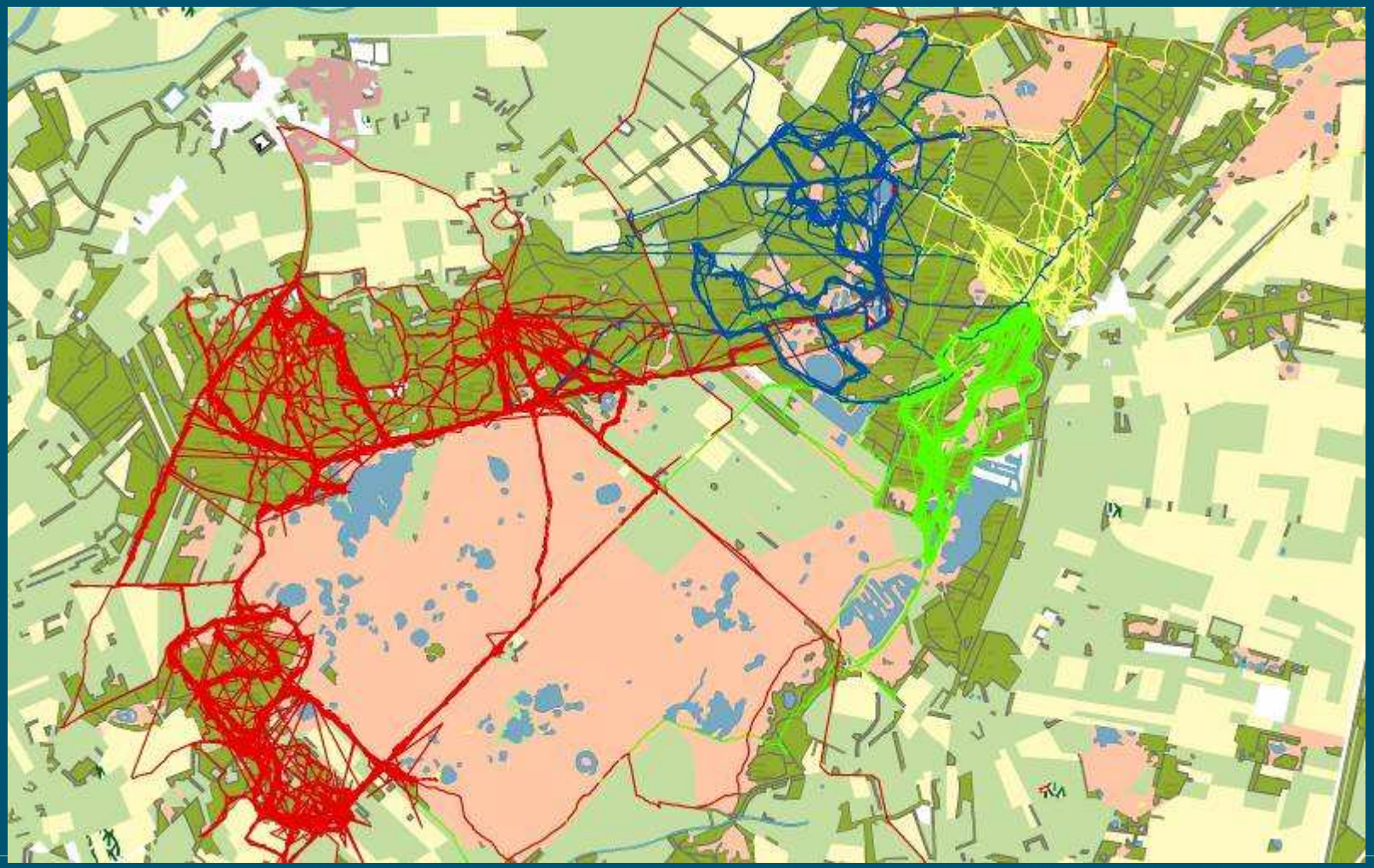
Similarity testing

- Fréchet distance is a measure of similarity between curves that takes into account the location and ordering of the points along the curves.
- Quantitative measure



Similarity



Conclusions

- Moving objects analyses offers additional tools to analyze visitor behavior
- Quality of current (handheld) GPS hampers adequate tracking of movements at low speeds (inaccuracy and noise)
- Data mining techniques like similarity matching and clustering might offer additional insights