Automatic generation of plant distributions for existing and future areas using spatial data

P5 presentation - Benny Onrust

Content

- Introduction and objective
- Plant placement algorithm
- Tests and validation
- Conclusions and future work

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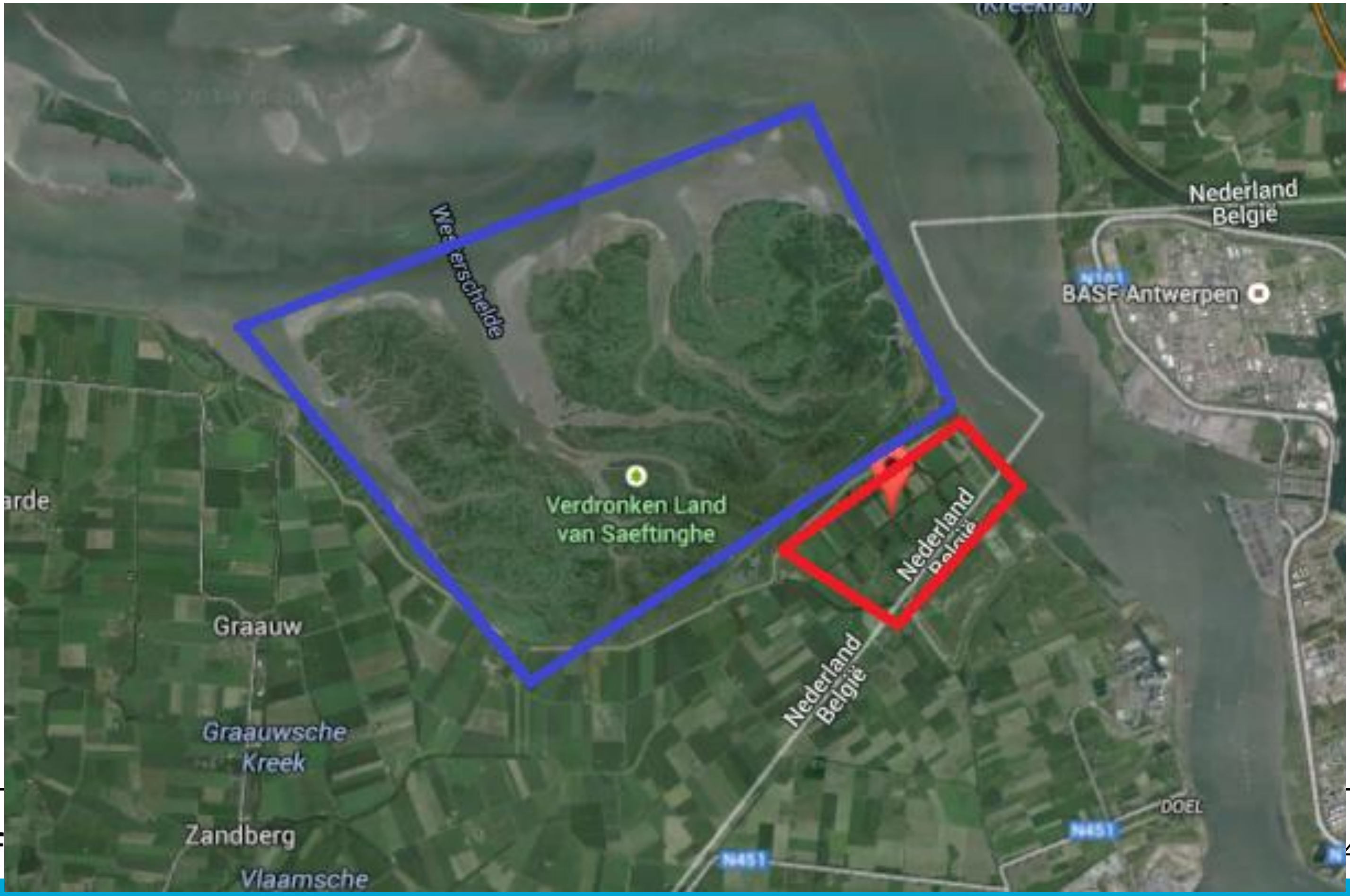
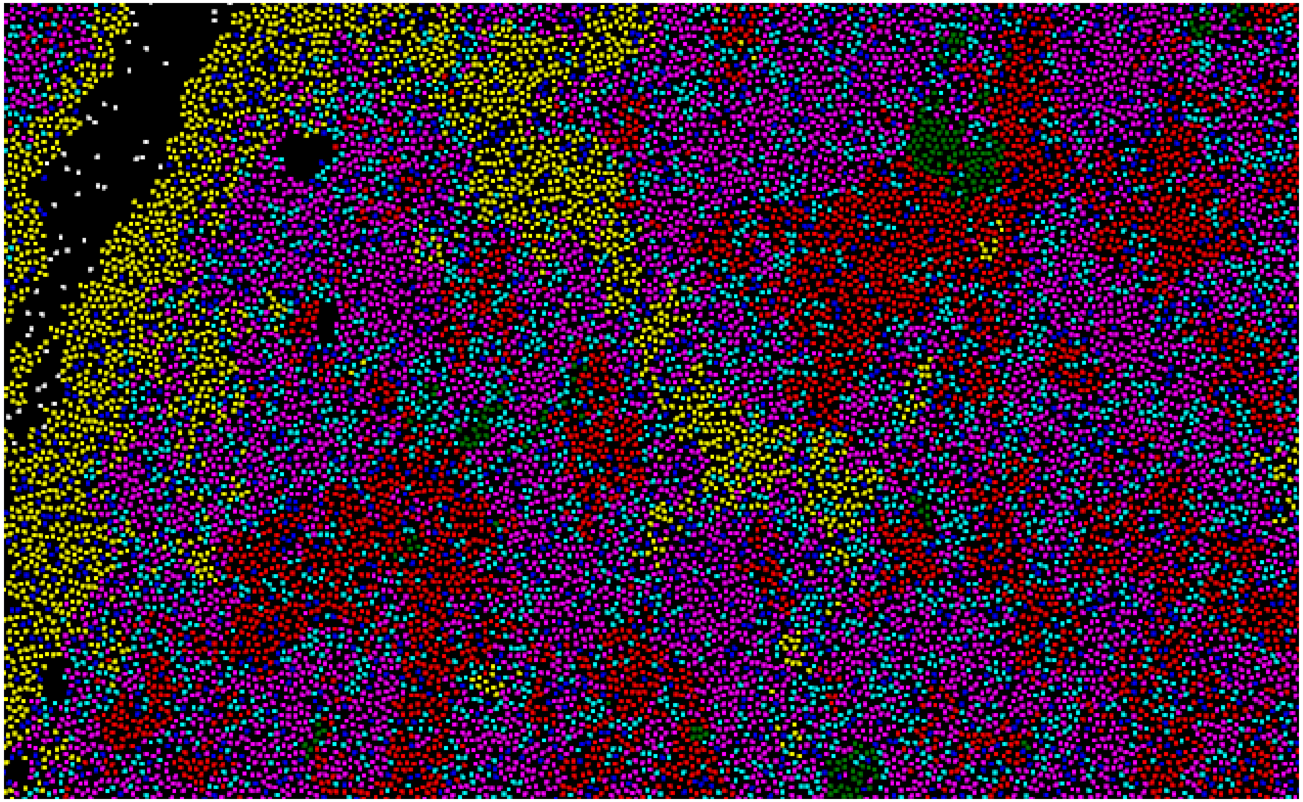
Introduction

- Generation of plant distributions. Why? → 3d visualizations



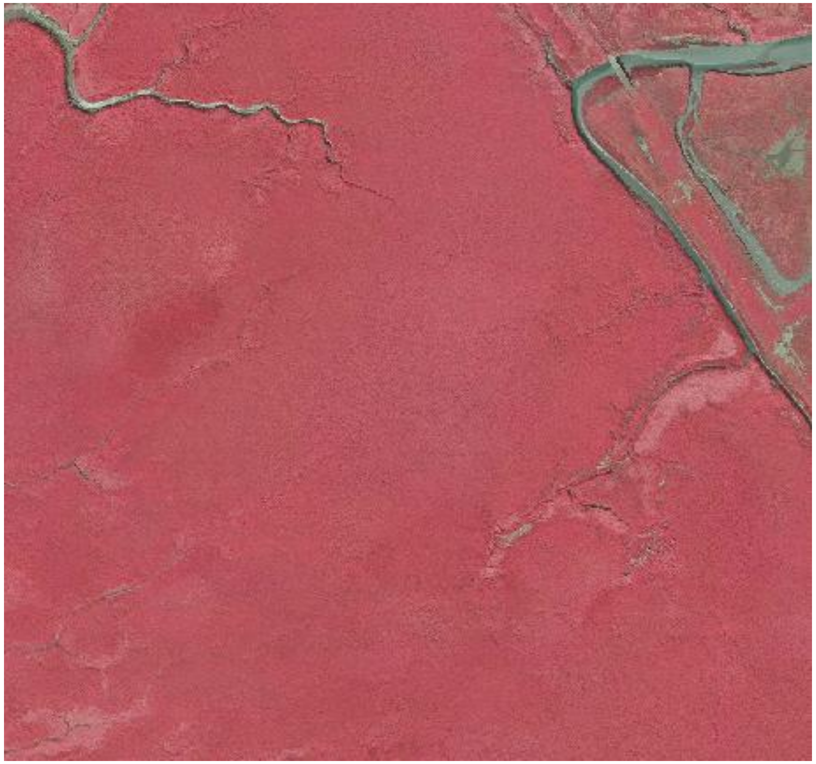
What is a plant distribution?

- Point distribution
- Plant types
- Patterns



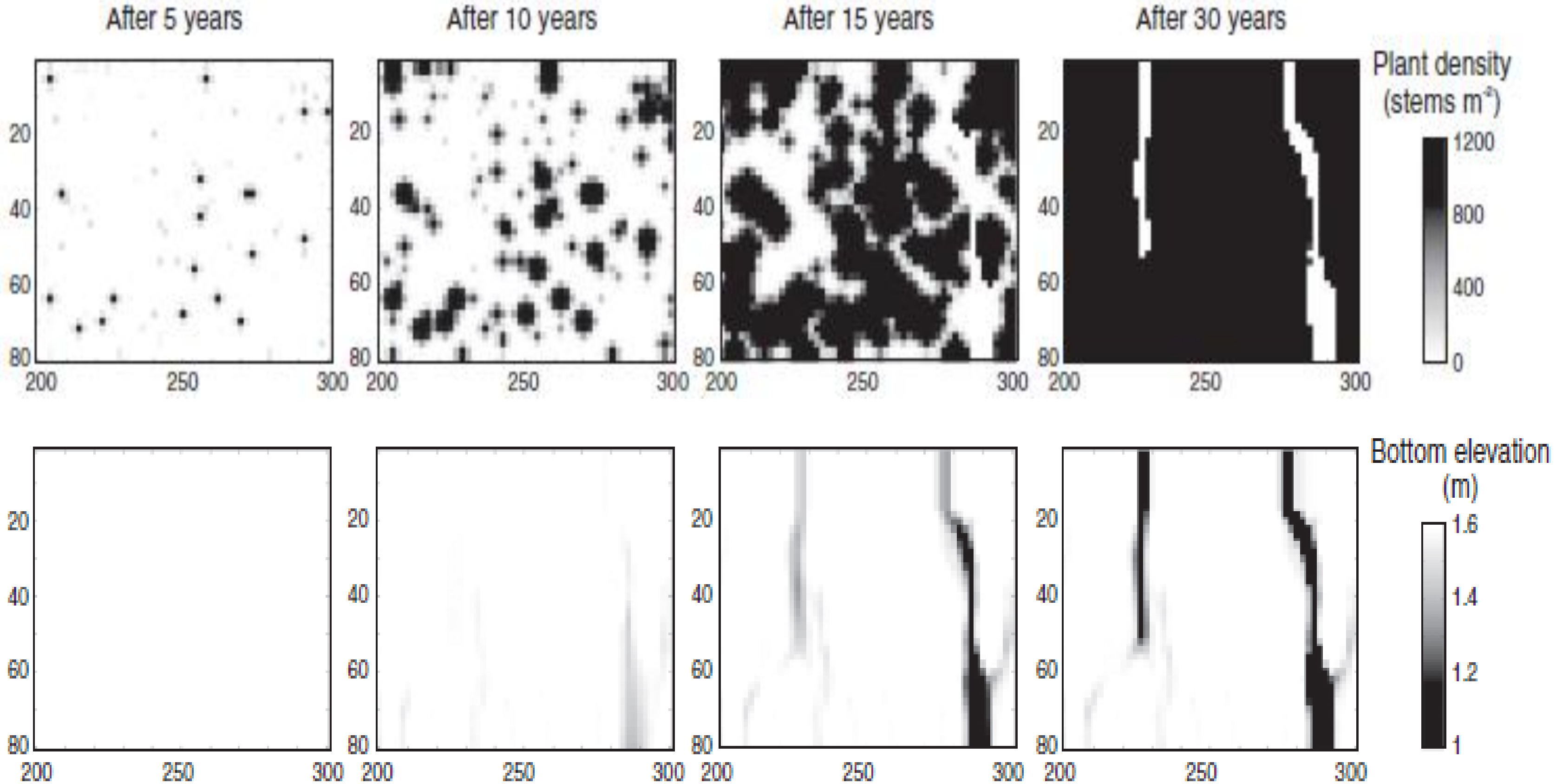
What are the problems? (1/2)

- Current techniques are limited → only detection large plants



What are the problems? (2/2)

- How to obtain data for future areas?



Introduction: objective

- Generation of realistic plant distributions for both existing and future areas
  - This includes small and large plants
- Method should work for different environments and data
- End product → realistic plant distribution

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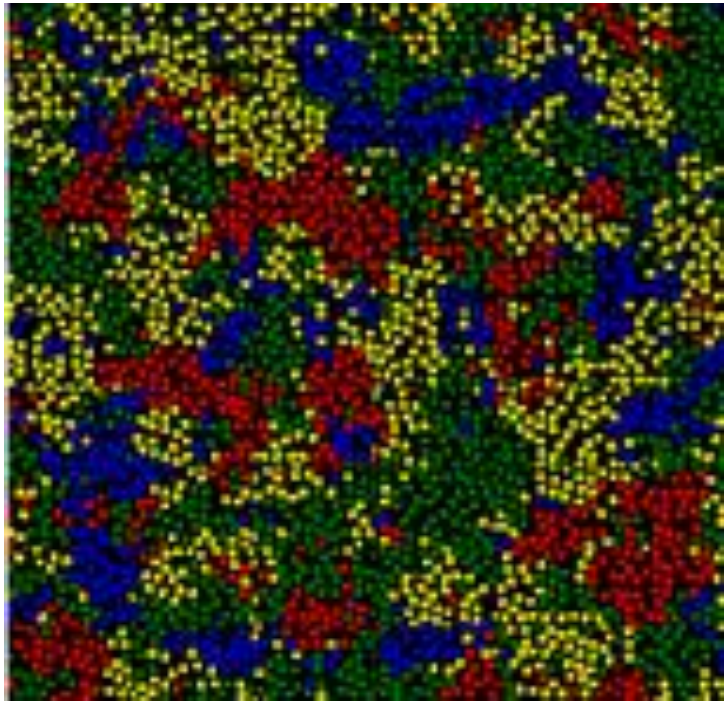
Overview of the algorithm

The algorithm has to deal with two main problems:

- Where is each plant located in the environment?
  → Point generation

- What are the plant types?
  → Point classification

But, what kind of data can be used?

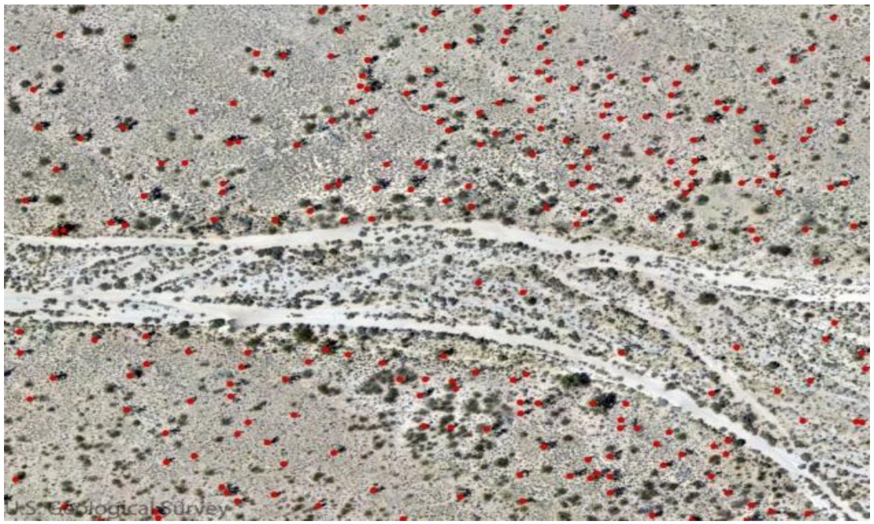


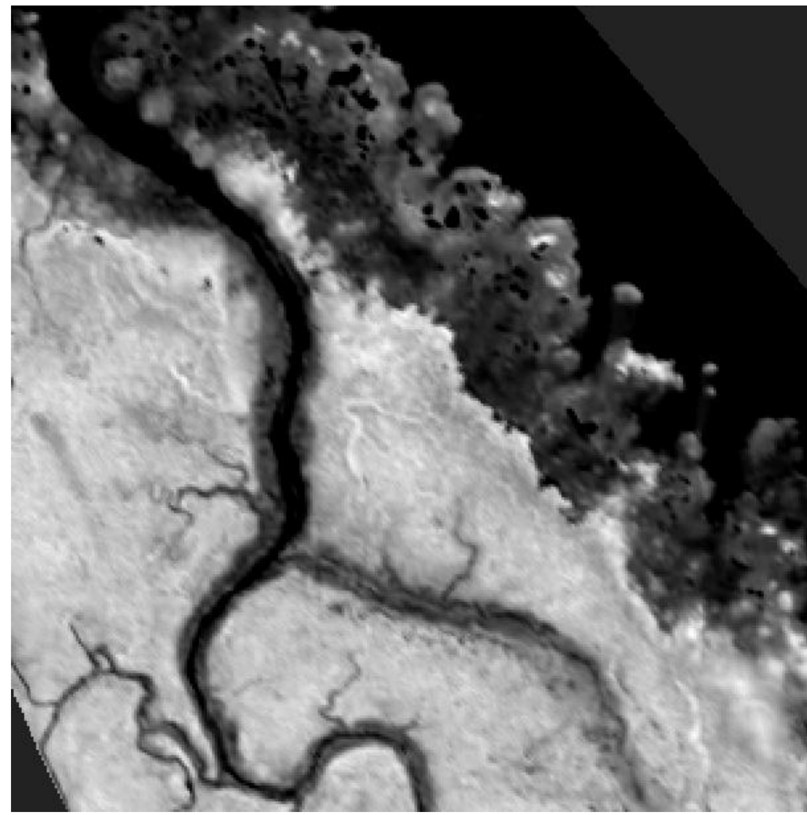
Input of the algorithm

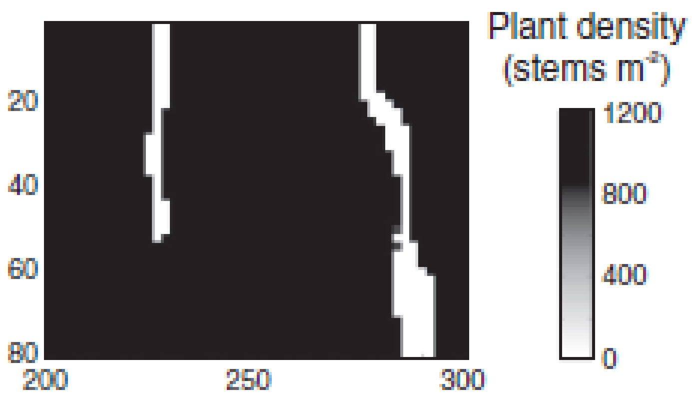
- Point generation
  - Data about vegetation presence
- Point classification
  - Data about composition/coverage
  - Data about the patterns

Input (1/3): Vegetation presence

- Where is vegetation?

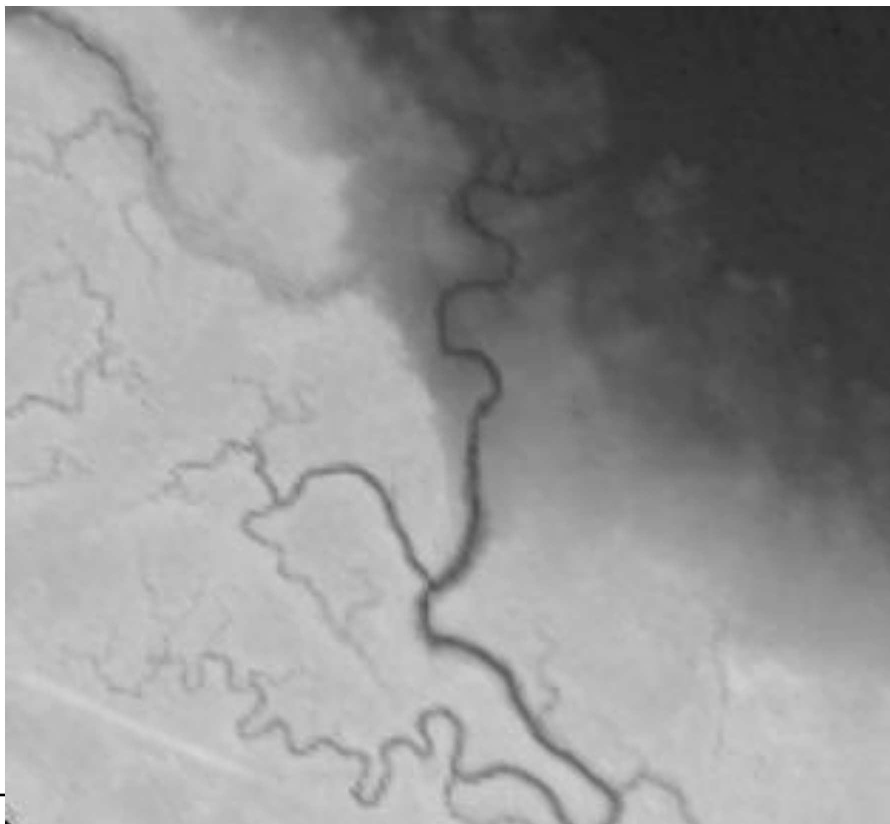


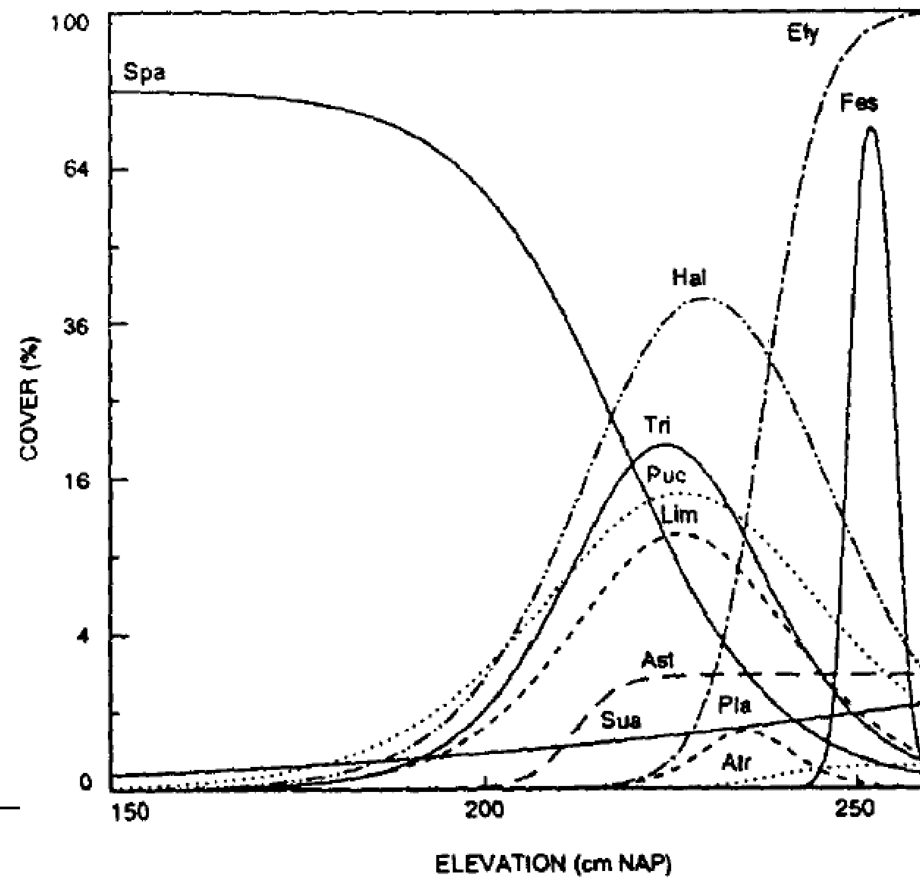




Input (2/3):Composition/Coverage

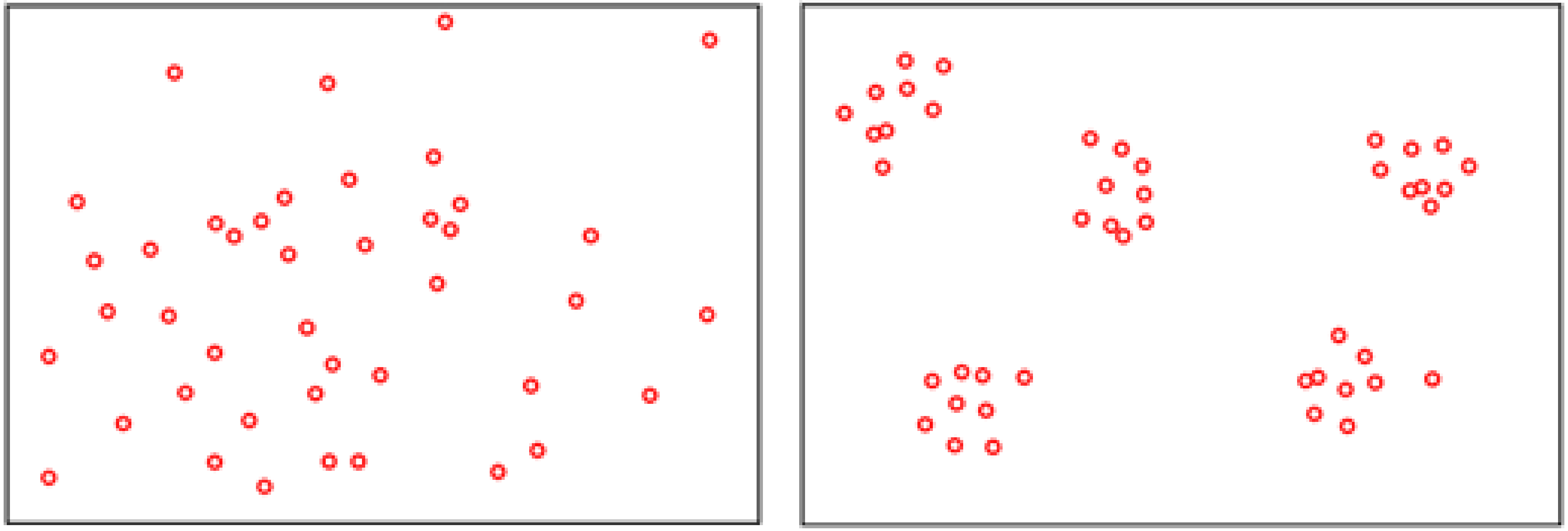
- Where is each plant type located?





Input (3/3): Patterns

- Shape metrics → Defines the shape of the patterns for a plant type



Point generation

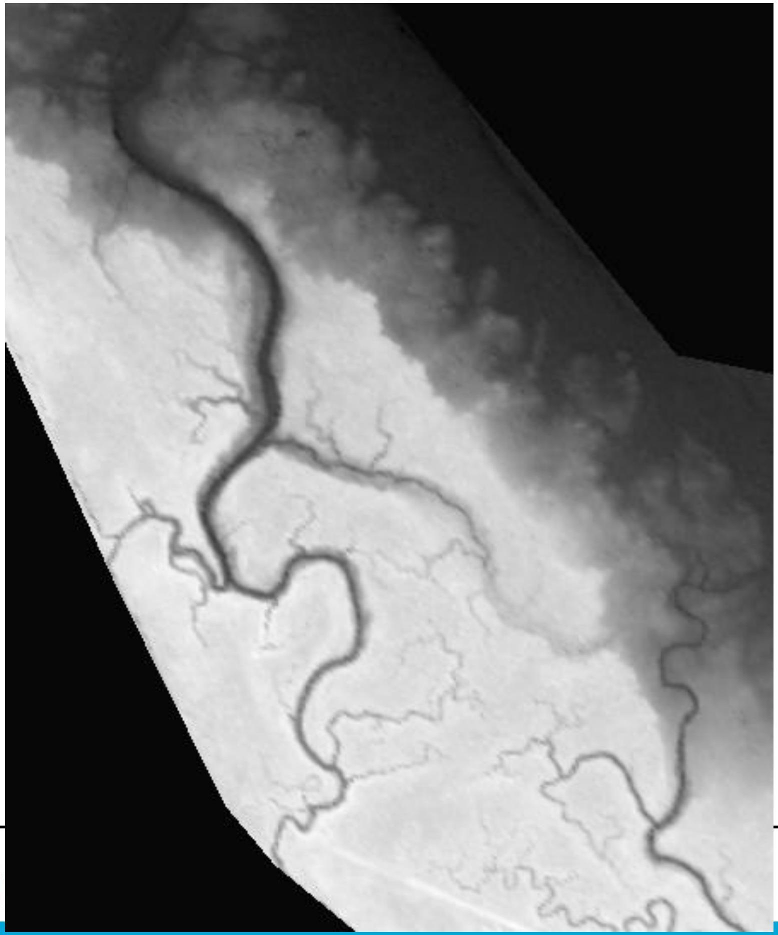
- How to translate the input data to point positions?

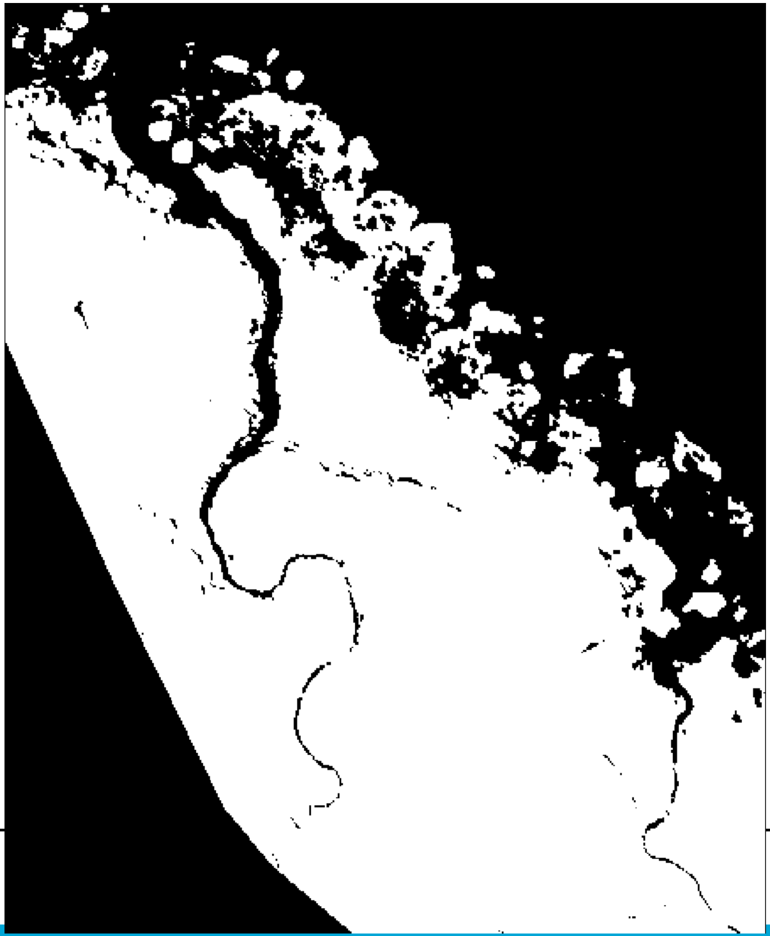
- Two-step process
  - Determine the presence of vegetation
  - Generate possible points

- It is possible to combine the different data sources
  - Point data and maps

Point generation (1/2)

- First, where is vegetation growing?





Point generation (2/2)

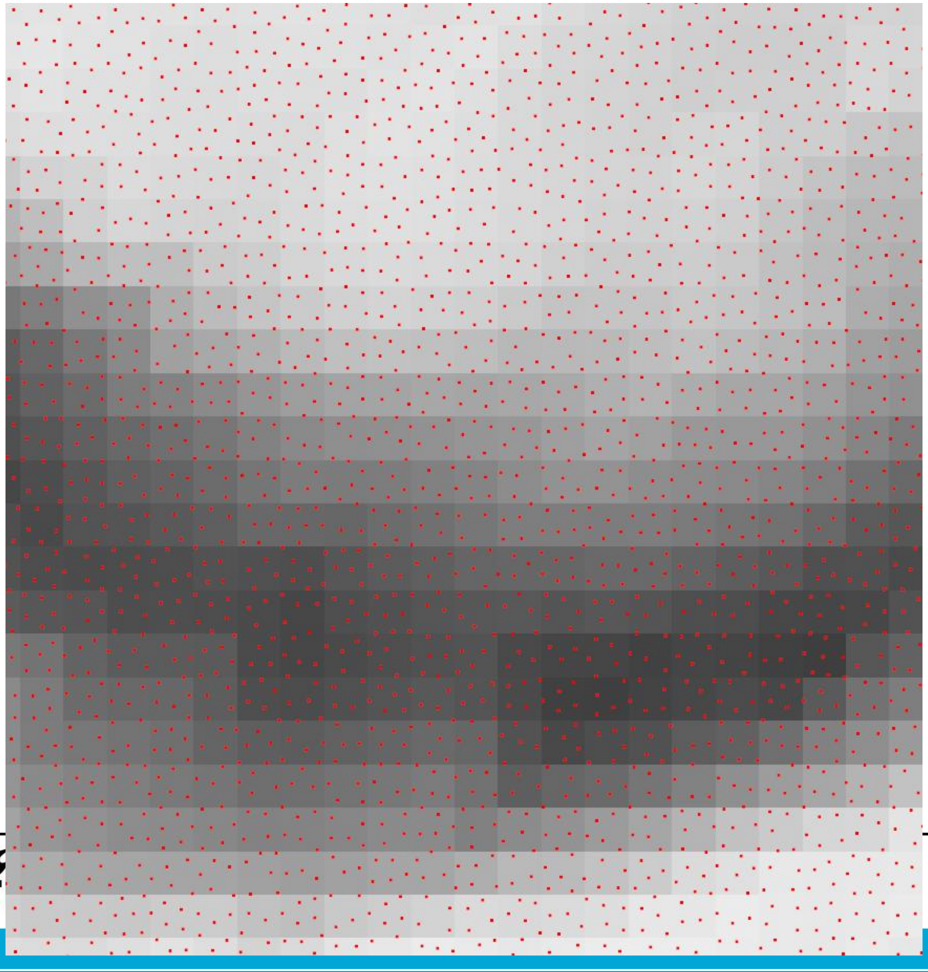
- Poisson Disk Distribution with Wang Tiling
  - Generate points efficiently with a minimal distance to each other
- Possible plant locations

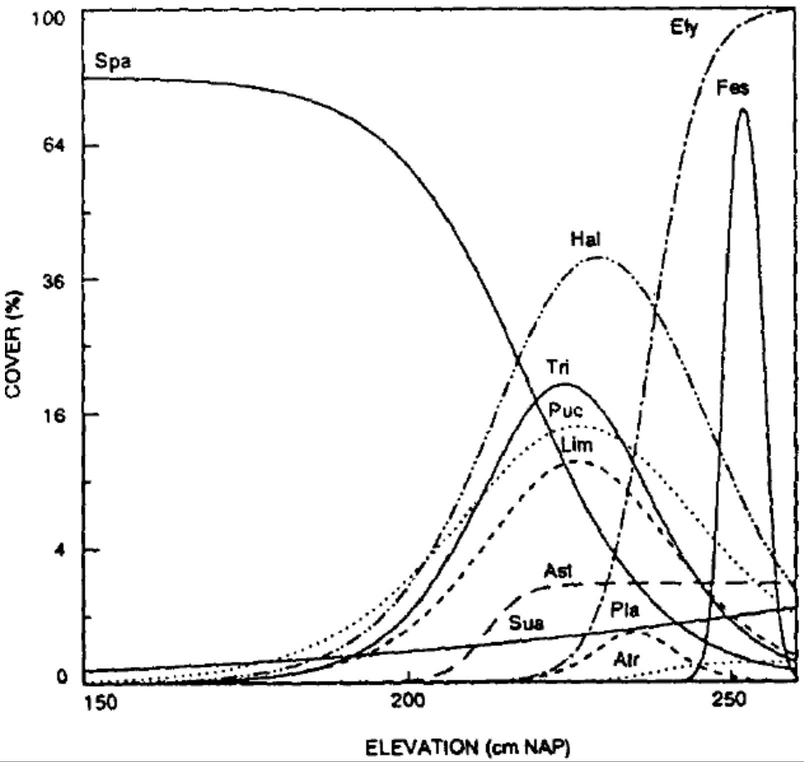
Point classification

- Now we have a large point set with no information about their plant types.
- Use the composition and shape metric data.
- Three-step process:
  - Connect composition/shape metric data to each point
  - Transform shape metric data to fractal values
  - Classify points using composition data and fractal values

Point classification (1/3): Connect composition and shape metric data

- Combination of different sources is possible by taking minimum value

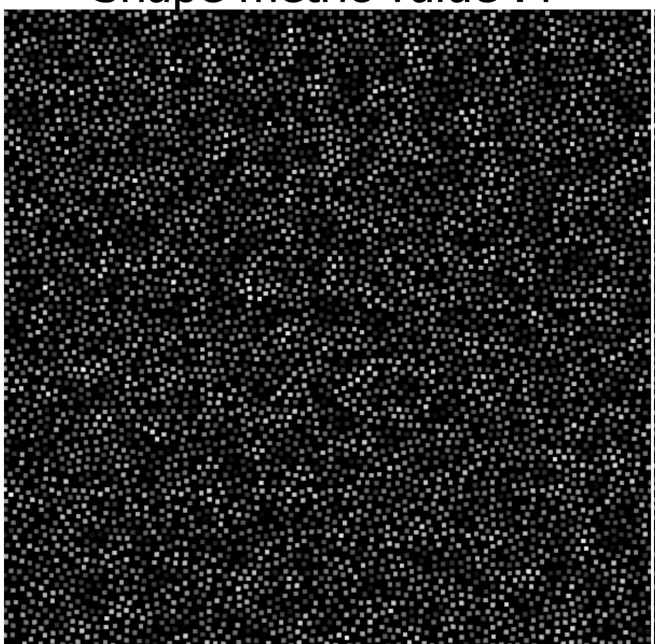




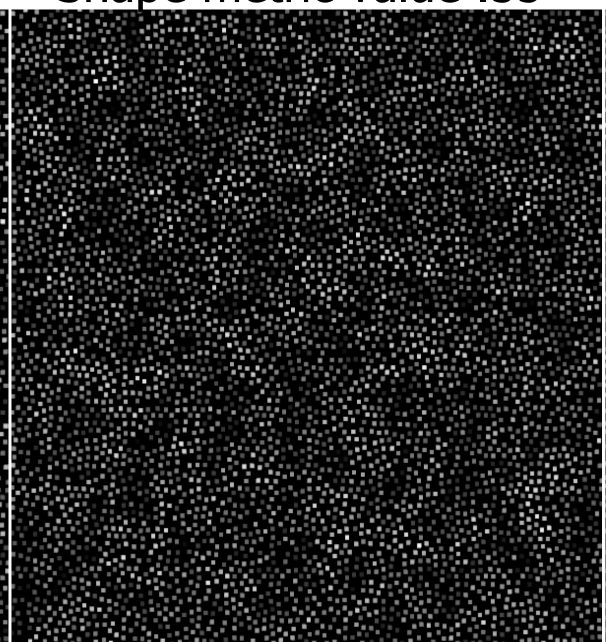
Point classification (2/3): Fractals

- Shape metrics are transformed to fractals
- Fractals are able to represent different kinds of patterns for plants
  - Plant patterns are fractal in nature

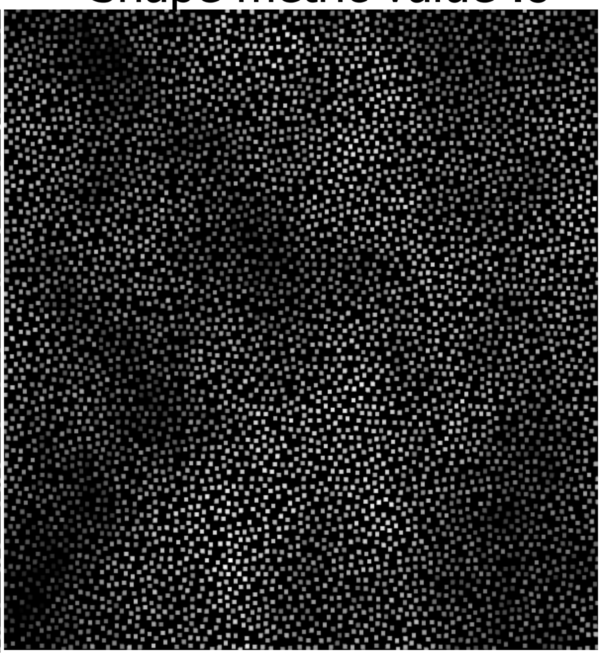
Shape metric value .4



Shape metric value .55



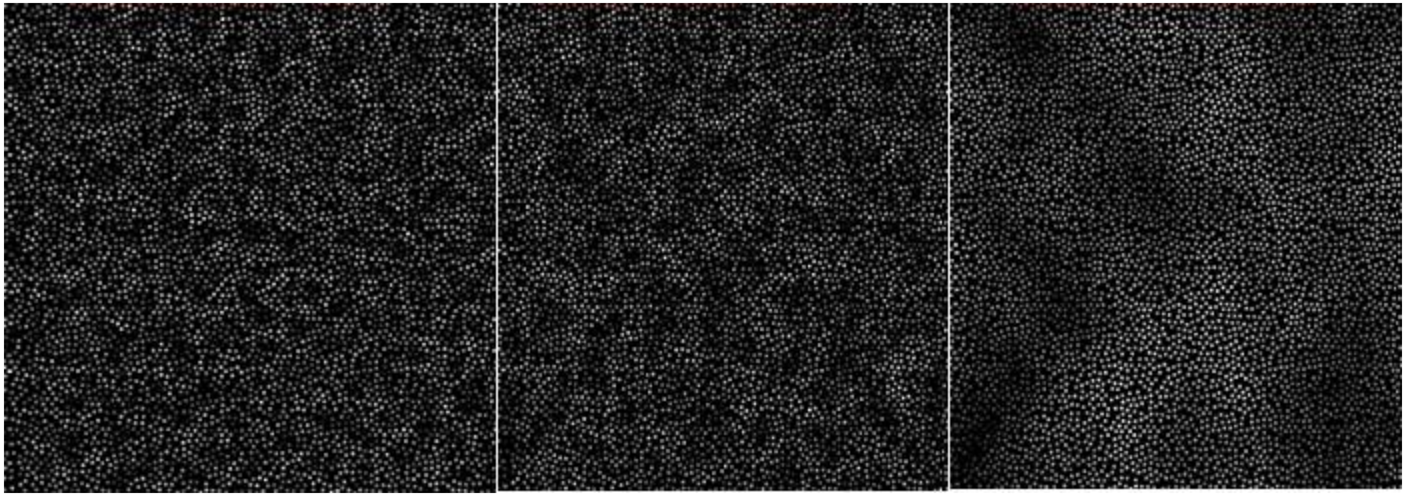
Shape metric value .8



Point classification (3/3): Classification process

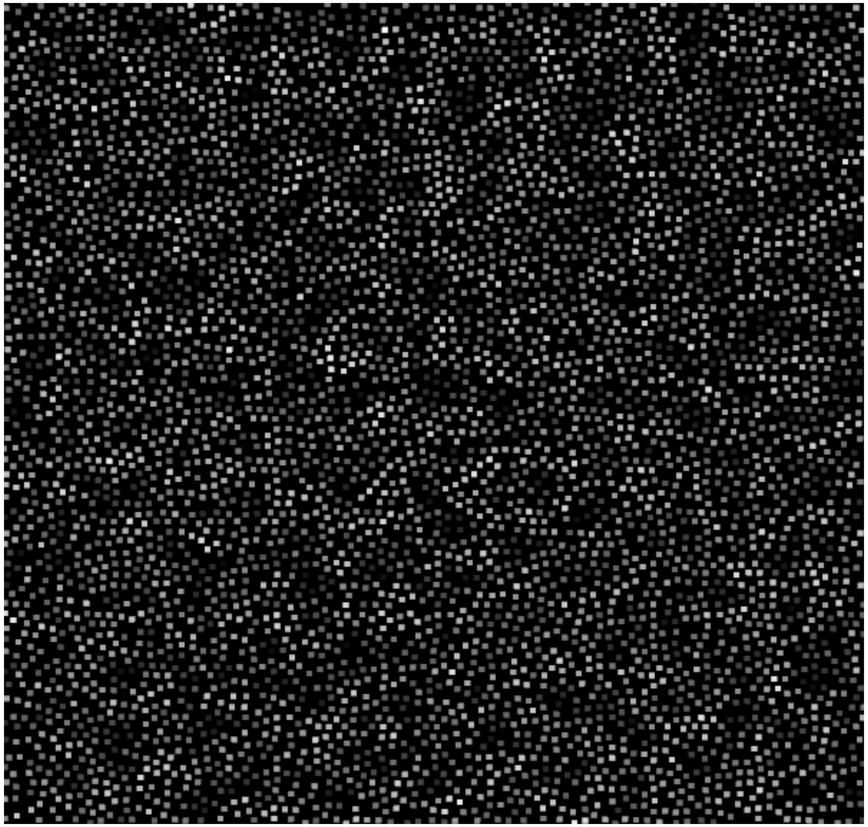
- How can we generate plant types for each point with this data?

- Demonstrated with example containing three plant types
  - Coverage A: 40%, coverage B: 50%, coverage C: 10%



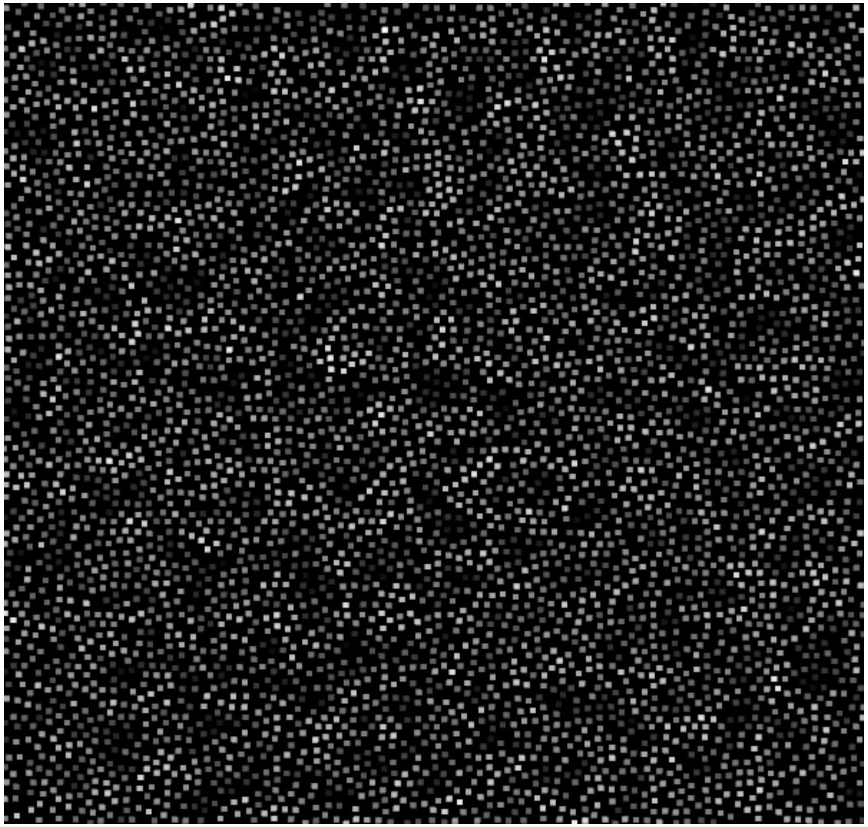
Step 1: plant type A

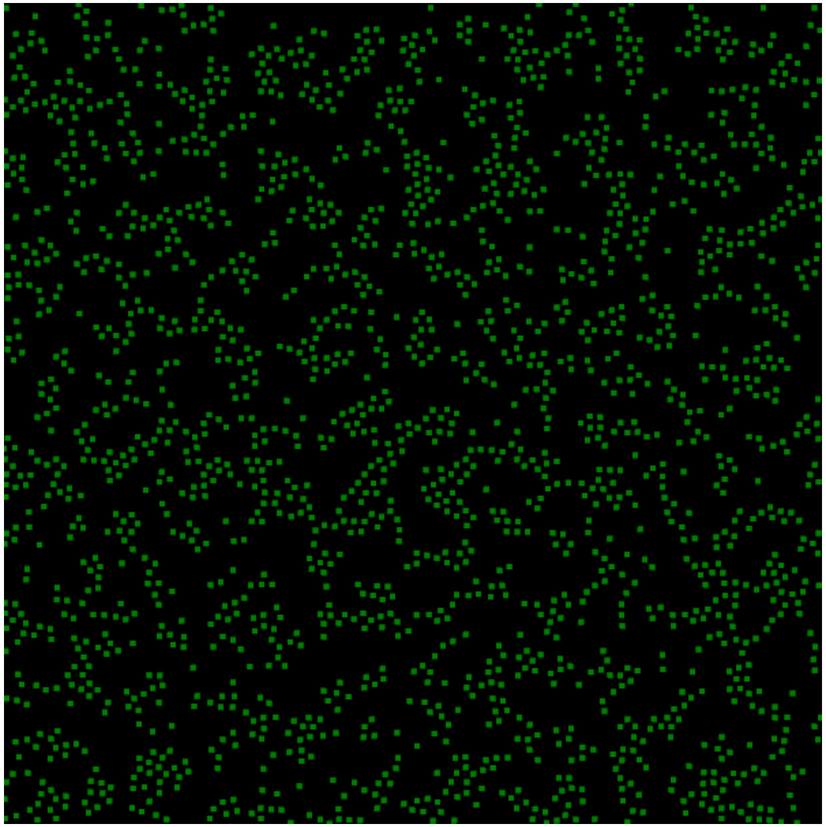
- 40% coverage



Step 1: plant type A

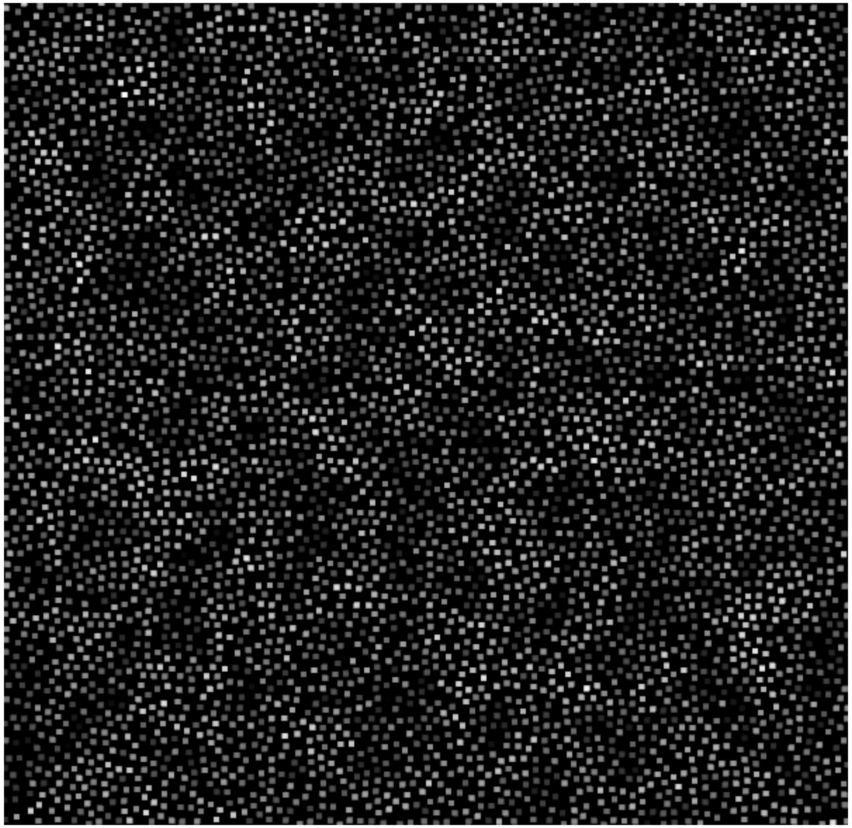
- 40% coverage





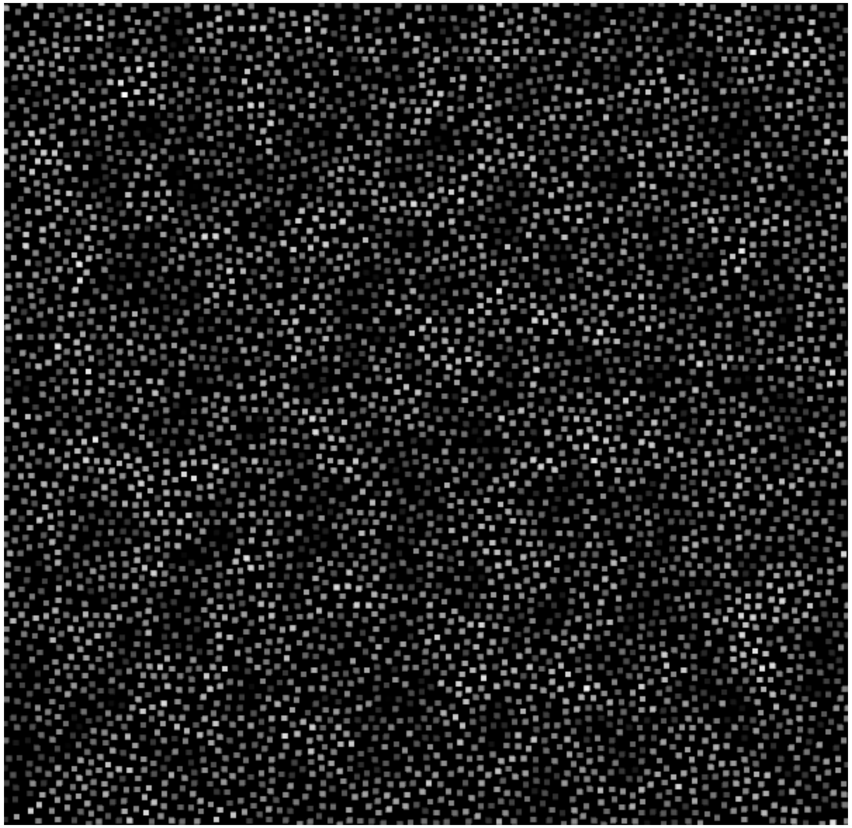
Step 1: plant type B

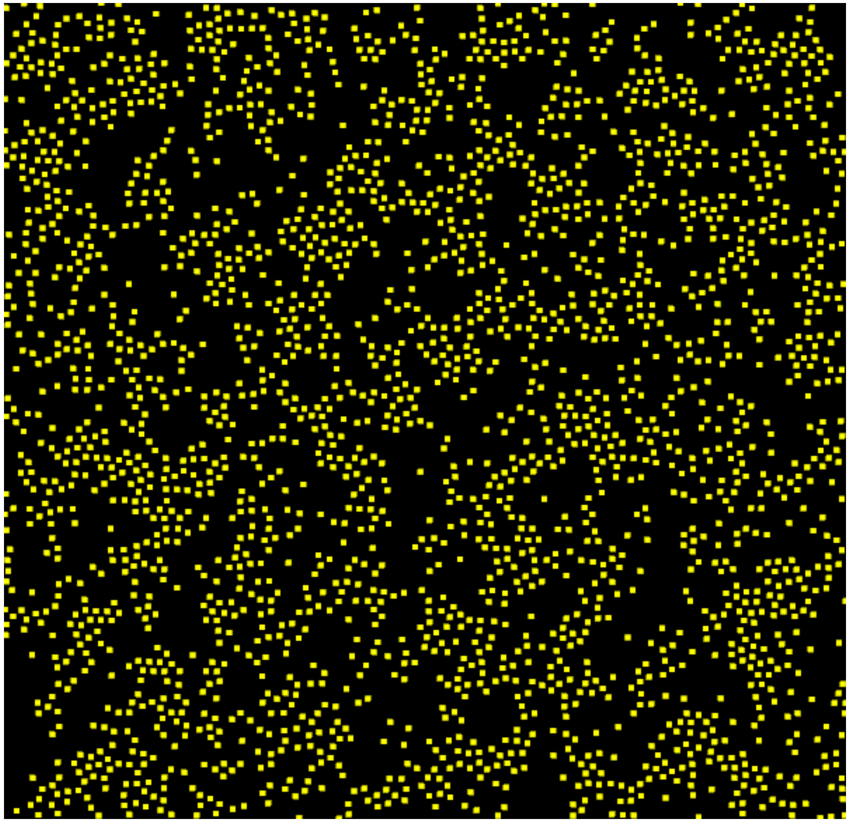
- 50% coverage



Step 1: plant type B

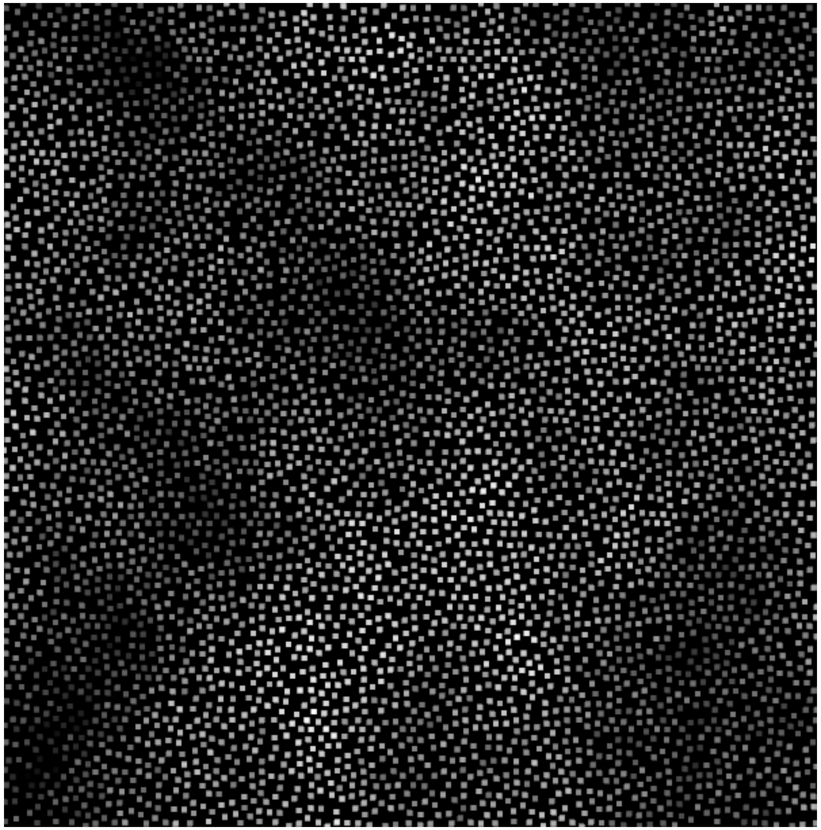
- 50% coverage





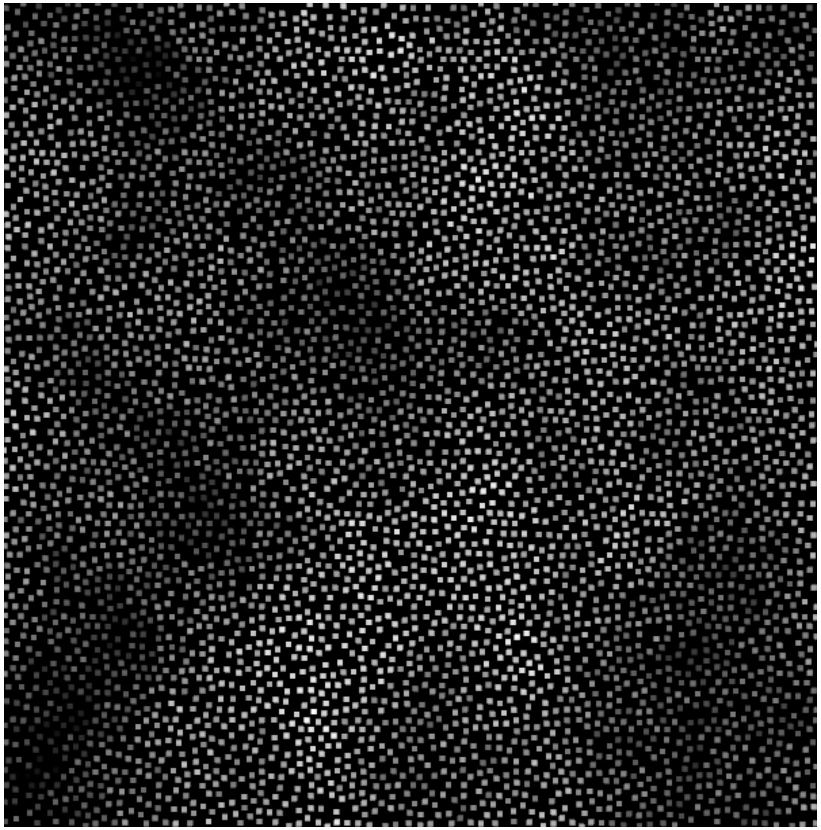
Step 1: plant type C

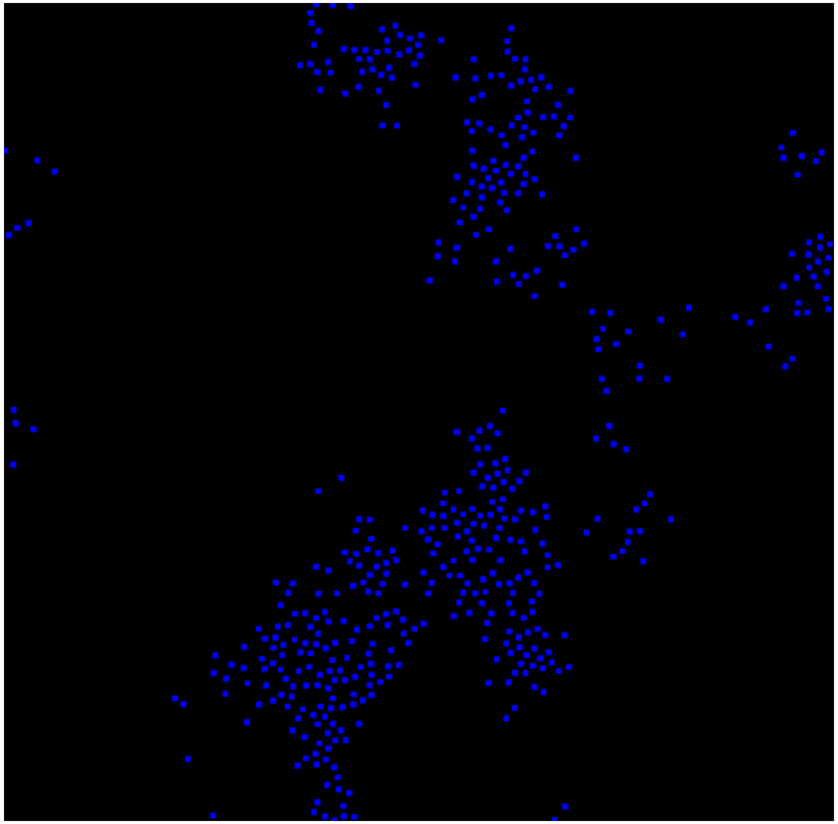
- 10% coverage



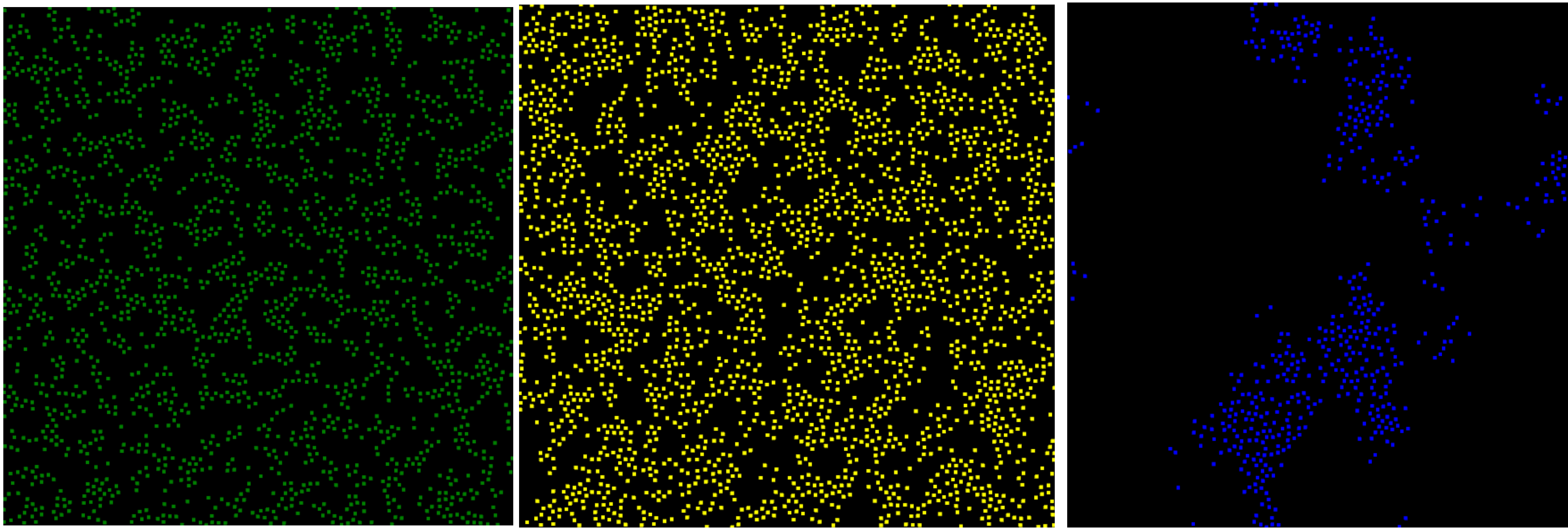
Step 1: plant type C

- 10% coverage

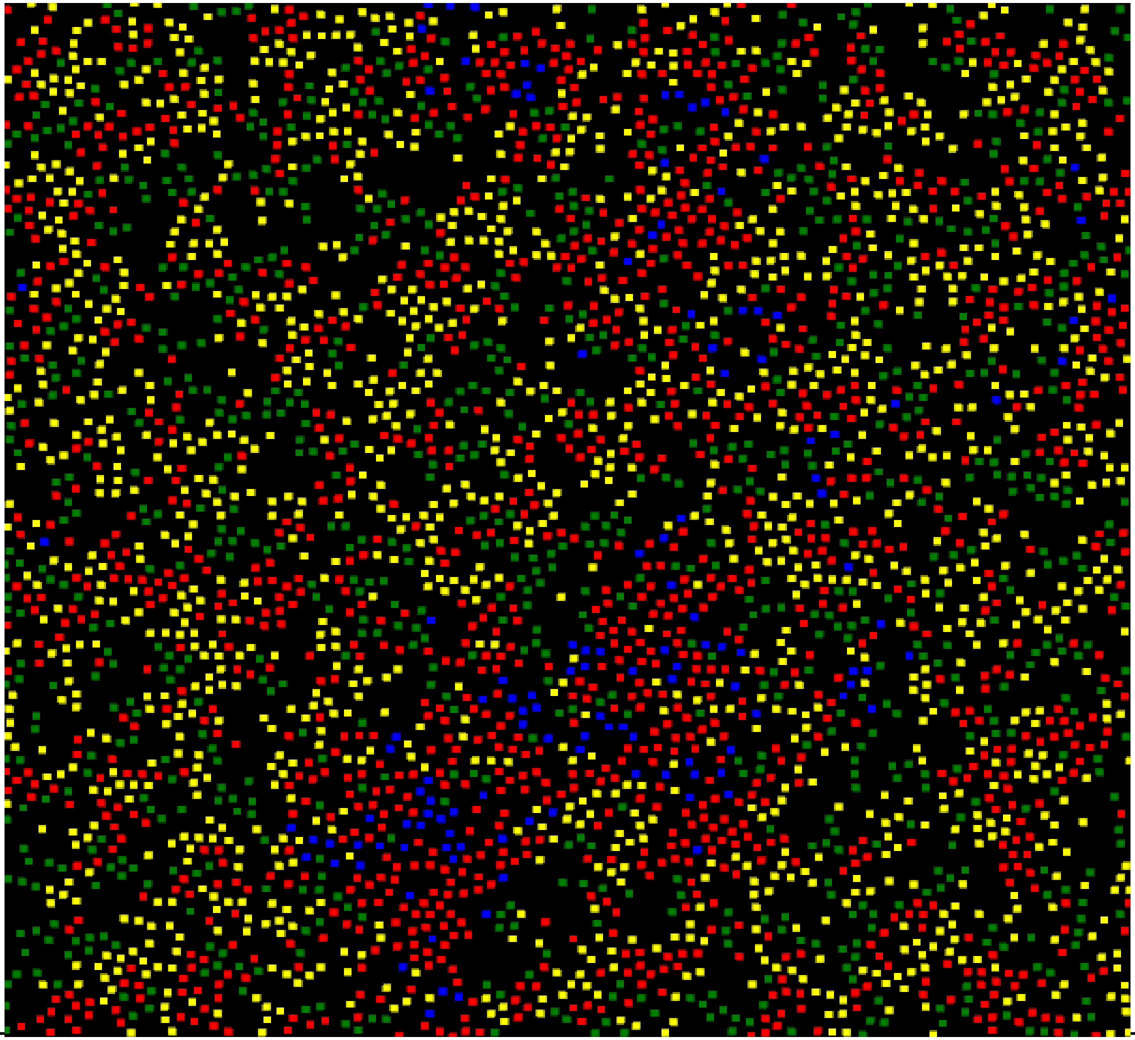




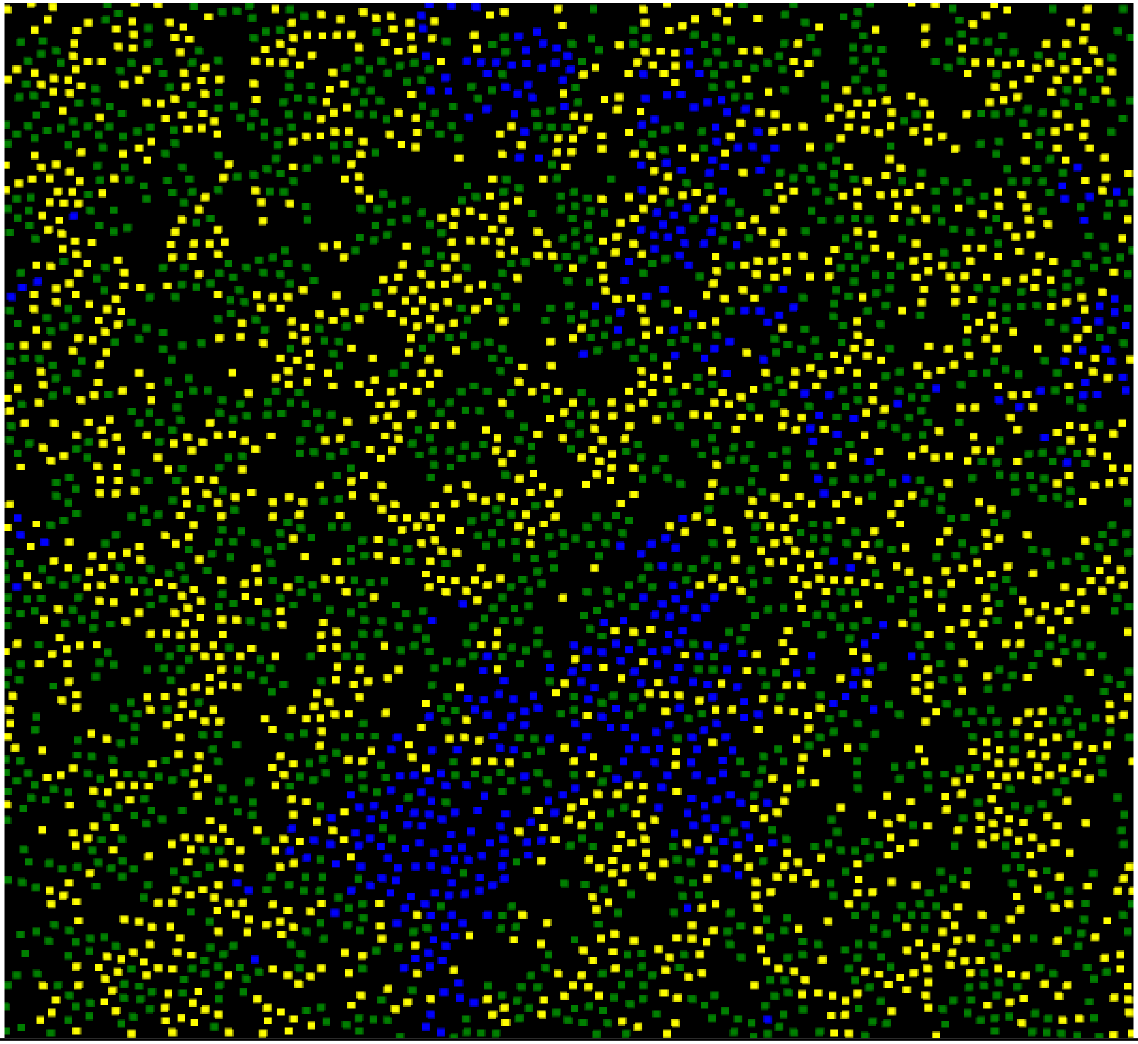
Step 1: Overlaps



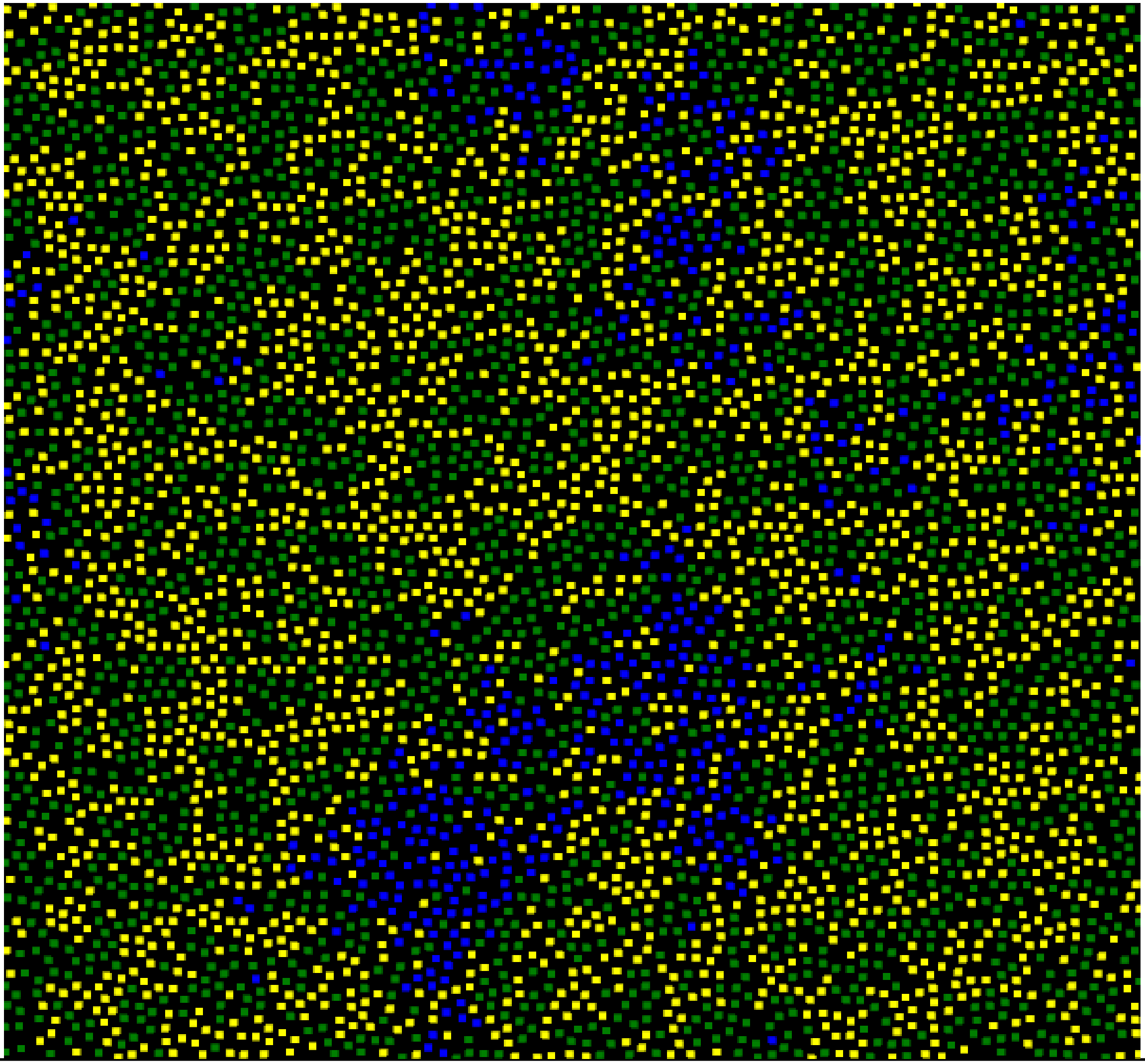
Step 2: Conflicts



Step 3: Solve conflicts



Step 4: Fill in remaining points



Extensions

- Existing point data
- Different plant sizes (groundcover plants vs trees)
- Non-static coverage
- Non-static shape metrices

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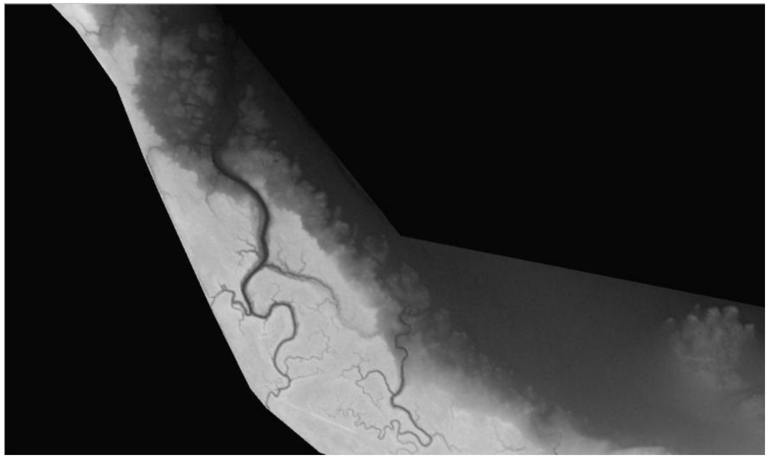
Tests and validation

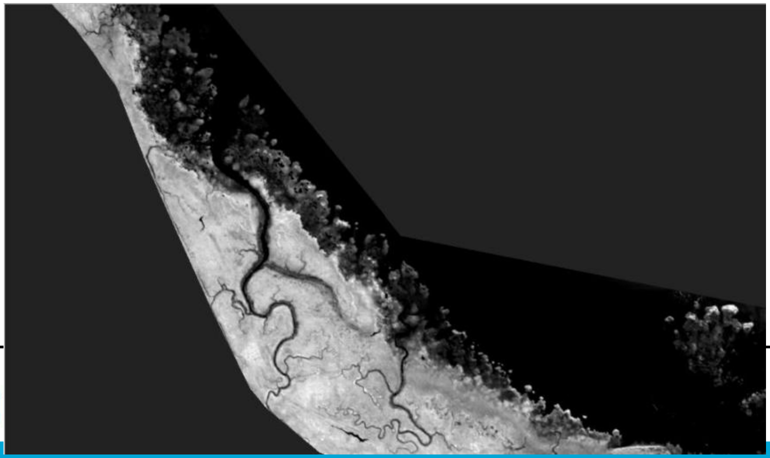
- Salt marshes
  - Two areas: Existing and future area
  - Three cases

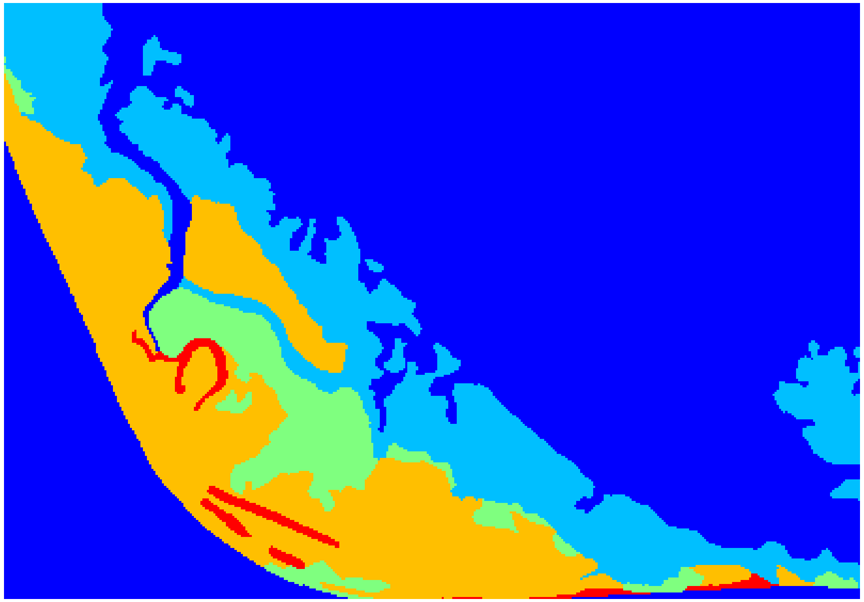
- Validation by expert and statistics

Existing area: Paulinapolder

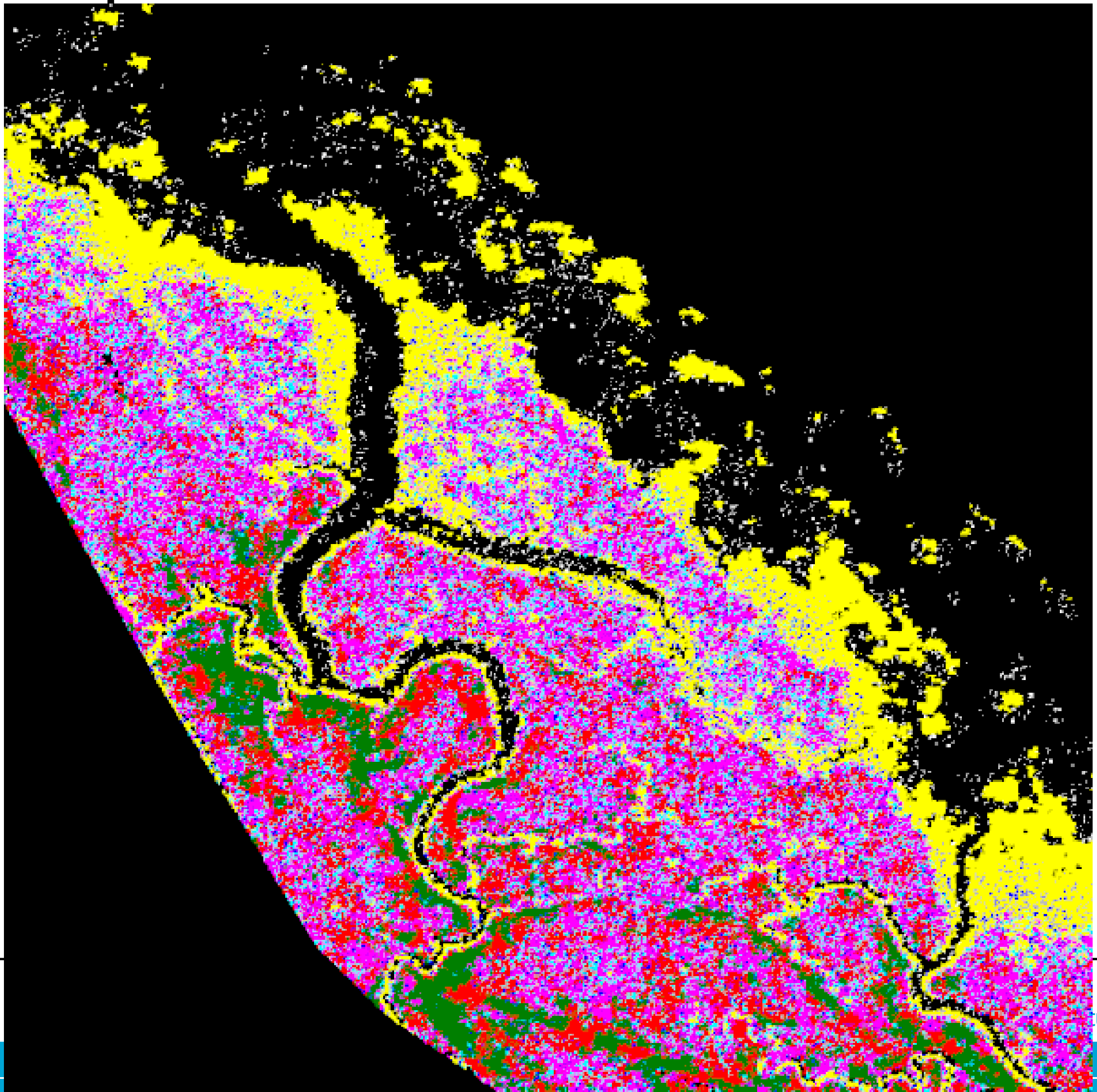
- Two cases: with and without Land Cover Classification data (LCC)



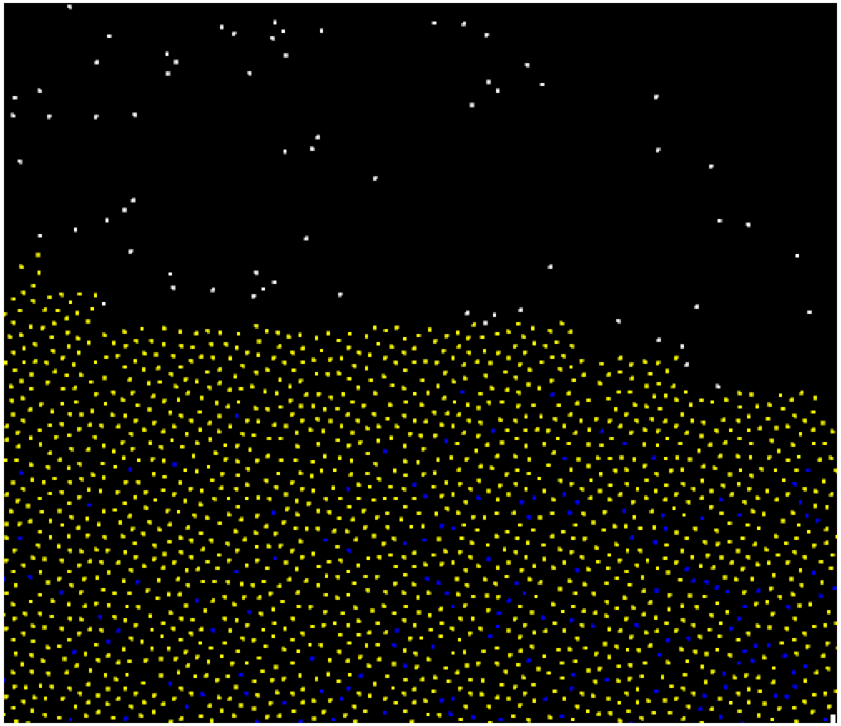




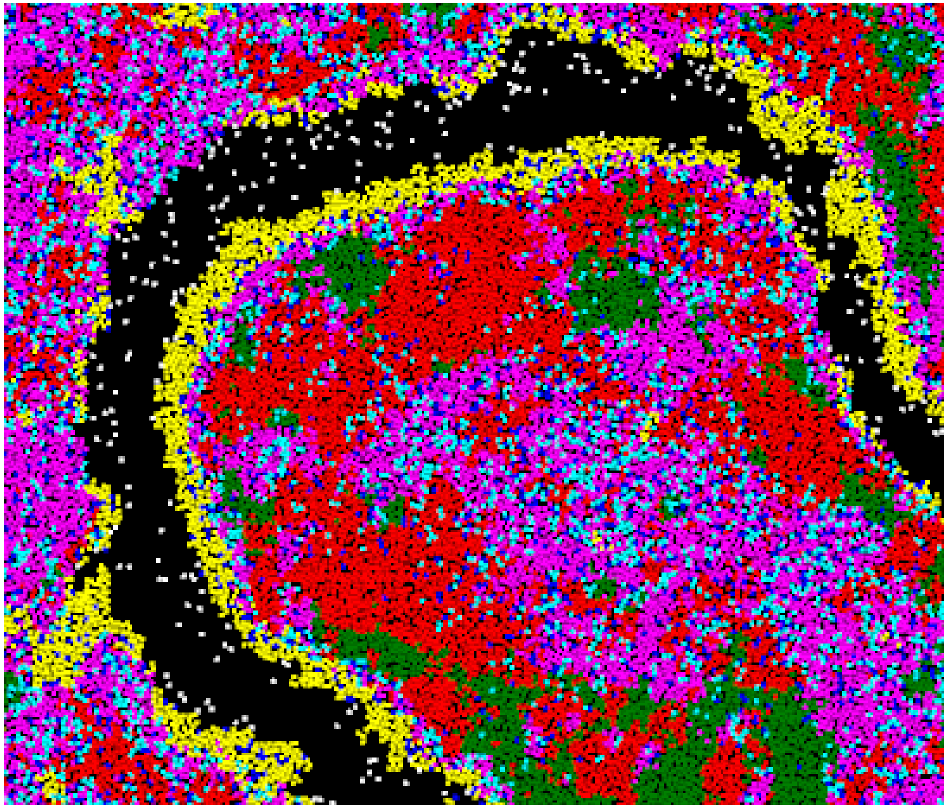
Paulinapolder without LCC data

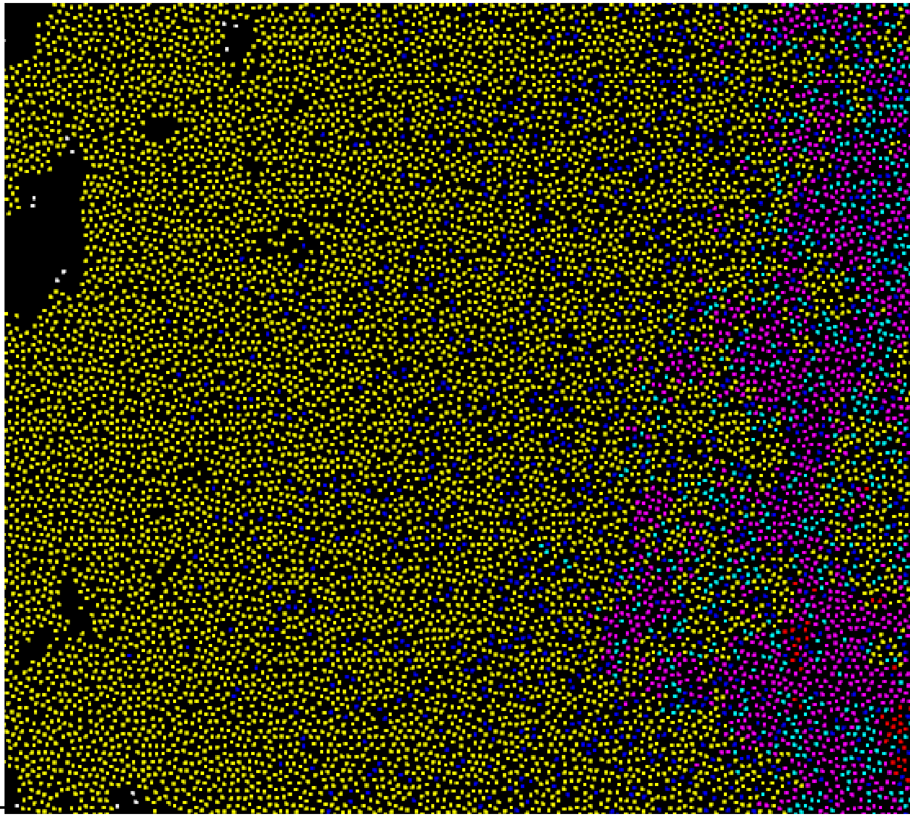


Validation by expert: Good

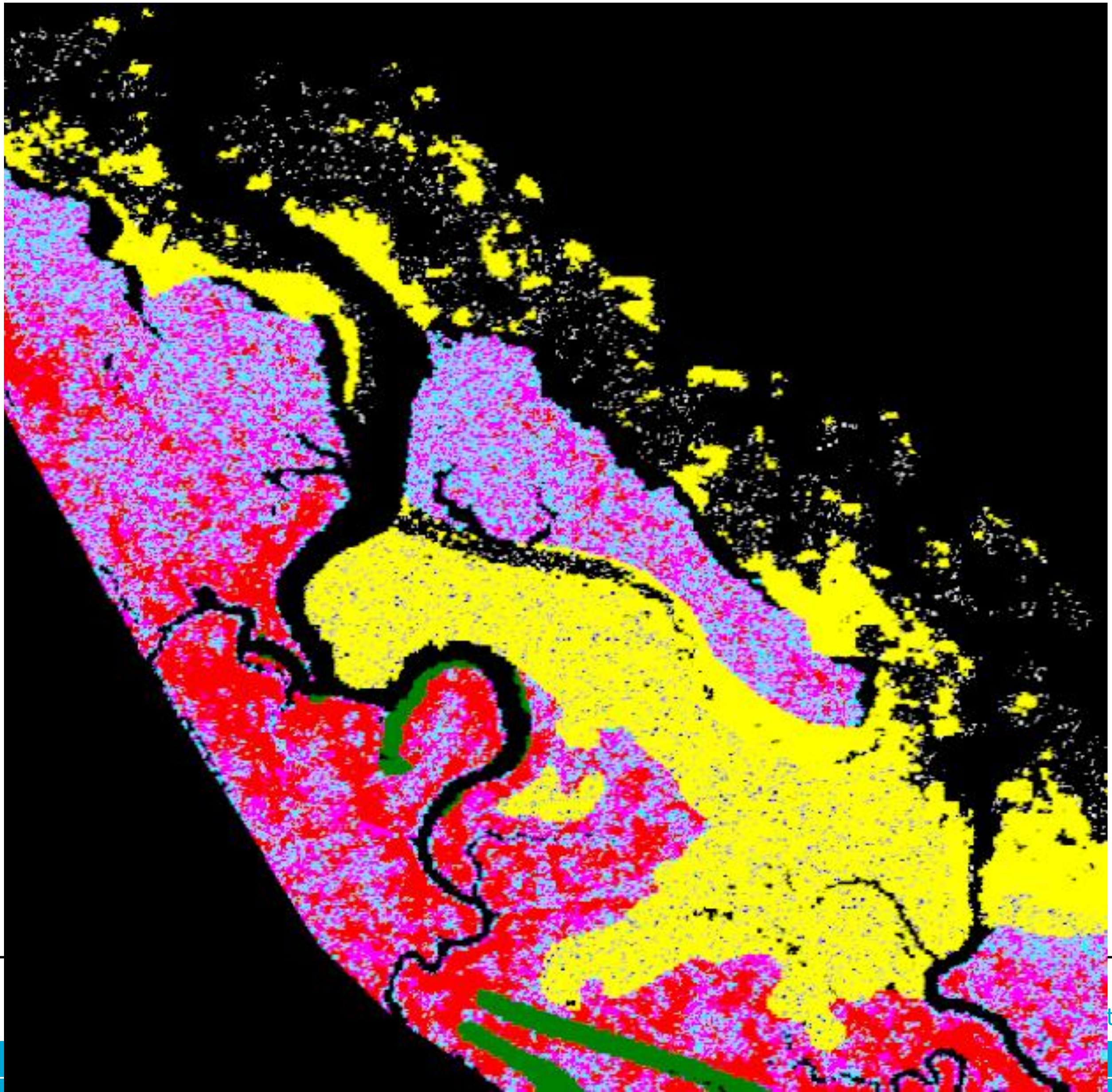


Validation by expert: Bad

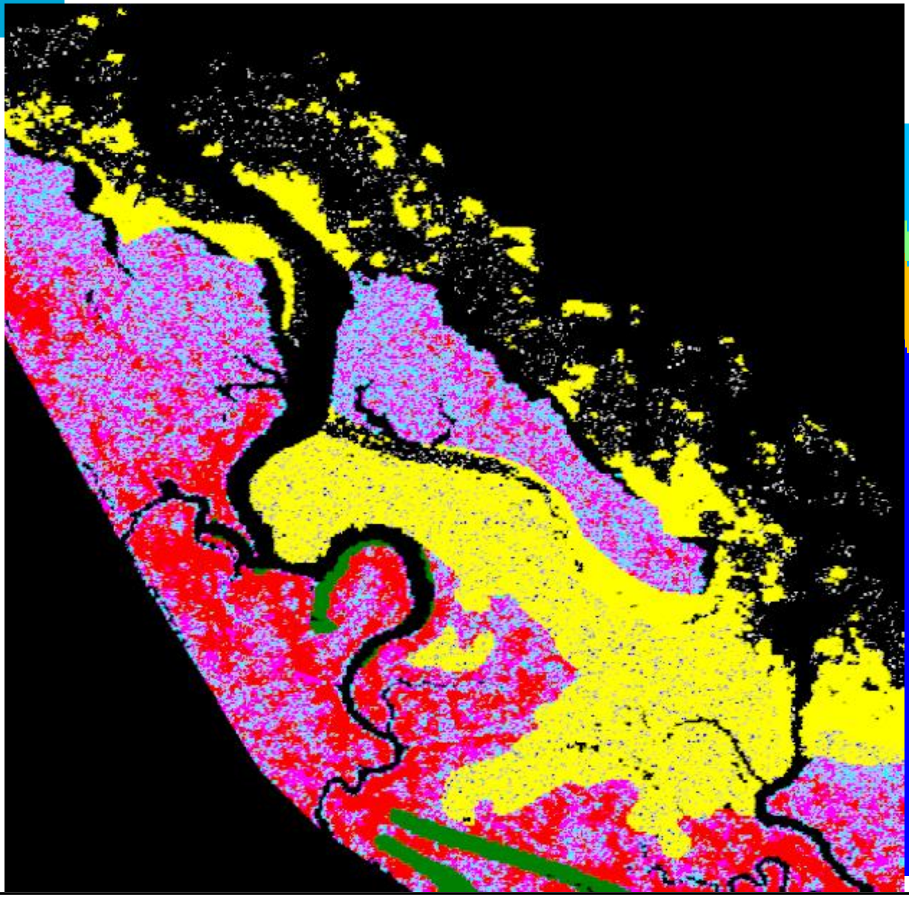


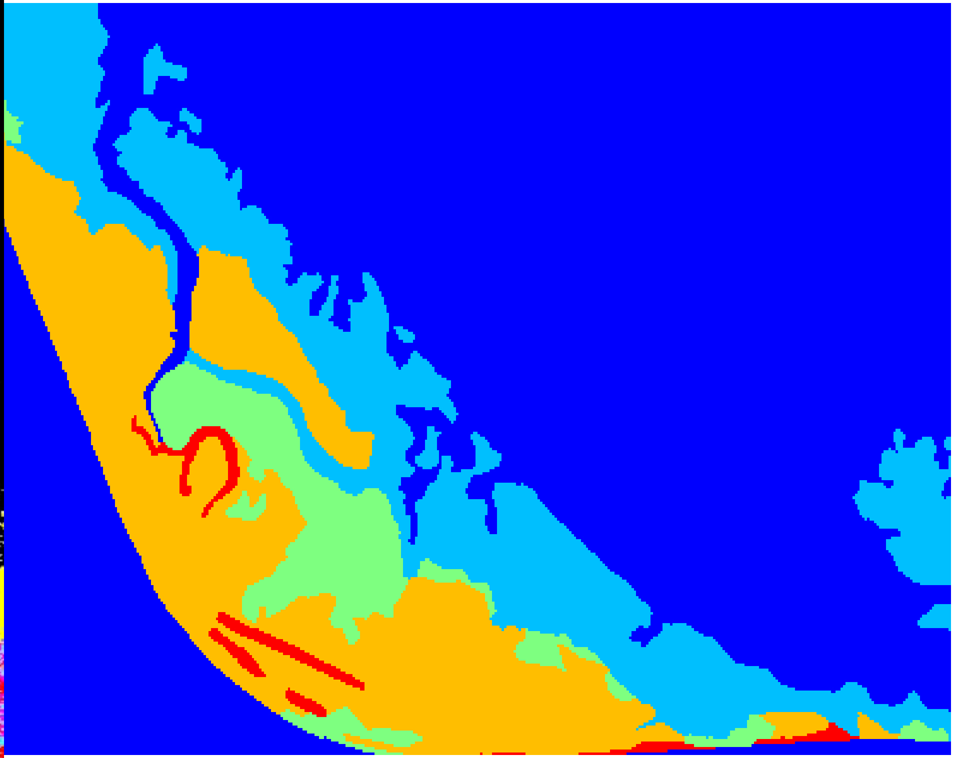


Paulinapolder with LCC data



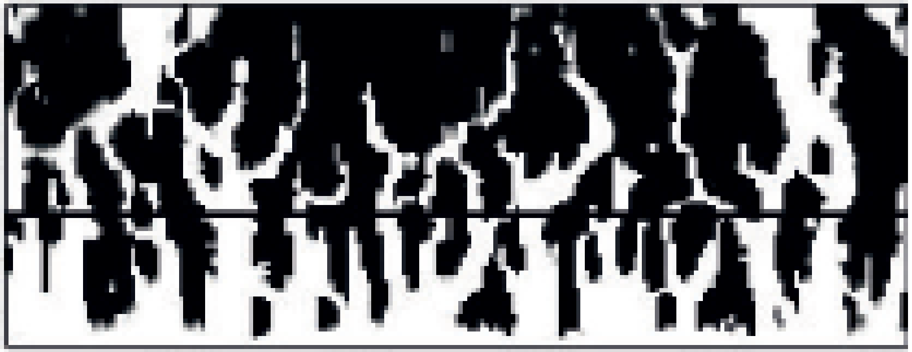
Validation: LCC



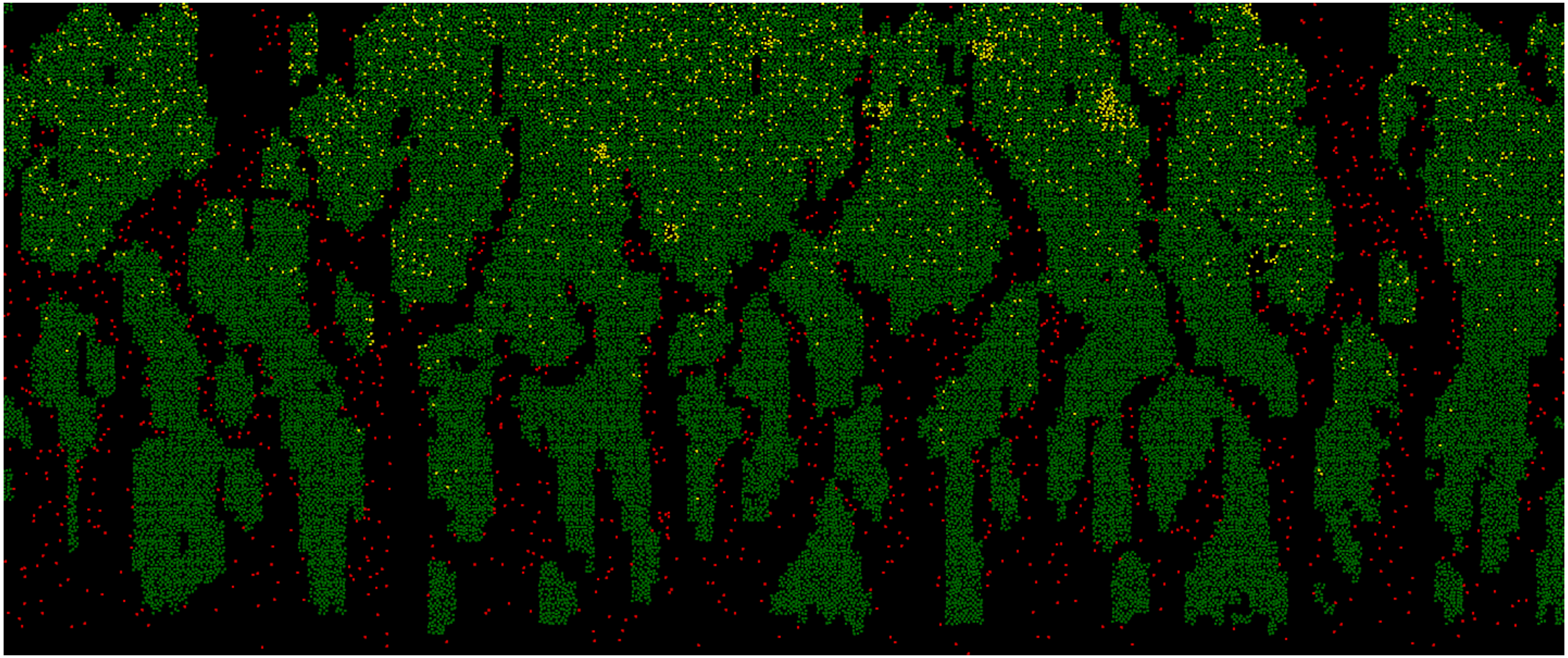


Future area: ecological model-based marsh

- Coverage map only used to determine where vegetation grows
- Compositions based on height statistics



Ecological model-based salt marsh result



Overview of the validation

- Paulinapolder without LCC data → Realistic
- Paulinapolder with LCC data → Not realistic
- Ecological model-based → Realistic

- Also performed statistical validation → correct

- Additional data is required for certain plant types

- LCC data requires additional processing

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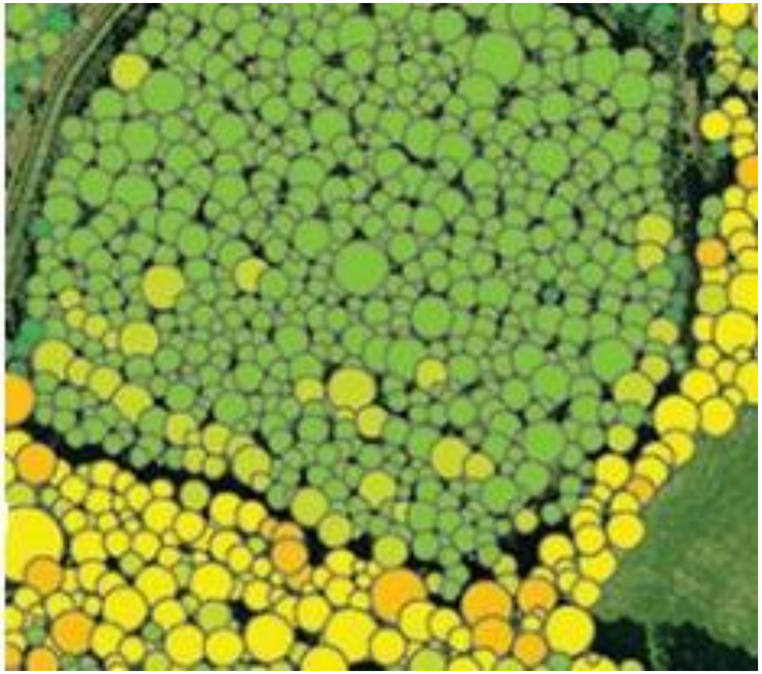
Conclusions

- Experiments have shown that this method is able to generate realistic plant distribution for small plants and future areas
- Method is not limited to a certain set of spatial data or areas
- Correctly maps spatial data
- Method does not replace current geo-related plant detection techniques, because the results of these techniques can be used input for the algorithm

Future work

- Tests using different environments
- Improvements in the algorithm
- Test with detection techniques
- 3D visualization (in-progress)
  - Demo



Thank you for your attention!